HELLENIC OPEN UNIVERSITY

School of Social Sciences

Master in Business Administration (MBA)

Postgraduate Dissertation

"Strategic Management in the Age of Artificial Intelligence: Integrating AI Solutions to Enhance Maritime Business Practices and Improve Strategic Decision-Making Processes"

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Supervisor: Anastasia Konstantelou

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Abstract

The shipping industry is one of the most dynamic sectors of the global economy and thus strategic management is a critical function for the growth of shipping organizations. This thesis aims to analyze how AI impacts strategic management practices in the shipping industry. More specifically, the Dissertation explains how AI contributes to enhancing strategic decision-making processes and improving the effectiveness of strategic management in the maritime industry. In addition, the Dissertation discusses issues of ethical uses of AI, when it is used to maritime strategic practices. Besides the Dissertation identifies the factors, that contribute to the successful integration of AI into the strategic and operational processes of maritime organizations. Finally, the Dissertation identifies the main challenges, that shipping companies face, when adopting AI at the strategic level.

To achieve the research objectives and answer the research questions, a literature review and systematic synthesis of sources were conducted. The review includes research studies published between 2019 and 2025. The literature search was conducted using the Scopus, ScienceDirect and Google Scholar databases, using relevant keywords and Boolean operators as well as specific thematic phrases.

Concerning the role of AI on improving decision-making and strategic management effectiveness in the maritime industry it was identified four business areas, that AI can effectively contribute: the port operations, the fuel consumption, the vehicle and route planning and the sustainable shipping. Concerning the issues of ethical use, it was found that transparency, accountability, data protection and trust are key elements on which technological innovation can be built. However, the Dissertation illustrated that the lack of transparency in AI systems is one of the most important concerns related to their use in strategic management. In addition, the findings shown, that the successful integration of AI in the maritime sector, depends on organizations' ability to align with international and European ethical governance principles. Furthermore, based on the strategic management literature it was revealed that the factors, which contribute to the successful integration of AI into the strategic processes of maritime organizations, are: the organizational knowledge management systems and the effective leadership. Finally, concerning the challenges, that shipping companies face, when adopting AI at the strategic level, the Dissertation identified two main areas of challenges: technological challenges and challenges related to organizational resistance. Concerning the organizational resistance, it is associated with employee attitudes toward change, organizational culture and trust in technology. At the same time, the lack of digital skills is another significant barrier. Therefore, organizations, that do not invest in employees' training to enhance their skills, face many difficulties when integrating AI into their strategic processes. Consequently, it is concluded that the successful integration of AI, requires the development of training programs.

Keywords: Strategic Management, Artificial Intelligent (AI), Maritime Industry, Decision-Making

Περίληψη

Η ναυτιλιακή βιομηχανία είναι ένας από τους πιο δυναμικούς τομείς της παγκόσμιας οικονομίας και ως εκ τούτου το στρατηγικό management αποτελεί κρίσιμη λειτουργία για την ανάπτυξη των επιχειρήσεων του κλάδου. Η παρούσα Διπλωματική στοχεύει στην ανάλυση του τρόπου με τον οποίο η Τεχνητή Νοημοσύνη (ΤΝ) επηρεάζει τη στρατηγική λήψη αποφάσεων στη συγκεκριμένη βιομηχανία. Αναλυτικότερα, η Διπλωματική εξηγεί πώς η ΤΝ συμβάλλει στην ενίσχυση των διαδικασιών λήψης αποφάσεων και στη βελτίωση της αποτελεσματικότητας της στρατηγικής διαχείρισης στη ναυτιλιακή βιομηχανία. Επιπλέον, η Διπλωματική συζητά ζητήματα ηθικής χρήσης της ΤΝ κατά την εφαρμογή της στο στρατηγικό management των ναυτιλιακών επιχειρήσεων. Παράλληλα, προσδιορίζονται οι παράγοντες, που συμβάλλουν στην επιτυχή ενσωμάτωση της ΤΝ, στις στρατηγικές διαδικασίες των ναυτιλιακών επιχειρήσεων. Τέλος, στο πλαίσιο της Διπλωματικής εντοπίζονται οι κύριες προκλήσεις, που αντιμετωπίζουν οι ναυτιλιακές εταιρείες, κατά την υιοθέτηση της ΤΝ σε στρατηγικό επίπεδο λήψης αποφάσεων. Για να επιτευχθούν οι ερευνητικοί στόχοι και να απαντηθούν τα ερευνητικά ερωτήματα, πραγματοποιήθηκε βιβλιογραφική ανασκόπηση και συστηματική σύνθεση πηγών. Η ανασκόπηση περιλαμβάνει ερευνητικές μελέτες που έχουν δημοσιευθεί κατά την περίοδο 2019-2025. Η αναζήτηση της βιβλιογραφίας πραγματοποιήθηκε μέσω των βάσεων δεδομένων Scopus, Science Direct και Google Scholar, με τη χρήση σχετικών λέξεων-κλειδιών, λογικών τελεστών (Boolean operators) καθώς και εξειδικευμένων θεματικών φράσεων.

Όσον αφορά στο ρόλο της ΤΝ στη βελτίωση της λήψης αποφάσεων και της αποτελεσματικότητας της στρατηγικής διαχείρισης στη ναυτιλιακή βιομηχανία, προσδιορίστηκαν τέσσερις επιχειρηματικοί τομείς στους οποίους μπορεί να συμβάλει αποτελεσματικά: οι λιμενικές λειτουργίες, η κατανάλωση καυσίμων, ο σχεδιασμός οχημάτων και διαδρομών και η βιώσιμη ναυτιλία. Όσον αφορά στα ζητήματα ηθικής χρήσης, διαπιστώθηκε ότι η διαφάνεια, η λογοδοσία, η προστασία δεδομένων και η εμπιστοσύνη είναι οι κύριοι παράμετροι που σχετίζονται με την χρήση συστημάτων ΤΝ. Ωστόσο, η Διατριβή κατέδειξε ότι η έλλειψη διαφάνειας είναι μία από τις σημαντικότερες προκλήσεις για τη χρήση τους στο στρατηγικό management. Επιπλέον, τα ευρήματα έδειξαν ότι η επιτυχής ενσωμάτωση της ΤΝ στον ναυτιλιακό τομέα εξαρτάται από την ικανότητα των επιχειρήσεων να εφαρμόσουν τις διεθνείς και ευρωπαϊκές αρχές ηθικής διακυβέρνησης. Επιπλέον, με βάση τη βιβλιογραφία του στρατηγικού management διαπιστώθηκε ότι οι παράγοντες που συμβάλλουν στην επιτυχή ενσωμάτωση της ΤΝ στις στρατηγικές διαδικασίες των ναυτιλιακών οργανισμών είναι: τα συστήματα διαχείρισης οργανωσιακής γνώσης και η αποτελεσματική ηγεσία. Τέλος, όσον αφορά στις προκλήσεις, που αντιμετωπίζουν οι ναυτιλιακές εταιρείες κατά την υιοθέτηση της ΤΝ σε στρατηγικό επίπεδο, η Διατριβή εντόπισε δύο κύριους τομείς προκλήσεων: τις τεχνολογικές προκλήσεις και τις προκλήσεις που σχετίζονται με την οργανωσιακή αντίσταση. Όσον αφορά στην οργανωσιακή αντίσταση, αυτή συνδέεται με τη στάση των εργαζομένων απέναντι στην αλλαγή, στην οργανωσιακή κουλτούρα και στην εμπιστοσύνη απέναντι στην τεχνολογία. Ταυτόχρονα, η έλλειψη ψηφιακών δεξιοτήτων αποτελεί ένα άλλο σημαντικό εμπόδιο. Επομένως οι οργανισμοί, που δεν επενδύουν στην εκπαίδευση των εργαζομένων για την ενίσχυση των δεξιοτήτων τους, αντιμετωπίζουν πολλές δυσκολίες κατά την ενσωμάτωση της ΤΝ στις στρατηγικές τους διαδικασίες. Κατά συνέπεια, συμπεραίνεται ότι η επιτυχής ενσωμάτωση της ΤΝ απαιτεί την ανάπτυξη προγραμμάτων κατάρτισης από τις επιχειρήσεις του κλάδου.

Λέξεις – Κλειδιά: Στρατηγικό Management, Τεχνητή Νοημοσύνη (ΤΝ), Ναυτιλιακή Βιομηχανία, Λήψη Αποφάσεων

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List of Abbreviations & Acronyms

AI: Artificial Intelligence

ERP: Enterprise Resource Planning

ESG: Environmental Sustainability Goals

GDPR: General Data Protection Regulation

HR: Human Resources

IMO: International Maritime Organization

ISO: International Organization for Standardization

IoT: Internet of Things

ML: Machine Learning

SOLAS: International Convention for the Safety of Life at Sea

1. Introduction

1.1 Background of the study

The shipping industry is one of the most dynamic sectors of the global economy and it serves as the backbone of global commerce, facilitating the transport of more than 90% of international trade. As trade volumes expand the sector needs-+98 to evolve through strategic innovation (Ali, 2025). This is because companies operating in this industry have to manage a wide range of challenges, such managing port operations and fuel consumption as well as optimizing vehicle and route planning (Dihn et al., 2024, Dewi, 2026, Kozerska, 2025). Considering these challenges, the examination of the maritime industry's capabilities regarding the implementation of Artificial Intelligence (AI) in strategic management has attracted scholars' interest. This is because in this environment, strategic management is essential for the expansion of shipping organizations, as it enables them to adapt effectively to changing conditions.

Strategic management refers to the process of defining an organization's mission, establishing objectives in response to internal and external environmental factors, developing appropriate policies and strategic actions to achieve these goals, and ensuring their effective implementation in order to accomplish the organization's fundamental purposes and objectives. (David & David, 2017). Within the shipping industry, strategic decision-making involves managing operational risks and ensuring compliance with international regulations and legal frameworks (Cullinane & Bergqvist, 2014, Lorange, 2009).

According to Hossain (2025) the maritime industry is currently undergoing a significant transformation driven by AI, which has emerged as a disruptive and transformative technology. This technological shift encompasses a wide range of applications, including route optimization and autonomous vessel operations. Furthermore, AI supports real-time monitoring and vessel performance management as well as the risk assessment and mitigation processes (Hossain, 2025). Accordingly, Russell and Norvig (2021) contended that the advancement of AI has started to substantially influence how organizations formulate and execute their strategies. A widely used definition of AI describes it as a technology that enables machines to replicate complex human abilities such as perception, goal-directed behaviour, action initiation, and learning through feedback mechanisms (Russell & Norvig, 2021). Historically AI was originally established as a subfield of computer science but today, this technology is used in many fields, especially in business. Munim et al. (2020) as Hossain (2025) stated that technological advancements in Big Data and AI are currently driving a transformation within the maritime sector. Specifically, as Munim et al. (2020) explain, these technologies are essential for maximizing operational metrics including safety and financial performance (Munim et al., 2021).

Other researchers such as Durlik et al. (2024) argue that AI solutions is a critical mechanism for emissions reduction in the maritime sector by facilitating fuel optimization. As Durlik et al. (2024) explain conventional fuel management systems, which typically rely on manual monitoring, are associated with excessive consumption. In contrast, AI algorithms provide an alternative solution by synthesizing data such as meteorological conditions and other parameters to determine optimal routing. For instance, as Durlik et al. (2024) illustrate AI systems can adjust vessel speed to optimize fuel efficiency.

Within this context, the maritime industry is characterized by a fundamental technological shift and therefore Ichimura et al. (2022) argue that there is a need for systematic change in organizational structures. While, other researchers (Cohen & Kietzmann, 2015, Kirkpatrick, 2020) are discussing the need of effective leadership models.

In addition, it is imperative for maritime organizations to consider issues of ethical use of AI systems, which necessitates the adoption of corporate governance frameworks. For instance, Islam (2024) and Johansson et al. (2021) explain that as the maritime sector moves toward full autonomy several ethical issues emerge, such as data privacy and issues related to bias, fairness, transparency, accountability.

1.2 Research Aim, Objectives and Questions

This thesis aims to analyze how AI impacts strategic management practices in the shipping industry. More specifically, the main **objectives of the research** are outlined below:

- To explain how artificial intelligence contributes to enhancing decision-making processes and improving the effectiveness of strategic management in the maritime industry.
- To discuss how ethical use, transparency and data protection can be ensured, when applying AI to maritime strategic practices.

- To identify the factors, that contribute to the successful integration of AI into the strategic and operational processes of maritime organizations.
- To identify the main challenges, that shipping companies face, when adopting AI at the strategic level.

The main research questions are the following:

- How does artificial intelligence contribute to improving decision-making and strategic management effectiveness in the maritime industry?
- How can ethical use, transparency and data protection be ensured when applying AI to maritime strategic practices?
- What are the factors that contribute to the successful integration of AI into the strategic and operational processes of maritime organizations?
- What are the challenges, that shipping companies face, when adopting AI at the strategic level?

1.3 Research Methodology

To achieve the research objectives and answer the research questions, a literature review and systematic synthesis of sources were conducted. According to Li and Wang (2018) due to its importance, literature review has increasingly been recognized as a research method in its own right. In addition, as Li and Wang (2018) argue before conducting a new study, the researcher must identify a research gap by examining what has already been explored by previous researchers in a specific research area. Thus an initial review of the existing literature conducted to examine the current body of knowledge in the field and identify a research gap.

Based on this initial review, I identified that recent studies highlight that the maritime industry is undergoing a significant transformation driven by AI. However, existing studies tend to focus on isolated dimensions of AI application, as I analyze in section 1.1. This fragmentation indicates a lack of integrated research that simultaneously examines AI's contribution to strategic decision-making, related ethical issues and potential barriers to its' implementation.

Consequently, the identified research gap guided the subsequent selection of relevant literature. The selection process was designed to ensure that only studies directly addressing the role of AI in strategic management within the maritime industry were included. However, the review also included studies that did not focus exclusively on maritime applications. Specifically, due to limited focus of maritime literature on successful integration of AI into the strategic processes, chapter 4 is primarily informed by studies belong to the broader field of strategic management literature.

The literature review conducted in this thesis follows a systematic approach, as the search, selection, and analysis of sources were based on predefined inclusion and exclusion criteria. Specifically, the review primarily included research studies published between 2019 and 2025, as this period reflects recent developments regarding the integration of AI into strategic management practices in the maritime industry. However, in certain cases, older studies were also included due to their significant theoretical contribution to the understanding of key the topic. Exclusion criteria included: a) studies that were not related to AI applications in strategic or operational management and b) publications outside the selected time frame.

The literature search was conducted using the Scopus, ScienceDirect and Google Scholar databases, using relevant keywords and Boolean operators including AI AND strategic management AND maritime industry, AI ethics AND maritime industry, maritime industry AND technological challenges related to AI. Additionally, more specific thematic phrases were used to identify studies addressing particular dimensions of AI integration in maritime operations, including *"The Strategic Role of AI in Port Operations", "AI Applications in Maritime Fuel Efficiency and Operational Sustainability", "Optimization of Route Planning AND AI",* and *"AI Contribution in Sustainable Shipping and Decarbonization Targets"*.

1.4 Structure of the Dissertation

This Dissertation consists of five chapters. Chapter one presents an introduction to the topic, analyzing the background of the study, the research objectives and questions and the methodological approach. Chapter two analyses the impact of AI on strategic management practices including the strategic role of AI in maritime management and port operations, the use of AI in fuel efficiency, the application of AI in route planning, and its' contribution to sustainable shipping. Chapter three examines the ethical implications associated with AI adoption, focusing on critical issues such as data privacy and security, bias and transparency, and regulatory compliance. It also explores the development of ethical guidelines, emphasizing the importance of ethical codes, stakeholder trust, and human supervision of AI systems. Chapter four analyzes the key factors that facilitate the successful integration of AI into strategic processes and identifies the main challenges faced by shipping companies when adopting AI at the strategic decision-making process. Finally, chapter five presents the discussion and conclusions of the study. This chapter also provides practical recommendations for the maritime industry and directions for future research as well as the limitations of the study.

2. Artificial Intelligence and Its Impact on Strategic Management Practices in the Maritime Industry

2.1 The Strategic Role of AI in Port Operations

Dihn et al. (2024) argue that in the rapid changing field of maritime port operations the demand for solutions to improve efficiency is imperative. In this context as researchers point out AI port management systems can enhance operational efficiency, support decision-making processes and optimize resource allocation. Dihn et al. (2024) with their study contributed to maritime logistics research by creating a port management system (XGBoost) based on prediction and classification algorithms for ships' stay durations and delays. During the testing phase researchers compared three models and found that XGBoost achieved the lowest RMSE, indicating higher predictive accuracy compared to DT and RF.

Dihn et al. (2024) highlighting the prospects of the port management system by arguing, that machine learning uses predictive analytics which can improve forecasting of vessel arrivals, cargo handling, and arrival times. It also strengthens the optimization processes by supporting better scheduling and resource allocation. In addition, according to researchers ML automation optimize routine port tasks such as cargo inspection, container tracking, and maintenance scheduling, reducing reliance on manual labour.

Another recent research, conducted by Kilinc (2025), moves the scientific discussion focus from AI models' effectiveness (Dihn et al., 2024) to the degree of organizational adoption and strategic implementation of AI technologies in the maritime industry. Specifically, Kilinc (2025) explains that despite the growing interest in AI practices in maritime sector a critical gap remains between experimentation and actual implementation. Although a large majority of industry practitioners (81%) have begun testing AI applications, only a relatively small proportion (33%) have successfully integrated these technologies into their strategic operations. This finding reveals, that while AI is recognized as critical tool, many shipping organizations still face practical challenges, that prevent them from adopting AI solutions.

However, in the shipping industry, where companies often face international pressures, being able to implement AI in business operations to support strategic management thinking can give to the companies a strong viable advantage (Davenport & Harris, 2017). This is because AI provides managers with the capability to make decisions based on large volumes of data, a process that would be difficult to achieve using traditional methods (Dihn et al., 2024).

For example, as Kilinc (2025) indicates, AI systems support the efficient allocation of vessels, ensuring optimal use of docking capacity while minimizing costly delays. More importantly, these systems can predict and address potential constraints preventing them from causing operational disruptions. An illustrative example of the transformative potential of AI is given by Liu and Yuen, who explain that the Port of Shanghai has enhanced its loading procedures through the adoption of AI technologies and the development of a digital twin to optimize day-to-day operations. Similarly, the Port of Rotterdam and PSA Singapore have implemented advanced AI systems to improve logistics coordination and operational management. Such examples, demonstrate how global ports are adopting digital innovation to increase ports' efficiency and performance.

In addition, Badea's et al. (2025) systematic analysis revealed a wide range of benefits related to port management and AI implementation. Specifically, researchers explain that such technologies are revolutionizing maritime operations through various applications including real-time data integration, which facilitates continuous information flow from sensors. Such a procedure can enhance supply chain transparency and decision-making. Specifically, as Badea et al. (2025) research findings reveal advanced modeling techniques, such as deep learning, have achieved 94% accuracy in satellite vessel detection in port surveillance. While hardware solutions like IoT sensors and autonomous systems have improved safety compliance from 60% to 85% and reduced monthly downtime from 50 to 20 hours.

In conclusion, these findings demonstrate that the maritime industry is experiencing a profound change. The success of global ports like Shanghai and Rotterdam proves that AI is an important tool for maritime organizations to stay competitive and manage effectively port operations. The benefits of adopting AI systems include: forecasting accuracy and optimization of routing and resource allocation. Despite the benefits many shipping companies still struggle to move from testing AI to fully integrating it in their strategic management operations. Therefore, nowadays the critical challenge for maritime organizations is to systematically integrate AI systems into their operational and strategic structures.

2.2 AI Applications in Maritime Fuel Efficiency and Operational Sustainability

Fuel efficiency is one key area, where AI is helping improve operations in the shipping industry. As Dewi (2026) argue the maritime industry faces increasing pressure to lower operational costs and carbon emissions. In this context, AI emerges as a strategic solution by enabling real-time, data-driven decision-making in navigation. The main argument of Dewi (2026) study is that AI significantly enhances fuel efficiency compared to conventional navigation methods.

Additionally, the researcher provides empirical findings, which show that ships using AI-based systems achieve a reduction in fuel consumption ranging from 15% to 25%. Statistical analysis further confirms that factors like ship speed, route selection, and environmental conditions have a significant impact on fuel consumption. Despite its benefits, Dewi (2026) study highlights several barriers to AI adoption such as high initial investment costs and the limited digital infrastructure.

Another study conducted by Tay et al. (2021) examines further the application of Big Data Analytics and Machine Learning in improving the energy efficiency of harbour craft vessels, with a particular emphasis on reducing fuel consumption and greenhouse gas emissions. The researchers argue that the integration of data-driven technologies and intelligent systems contribute to operational optimization and sustainability. Thus, the study proposes a digitalization framework in which data are collected through onboard telemetry systems, including sensors that monitor fuel consumption, vessel speed, and environmental conditions such as wind. These data are transmitted to onshore systems where they are processed using analysis techniques to identify patterns and correlations influencing fuel efficiency.

Furthermore, the study explores the application of both supervised and unsupervised machine learning models for fuel consumption prediction. As researchers explain traditional approaches such as multi-linear regression are preferred due to their simplicity, while more advanced models, including Artificial Neural Networks provide improved predictive capabilities. Among these, Long Short-Term Memory (LSTM) networks are identified as particularly effective due to their ability to process time-series data and handle sequential information. The findings suggest that the integration of BDA and ML not only supports more accurate fuel consumption forecasting but also enables informed decision-making regarding optimal vessel speed and routing.

Another important recent study, which is highlighting the role of AI in fuel consumption optimization is conducted by Bolkvadze et al. (2025). This study was carried out to evaluate how effective AI-based optimization can be in real maritime operations. The research combined deep learning with dynamic routing and was applied to telemetry data from 16 vessels, including container ships (3,000 TEU) and Handymax bulk carriers, across 97 voyages. The results showed significant improvements, with an average reduction of 12.4% in fuel consumption, an 8.2% decrease in voyage time and a 22% reduction in roll motion. In addition, predictive maintenance models achieved an accuracy of 95%, leading to a 15.3% decrease in unexpected equipment failures and an increase in technical readiness from 93.5% to 97.8%. From an economic perspective, the implementation of these AI systems resulted in estimated annual fuel savings of 5.9 million USD and an internal rate of return of 23%. Environmentally, the system contributed to a 4.2% reduction in carbon intensity, supporting compliance with IMO regulations.

Considering the research findings analyzed in this chapter, it is argued that AI-driven solutions present significant potential for optimizing maritime operations particularly in the domain of fuel efficiency. Therefore, maritime organizations which adopt AI systems for fuel optimization practices, can effectively contribute to the reduction of greenhouse emissions. These findings are important considering that maritime industry is the backbone of global commerce and facilitates the transport of more than 90% of international trade (Ali, 2025).

2.3 Optimization of Route Planning

Vehicle route planning is a complex decision-making process that aims to design the most efficient routes for a fleet of vehicles by minimizing cost and reducing operational risk. Such a process involves not only selecting which locations each vehicle should visit, but also determining the most efficient sequence of visits. Depending on operational constraints, the optimization process may include scheduling departure and arrival times, managing driver working hours and selecting the most appropriate paths between destinations (Kozerska, 2025).

According to recent research (Bukhari & Gokpinar, 2022, Crist et al., 2019, Kozerska, 2024, Weluru, 2023, Ramasamy et al., 2024) AI plays a key role in improving route planning. As Weluru (2023) explains the core objective of route optimization is to allocate limited resources in the most effective way possible. As researcher explain this requires a structured approach that integrates multiple operational variables to support efficient and reliable logistics performance.

In this context, Kozerska (2025) give emphasis on advanced Transportation Management Systems which support the optimization process of logistics. As the researcher illustrates using machine learning and AI algorithms, complex datasets can be analyzed enabling real-time data processing and continuous improvement in logistics decision-making. Therefore, these systems can support the development of efficient routing strategies and assist companies to evaluate the performance of their logistics.

While Ramasamy et al. (2024) highlight that a TMS must consider multiple operational variables including traffic conditions, vehicle capacity, fuel consumption, and delivery schedules to achieve efficiency in route planning. Therefore, advanced route optimization requires a strategic data-driven approach that considers the complexity of transportation systems.

In the same line with Ramasamy et al. (2024) Crist et al. (2019) stated that by analyzing real-time data such as weather conditions, port traffic and low-emission zone AI systems can suggest paths that save fuel, reduces delay time and avoids hazardous areas. In addition, according to Crist et al. (2019) AI is used for predictive scheduling and this capability allows fleet managers to schedule arrivals and departures more accurately.

Kozerska (2025) gives one illustrative real-world application of AI in route optimization, the case of UPS's ORION system, which uses machine learning and advanced analytics to optimize daily delivery routes. The system evaluates a vast number of possible route combinations (reportedly over 200,000 per driver per day) by processing variables such as delivery sequences, pickup constraints, traffic conditions, and historical performance data. The system then selects the most efficient route in terms of distance, time, and fuel consumption. According to industry reports, this optimization has generated significant operational benefits, including reductions in annual cost (Kozerska, 2025). Another case study conducted by Bukhari and Gokpinar (2022) further confirms these advancements, showing that AI route planning and fuel optimization can lead to cost reductions and improved compliance with international decarbonization targets.

In conclusion, the reviewed literature (Bukhari & Gokpinar, 2022, Crist et al., 2019, Kozerska, 2024, Weluru, 2023, Ramasamy et al., 2024) reveals that AI has become a crucial technology in route planning and optimization as it integrates dynamic dataset to drive decision-making process that improve routing accuracy and efficiency. Empirical evidence from systems such as UPS's ORION and AI TMS indicates that these technologies do not only automate routing decisions but also enhance strategic resource allocation. Therefore, the key argument emerged from the literature is that AI route optimization should be viewed as a strategic capability for maritime companies, which support the optimization process of logistics. Finally, a key argument emerged from the reviewed literature is that AI capabilities concerning route optimization help maritime companies to align their practices with the decarbonization targets. This particular area is analyzed more extensively in the next chapter.

2.4 AI contribution in Sustainable Shipping and Decarbonization Targets

As it was stated in the Introduction maritime industry is responsible for transporting around 90% of global trade and it also plays a crucial role in environmental pollution, contributing approximately 2.5% of global greenhouse gas emissions. Therefore, Durlik et al. (2024) in their review examined how AI is being integrated into maritime shipping and port operations to support more sustainable practices. The findings revealed that AI has strong potential to reduce environmental impact by optimizing energy use, lowering emissions, and increasing overall operational performance. As researchers explain real-world applications, particularly from companies like Maersk Line and the Port of Rotterdam, demonstrate that these technologies can lead to critical sustainable practices including reduced fuel usage, lower emissions, and more effective environmental monitoring systems (Durlik et al., 2024).

Drawing on the findings presented above, it becomes clear that sustainability has emerged as a strategic priority for shipping companies, driven by the international demands for compliance with environmental standards. In this regard, Prousaloglou et al. (2024) note that AI provides important tools for monitoring and assessing sustainability initiatives, thereby strengthening transparency and accountability.

Aligned with the International Maritime Organization's (IMO) target of reducing greenhouse gas emissions from shipping by at least 50% by 2050, the maritime sector increasingly needs advanced solutions concerning their sustainability practices. These solutions are expected complement existing strategies, such as energy-efficient systems and the adoption of alternative fuels, which are already highlighted in the literature as significant approaches toward decarbonization (Prousaloglou et al., 2024).

With the help of big data analysis algorithms, shipping companies can monitor in real time CO_2 emissions, fuel consumption, fleet performance, environmental footprint and other environmental indicators. AI-based applications can identify deviations from Environmental Sustainability Goals (ESG) by recommending timely corrective actions. At the same time, the use of predictive models helps companies adapt their business strategies based on environmental scenarios such as MARPOL or the EU ETS.

In this context, Uchechukwu (2024) study explored how the maritime industry can improve both environmental sustainability and operational performance through the combined use of green technologies and autonomous systems. The study highlights that, in addition to regulatory pressure, the sector is also driven by the need to remain economically competitive while adapting to rapid technological change. From the environmental perspective as Uchechukwu (2024) argued green technologies such as alternative fuels (including LNG and hydrogen), energy-efficient ship designs, and emission reduction systems are identified as essential approaches for meeting international frameworks like IMO and the Paris Agreement. These solutions contribute to reducing the industry's carbon footprint and supporting long-term decarbonization goals. Consequently, Uchechukwu (2024) argues that international cooperation and strong policy frameworks are essential to accelerate the adoption of AI systems that support sustainable shipping practices.

In conclusion, a central argument, that is emerged from the above reviewed literature, is that AI offers strategic sustainable capabilities to the maritime industry as its' value lies in its ability to integrate environmental, operational and regulatory data into real-time decision-making systems. Therefore, maritime industry's companies can adopt proactive sustainable management practices where emissions reduction, fuel efficiency, and ESG (Environmental Sustainability Goals) performance are continuously monitored and optimized. Thus, from a strategic point of view organizations, that integrate AI effectively in their management systems, can comply with IMO and EU environmental regulations and strengthen their ESG practices. This is of particular importance considering IMO's target of reducing greenhouse gas emissions from shipping by at least 50% by 2050.

3.Ethical use of AI in Maritime Strategic Practices

3.1 Data Privacy and Security

AI systems often rely on sensitive and strategically important data, and insufficient protection of this information can result in severe implications for maritime companies, including legal issues. To mitigate these risks, regulatory frameworks have been introduced at both European and international levels. In particular, the European Union's General Data Protection Regulation (GDPR) establishes strict requirements governing the collection, processing, and storage of personal and sensitive data. As a result, organizations implementing AI technologies are required to ensure transparency and obtain user consent (Voigt & Von dem Bussche, 2017).

As the International Maritime Organization (2025) highlights the maritime sector's growing digitalisation has introduced significant data protection challenges for shipping companies. In response, the IMO has developed cybersecurity guidelines for the shipping industry, to identify, prevent, and respond to threats associated with AI ethics and digital maritime systems. Within this framework, the adoption of encryption technologies, the strengthening of cybersecurity protocols, and the regular training of personnel are considered essential for effectively leveraging AI capabilities. The IMO (2025) further emphasizes that the secure application of AI represents a strategic organisational priority that must be embedded within the strategic management practices of maritime companies.

Accordingly, maritime organizations that invest in data protection frameworks they strengthen their credibility and transparency. European legislation, particularly the General Data Protection Regulation (GDPR), clarifies that even organizational datasets may fall under the category of personal data, when they relate to identifiable individuals, such as maritime employees (Voigt & Von dem Bussche, 2017). In practice, platforms such as Kongsberg Vessel Insight and DNV Veracity gather data from fleets, which is stored in cloud environments and processed through AI systems. In these contexts, it is essential that data is encrypted, transmitted via secure protocols, and restricted to authorised users (ISO/IEC 27001:2022).

However, in situations involving interoperability between multiple systems and service providers, which is a common situation in the shipping industry, the complexity of ensuring data security increases. For instance, when common standards and clearly defined data-sharing policies are lacking, there is a high risk of uncontrolled data exposure.

Therefore, it is crucial to emphasize that an effective strategic approach to data protection requires the development of a strong data protection culture across all levels of maritime organizations.

In summary, the integration of AI systems in the maritime sector is strictly limited by the European and international regulatory framework such a GDPR and IMO's guidelines. This framework has critical provisions for practices such as data protection and safety. Therefore, maritime organizations need to develop approaches to ensure their compliance with the international standards. To achieve such compliance, it is important to develop organizational security protocols and to cultivate a relevant organizational culture. Such initiatives can help maritime organizations to comply with international regulatory system and to achieve ethical use of AI by protecting sensitive personal data.

3.2 Bias, Fairness, Transparency, Accountability and the Role of Human Supervision

Key concerns such as bias, fairness, and transparency lie at the core of discussions on the responsible deployment of AI at both operational and managerial levels (Floridi et al., 2018). Bias may emerge when the training data of an AI system reflects existing historical inequalities. Within the context of strategic management, such biases can affect decision-making processes. Since fairness is fundamentally associated with the equitable treatment of all stakeholders it becomes essential to ensure that AI-supported decisions rely on principles of equal access and non-discriminatory (Doshi-Velez & Kim, 2017).

In highly international contexts such as the shipping industry, this issue becomes significant (Mehrabi et al., 2021), as limited transparency in AI systems is a critical constraint on their application in strategic management. For instance, many algorithms, particularly those based on deep learning, function as "black boxes," making it difficult to understand how specific decisions are produced (Doshi-Velez & Kim, 2017).

Therefore, maritime organizations need mechanisms that justify AI decisions and ensure transparency through specific policies, managerial training, and internal controls. High-accountability sectors like shipping are often hesitant to adopt "black box" systems, which increases the importance of Explainable AI (XAI) as an ethical solution (Doshi-Velez & Kim, 2017). This is because XAI enhances transparency by making AI outputs understandable, which is crucial for accountability. Platforms such as IBM Watson OpenScale support this by offering real-time monitoring, bias detection, and human-explanations, enabling managers to understand the reasoning behind them (IBM, 2023).

Furthermore, approaches such as decision trees and LIME (Local Interpretable Model-Agnostic Explanations) have been incorporated into maritime analytics to improve the interpretation of vessel performance indicators. These methods enable AI-generated decisions to be explained to non-technical managers, thereby supporting the wider acceptance of AI applications at the managerial level. An important example of an international initiative is DARPA's Explainable Artificial Intelligence (XAI) program, which seeks to develop AI models that provide to the users sufficient explanations regarding their decision-making processes. Nevertheless, it is essential to achieve a balance between interpretability and performance, as models with greater transparency may sometimes demonstrate lower accuracy compared to more complex algorithm-based systems.

Furthermore, according to Islam (2025) at core of the ethical issue of AI systems lies at their limited capacity to execute contextual judgment in complex and unpredictable situations at sea. However, maritime environments are determined by unpredictable human behavior and environmental changes. The inability of AI systems to fully interpret and respond to such challenges introduces ethical concerns regarding the adequacy of machine decision-making when human lives are at risk (Islam, 2025).

In addition, the growing reliance on AI raises questions about the disappearance of human supervision. Specifically, from an ethical governance perspective, giving navigational control to autonomous systems may lead to a diffusion of responsibility. This is because in cases of system failure the question of who is accountable becomes complex (Islam, 2025). In this context, maintaining continuous human supervision is an ethical imperative as according to Islam (2025) human judgment remains essential to ensure accountability in maritime sector.

In conclusion, the adoption of AI in maritime strategic management necessitates that maritime organizations should overcome critical issues related to bias and algorithmic judgment. Based on the above-mentioned literature, it is concluded that maritime businesses should develop ethical governance practices to deal with biased algorithmic judgment. In this context continuous human supervision remains critical for ensuring that automated recommendations are filtered through human judgment.

3.3 Cybersecurity and malicious Attacks Risks

As maritime organizations adopt systems reliant on real-time data and interconnected digital infrastructures, their exposure to cyber threats has grown. Such malicious activities may affect the onboard vessel operations, potentially resulting in severe operational and safety consequences. In response to these emerging risks, the International Maritime Organization (IMO) requires shipping companies to incorporate cyber risk management practices into their Safety Management Systems (IMO, 2025).

Real-world incidents, such as the cyberattack against Maersk in 2017, which significantly disrupted its operational activities for several days, illustrate the vulnerability of even the largest maritime organizations to cyber threats. Similarly, AI-based platforms employed for risk prediction and automated route optimization may become targets of malicious attacks. To address these challenges, the implementation of protective measures, including multi-factor authentication, encryption mechanisms for AI system access and regular cybersecurity assessments, is considered essential (ENISA, 2021).

Furthermore, it is important to recognize that cybersecurity constitutes a strategic dimension of corporate governance. Therefore, maritime organizations' leadership must develop a comprehensive understanding of cyber-related risks and allocate resources toward continuous preparedness, risk management, and organizational resilience against emerging threats. A recent systematic review by Miller et al. (2025) further highlights the increasing role of AI in enhancing maritime cybersecurity. Specifically, this study examined various AI-driven approaches, including predictive threat modelling, demonstrating their potential to identify cyber threats in real time.

However, despite the importance of cybersecurity practices, a critical challenge facing the maritime sector is the lack of standardization in cybersecurity practices. Specifically, according to Erdoğan and Erdoğan (2025) although initiatives such as the International Maritime Organization Guidelines and the National Institute of Standards and Technology Cybersecurity Framework offer important direction, their implementation remains inconsistent across maritime organizations. This situation creates vulnerabilities because large shipping companies often possess the resources to adopt advanced cybersecurity infrastructures, smaller operators struggle to meet the basic requirements. This fragmentation undermines the sector's ability to share real-time threat intelligence. For example, a cyber incident affecting a port's cargo management system may remain isolated and undetected by neighboring ports, if there are no shared protocols (Erdoğan & Erdoğan, 2025).

3.4 The Need for Regulatory Compliance: Ethical Codes for AI Implementation at European Level and Worldwide: Building Stakeholder Trust

Within the European regulatory framework, the General Data Protection Regulation (GDPR) establishes obligations for organizations regarding the monitoring, documentation, and processing of personal data (Voigt & Von dem Bussche, 2017). In parallel, maritime operations are governed by a compliance landscape, where adherence to international conventions such as SOLAS, MARPOL, and relevant International Maritime Organization (IMO) directives remains mandatory (DNV, 2023).

At the international policy level, the European Commission, since 2019, has advanced the Ethics Guidelines for Trustworthy AI, which articulate seven core principles: human oversight, technical robustness, data privacy, transparency, inclusiveness, fairness, and accountability (European Commission, 2019). These principles provide a framework that can be effectively adapted to inform the development of ethical governance standards within the maritime sector. Shipping companies that incorporate AI into operational functions such as risk assessment, are increasingly required to establish internal ethical governance frameworks. These frameworks should indicate the scope of AI application, define accountability structures and specify the boundaries of human oversight within automated processes. While the development of such ethical frameworks can supported through mechanisms, including systematic evaluation of AI models to ensure alignment with operational, legal, and ethical standards.

In this context, a study conducted by Jobin, Ienca, and Vayena (2019) identified more than 80 AI ethics guidelines developed globally by governments, organizations, and academic institutions. Although these frameworks frequently converge on core principles such as transparency, fairness, and data privacy, the authors highlight a lack of harmonization and standardization across procedures. This fragmentation reveals the need for more coherent ethical standards, particularly in highly regulated sectors such as maritime transport.

However, it is essential to emphasize that the effective adoption of AI within the maritime sector is determined by organizational capacity to establish trust among key stakeholders. In this regard, shipping companies are encouraged to adopt a human-centered approach to technological integration, prioritizing accountability structures, transparent communication practices, and a systematic understanding of how AI systems influence trust.

Moreover, the confidence of external stakeholders, including regulators and investors, can be reinforced through the implementation of clearly defined AI governance and ethics frameworks, such as ISO/IEC 42001. For maritime enterprises operating within highly regulated environments, the adoption of such practices contributes to the strengthening of international reputation and credibility.

As highlighted by Dignum (2019), the responsible implementation of AI requires the integration of ethical principles, sustained human oversight, and clearly defined organizational accountability structures. In addition, Olaniyi et al. (2024) underscore that trust in AI systems within the maritime sector is strongly influenced by the degree of stakeholder engagement. Their findings indicate that ethical considerations vary according to roles, responsibilities, and expectations. Consequently, the establishment of participatory governance mechanisms, in accordance with the systematic consideration of stakeholder concerns, is essential for maintaining long-term trust in AI solutions in the maritime sector.

Regarding the principle of human oversight, it constitutes a core component of ethical AI governance frameworks. Effective oversight requires organizations to establish mechanisms that ensure explainability of AI decisions. Within the shipping sector, such supervisory practices may include the validation of AI-generated scenario forecasts, the critical evaluation of automated risk assessment reports, and the verification of system-generated recommendations related to compliance with regulatory instruments such as SOLAS or MARPOL (BIMCO, 2023).

4. Factors that contribute to the successful integration of AI into the strategic processes of maritime organizations and Main Challenges

4.1 Success Factors

4.1.1 Organizational Change, Knowledge Management Systems and Knowledge Sharing

The existing literature in maritime studies demonstrates a limited focus on empirical studies examining successful integration of AI into the strategic processes of maritime organizations. Consequently, this research area is primarily informed by the strategic management literature, which emphasizes the role of organizational change and innovation adoption in the context of organizational transformation. According to Cosa (2024) organizational change frameworks and models demonstrate the processes through which change occurs (Cosa, 2024).

As Hitt et al. (2016) argue while the late 20th century was defined by a focus on maximizing shareholder value, this approach has changed in the modern era. Today's rapidly economic landscape proves that cost reduction and profit-centric strategies are no longer sufficient for long-term viability. Contemporary businesses' success requires shifting the strategic focus from static competitive positioning toward dynamic organizational innovations.

In this context knowledge management and sharing is the primary factor of organizational change. By transforming organizations into learning entities, knowledge management systems ensure the efficient utilization of intellectual capital to foster growth (Soliman, 2015). These systems constitute critical resources for maintaining a competitive advantage particularly when supported by a well-designed learning environment. Despite these theoretical advancements, modern firms continue to struggle with two fundamental challenges: a) identifying the optimal organizational structure to integrate innovation and b) developing a measurement system to value intangible assets (Cosa et al., 2024).

Cosa (2024) discusses and evaluates two models to integrate dynamic innovation as a core pillar of strategic management. The first is the sequential model which utilizing existing strategy as a foundation for future innovation. The second is the simultaneous model which proposes that strategic performance is driven by continuous innovation and dynamic capabilities. As Cosa (2024) explains the adoption of innovation is influenced by different factors depending on whether organizations follow a sequential or a simultaneous model of strategic management. In the sequential model, adoption is mainly affected by the organization's existing strategy and resources. Thus, organizations adopting this model tend to prefer gradual and low-risk innovation processes. In contrast, the simultaneous model emphasizes continuous innovation and dynamic capabilities. Therefore, while the sequential model prioritizes stability, the simultaneous model relies on continuous organizational transformation.

In the same line with Cosa (2024), Olan et al. (2024) argues that a significant organizational advancement is the optimization of knowledge activities, which empower managers to use expertise effectively. Within this framework, knowledge serves as the fundamental element for innovation and growth. Despite its importance, establishing a well-designed knowledge sharing culture and implementing its supporting systems presents complex challenges. To address these challenges researchers have focused their interest on identifying strategies to overcome them (Olan et al., 2022).

In this context, as Cummings (2004) argue the internal exchange of knowledge among employees is of critical importance for the organizational knowledge process. Grounded in the Resource-Based View an organization's strategic advantage is derived from its physical, human, and organizational resources. To sustain this advantage, a firm must rely on resources that are valuable, rare, inimitable, and non-substitutable. Scholars (Olan et al., 2022, Lin, 2008, Yang & Wu, 2008) argue that organizational knowledge fulfills these criteria. Furthermore, this knowledge is often built upon a specific history of internal and external interactions, lessons learned, and evolving policies. Thus, Dong and Yang (2015) demonstrate that organizations depend on the alignment between technological tools and knowledge sharing processes to generate innovative solutions. When viewed through the lens of Social Exchange Theory the integration of AI and knowledge sharing creates a sequence of interactions that fosters reciprocity between the entities involved. These exchanges facilitate the development of new relationships, deepening the collective understanding of employee knowledge.

In conclusion, based on strategic management literature the successful integration of AI into the strategic processes of organizations is primarily a structural and knowledge-driven transformation. Therefore, this integration requires alignment between strategy, organizational structure, and innovation management practices. In this context, knowledge management systems and knowledge sharing emerge as central success factors, as they facilitate the effective utilization of intellectual capital and support the continuous organizational learning. From a Resource-Based View perspective, organizational knowledge constitutes a key strategic asset that is valuable, rare, and difficult to imitate, thereby sustaining competitive advantage. The integration of AI enhances this capability by enabling more efficient knowledge processes and supporting data-driven decision-making. Additionally, through the lens of Social Exchange Theory, AI can be understood as a mediating mechanism that strengthens interaction and collaboration among stakeholders. Despite these advantages, significant challenges remain, particularly in designing appropriate organizational structures and cultivating a strong knowledge-sharing culture.

4.1.2 The role of leadership

The emergence of AI has changed the organizational dynamics, calling into question established approaches to leadership and strategic governance. As contemporary organizations depend on data-driven insights to guide their operations, the incorporation of AI into executive decision-making processes becomes more prominent. The digital era, shaped by the convergence of big data, machine learning, and automation, has altered the ways in which leaders assess risk and allocate resources. To remain effective and facilitate organizational change, leadership must evolve (Fischer & Varga, 2020).

According to Fischer and Varga (2020) traditional approaches, which have relied on subjective judgement are being changed by AI's capacity for real-time data integration and rapid information processing. This development introduces more complex situations for leaders, which require a reconsideration of leadership approaches and workplace culture (Fischer & Varga, 2020).

Furthermore, as Kirkpatrick (2020) explain traditional leadership models need to shift toward collaborative frameworks that systematically incorporate AI capabilities. Specifically, Kirkpatrick (2020) argues that this transition involves moving away from top-down hierarchies toward environments that prioritise team engagement (Nathaniel & Egbivwe, 2025).

In addition, as Cohen and Kietzmann (2014) explain, effective leadership requires moving beyond a basic understanding of how AI works toward the strategic coordination of these technologies within the organization. While González-Reyes et al. (2026) acknowledges that the integration of AI into organizations can be understood through the lens of existing leadership theories. Transformational leadership, for example, is closely associated with leaders' ability to communicate a clear vision for digital change and encourage others to work towards it. Estherita (2024) suggests that AI technologies can strengthen transformational practices by fostering employee empowerment, whereas Alharbi (2025) identifies a strong association between transformational leadership and AI adoption. Moreover, recent studies indicate that productive interaction between employees and AI systems can enhance coordination, facilitate knowledge exchange, and improve problem-solving capabilities. Considering the existing research findings, that analyzed above, AI is challenging how organizations adapt and manage change.

However, to move to a more structured analytical explanation of how AI-driven transformation functions in practice, it is necessary to ground this discussion in established strategic and organizational theories. In this regard Dynamic Capabilities theory highlights an organization's ability to identify opportunities and transform its operations in response to rapidly changing environments.

While,Technology–Organization–Environment Framework offers a multidimensional approach to understanding technology adoption, including AI integration, through three key dimensions. The technological dimension considers the maturity, availability, and applicability of AI tools (González-Reyes et al., 2026). The organizational dimension focuses on leadership structure, cultural readiness, and digital capability within the organization. The environmental dimension addresses external factors such as regulations, competitive pressure, and societal expectations (González-Reyes et al., 2026).

From the above-mentioned discussion, which is based on literature from the strategic management field, it is concluded that the successful integration of AI requires a coordinated transformation of leadership, organizational structures and strategic management principles. First, organizations must develop dynamic capabilities, and transform workflows and governance structures. Second, effective implementation depends on alignment across the technology–organization–environment dimensions.

4.2 Main Challenges

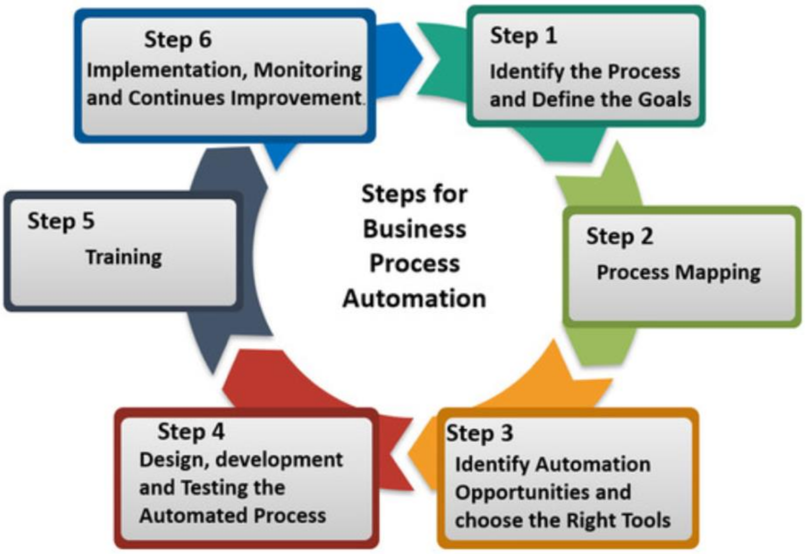
4.2.1 Technological Challenges and Challenges related to Business Processes

According to Aldoseri et al. (2024) digital transformation involves the integration of digital technologies across all areas of an organization, leading to fundamental changes in how it operates and creates value. Therefore, it requires a re-evaluation of business models and processes. Building on this foundation, AI-based digital transformation extends the concept by emphasizing the strategic use of AI technologies to enable organizational change and support the achievement of key business objectives. In this context AI-driven digital transformation refers to a strategic orientation that uses artificial intelligence to enable organizational change and reshape how firms operate and make decisions.

Despite the significant potential of AI in strategic management, its adoption in many organizations remains limited due to various technological barriers. These challenges are related to both infrastructure and the complexity of the technological tools themselves and their incomplete integration into existing business structures (Bughin et al., 2018). Specifically, according to Romeo and Laco (2026) availability of financial resources and technological infrastructure is a key determinant for the successful adoption of AI. Indeed, research highlights, that effective AI implementation, is strongly influenced by an organization’s existing technological capabilities and the extent to which these are aligned with both current operations and strategic objectives.

Moreover, inadequate technical infrastructure can set barriers to the implementation of AI solutions. Effective deployment typically depends on the integration of IT systems, cloud computing capabilities, sensor networks, IoT-enabled connectivity, and specialized software platforms. However, the maritime sector often experiences lags in developing and integrating these infrastructures (Mahmood et al., 2024).

Another critical barrier is related to the complexity of embedding AI solutions into existing organizational strategies and operational processes. This is because such solutions require strategic frameworks and strong managerial commitment, otherwise AI initiatives often fail to deliver sustained value (Chui et al., 2018; Aldoseri et al., 2024).



Source: Aldoseri et al. (2024)

As Aldoseri et al. (2024) argue the initial stage of business process involves identifying which processes are suitable for automation. These are typically tasks that are repetitive. Automating such activities can relieve employees from routine workloads and improve productivity. At this stage, clear objectives should be established, such as enhancing efficiency, reducing errors, or achieving broader strategic goals (Aldoseri et al., 2024).

The second step requires a detailed examination and documentation of the existing workflow from beginning to end. It involves outlining each stage of the process, identifying key stakeholders, and mapping the tools and systems currently in use. This provides an understanding of how the process operates. Once the process has been mapped, the next step is to determine which components are suitable for automation. It is important to assess each step carefully, as not all activities will necessarily benefit from automation. Based on the complexity of the process and organizational requirements, appropriate tools should be selected (Aldoseri et al., 2024).

At the stage naming “Design, Development, and Testing of the Automated Process” the process is redesigned to incorporate automation technologies. Special attention should be given to exception handling and error management to ensure process reliability. A clear and well-structured process flow should be developed to ensure transparency and usability for all stakeholders. Following the design phase, the automated process is developed and tested, often with the involvement of IT specialists. Prior to full adoption all relevant stakeholders should be adequately trained on the new automated process. This includes understanding system functionality and knowing how to interact with the automation tools. In the final step, the automated process is implemented. After implementation, ongoing monitoring is essential to evaluate performance and identify potential issues for improvement (Aldoseri et al., 2024).

4.2.2 Organizational Resistance

The introduction of AI in strategic management depends not only on technology but also on human acceptance and organizational culture. One of the key barriers to the successful implementation of AI solutions is the resistance to change (Fountaine et al., 2019).

According to El-Taliawi (2023) the concept of "resistance" has been extensively explored across multiple disciplines, including psychology and human resources. The consequences of resistance to change can slow down the change process, increase implementation costs, and in some cases prevent successful adoption. Therefore, numerous organizational change initiatives fail due to organizational resistance. As El-Taliawi (2023) explain from a behavioral perspective organizational change may cause emotional and cognitive responses such as denial and stress, which can contribute to resistance rather than acceptance.

In the context of technological innovation, such as AI adoption, resistance often emerges due to concerns about job displacement, limited understanding of the technology, and concerns regarding the replacement of human judgment. In parallel, insufficient digital competencies constitute a significant additional barrier. Organizations that fail to invest in continuous training of their workforce typically struggle to integrate AI effectively into their strategic processes (Westerman et al., 2014). Therefore, managing organizational resistance is a matter of strategic leadership and companies, that invest in training can achieve successful adoption.

5. Discussion and Conclusions

5.1 The role of AI to Improve Strategic Management Decision-Making in the Maritime Industry and Issues of Ethical Use

This Dissertation highlighted the important role of AI in strategic management of the maritime sector. As indicated through the literature review the shipping industry is one of the most dynamic sectors of the global economy and thus strategic management is critical for the growth of shipping organizations. In the Dissertation strategic management defined as the process of developing, implementing, and evaluating long-term strategic plans aimed at achieving an organization's key objectives. The research results revealed that shipping industry is currently undergoing a significant transformation driven by AI which have changed business operations. In this context, as it occurred by the analysis of the relevant literature, the proper implementation of strategic management in shipping companies help maritime companies to make informed decisions and adapt to changing market conditions. This finding reveals that the shipping sector is entering a new technological era, in which competitiveness depends on how effectively companies integrate AI into their strategic management processes.

More specifically, concerning the role of AI on improving decision-making and strategic management effectiveness in the maritime industry, the Dissertation focused on four business areas that AI can effectively contribute. The first area is the port operations. In this context the Dissertation identified that although a large majority of industry practitioners have begun testing AI applications only a relatively small proportion have successfully integrated these technologies into their organizational operations. This means that the shipping and specifically port sector is still in a transitional phase concerning the implementation of AI.

However, the implementation of AI solutions on port operations, as the literature review revealed, can support management thinking in various ways. Firstly, by supporting the efficient allocation of vessels, ensuring optimal use of docking capacity and avoiding costly delays. In addition, AI systems can help managers to predict potential disruptions or delays in advance, preventing them from causing operational problems. For instance, as literature review indicated, AI systems can be implemented to port logistics to improve coordination and operational management. Furthermore, AI systems can optimize routing, resource allocation, and risk management. The findings suggests that AI technologies can enhance the operational efficiency and strategic management of port logistics by enabling predictive decision-making, optimizing resource allocation, and improving the resilience and responsiveness of port operations.

The second area, that AI can improve strategic management decision-making, is fuel consumption as Dissertation emphasized that this is of critical importance as the maritime industry faces increasing pressure to lower operational costs and carbon emissions. Based on previous research findings, that analyzed in the Dissertation AI-based systems achieve a reduction in fuel consumption ranging from 15% to 25%. This finding shows that AI technologies can play a crucial role in promoting both economic efficiency and environmental sustainability.

The third area, that AI can improve strategic management decision-making, is the vehicle route planning. Specifically, based on research findings of the Dissertation AI plays a key role in improving route planning by helping allocated effectively limited resources. Specifically, the advanced Transportation Management Systems, which support the optimization process, support the development of more efficient routing strategies. However, as Dissertation suggests, TMS must consider multiple operational variables including traffic conditions, road quality, weather patterns, vehicle capacity, fuel consumption, delivery schedules, and distances.

In addition, research findings revealed that AI is used for predictive scheduling, incorporating data from historical delays, port load, and shipper needs. Such capabilities allow fleet managers to schedule arrivals and departures more accurately. A real case example, that analyzed in the Dissertation, is the UPS's ORION system, which evaluates a vast number of possible route combinations by processing variables such as delivery sequences, pickup constraints, traffic conditions, and historical performance data. With this data the system can select the most efficient route in terms of distance, time, and fuel consumption. Therefore, it is concluded that TMS with the help of AI are transforming logistics and fleet operations from traditional planning models into intelligent decision-making systems.

The fourth area, that AI can improve strategic management decision-making, is sustainable shipping. This is of particular importance as the maritime industry is responsible for transporting around 90% of global trade, but it also plays a crucial role in environmental pollution, contributing approximately 2.5% of global greenhouse gas emissions. In this context, the research findings revealed that AI has strong potential to reduce environmental impact by improving fuel efficiency, optimizing energy use, lowering emissions, and increasing operational performance. In addition, based on the research findings it is argued that AI offers important tools for monitoring and evaluating sustainability metrics. Therefore, previous research findings revealed also that the maritime industry can improve both environmental sustainability and operational performance through the combined use of green technologies and autonomous systems.

Concerning the ethical and responsible AI use, this is a fundamental prerequisite for successful adoption. The research highlights that transparency, accountability, data protection, and trust are central factos for enabling sustainable technological innovation. In the maritime sector, these issues are complex due to the geographically distributed nature of operations. As a result, measures such as encryption protocols and ongoing staff training are becoming essential for ensuring data security. However, interoperability challenges across different systems and providers further complicate the practices related to effective cybersecurity management.

The dissertation further identified lack of transparency as a major limitation in the strategic use of AI, as many systems and particularly deep learning models, operate as “black boxes” with limited explainability of their decision-making processes. This creates a strong need for mechanisms that can justify and interpret AI-generated outputs. In response, maritime organizations must establish governance policies that promote transparency.

Finally, the Dissertation illustrated that cybersecurity is one issue of critical importance for the maritime industry due to the increased likelihood of malicious attacks. Thus, shipping companies are required to integrate cyber risk management into their Safety Management Systems. In addition, strategies such as: use of multi-factor authentication and encryption for access to AI systems, periodic security checks, cyber training for staff and integration of AI security protocols are of critical importance.

These findings are particularly critical especially within the context of the international and European regulatory framework for AI, cybersecurity, and data protection. In particular, as analyzed in the Dissertation, the EU AI Act highlights the necessity of transparency, accountability, human oversight, and risk management in AI applications. Therefore, the findings indicate, that the successful integration of AI in the maritime sector, depends on organizations’ ability to align AI implementation with international ethical governance principles, promoted by European Union.

5.2 Factors that Contribute to the Successful Integration of AI into the Strategic and Operational Processes of Maritime Organizations and Main Challenges

Concerning the factors, that contribute to the successful integration of AI into the strategic and operational processes of maritime organizations, the Dissertation highlighted the need for organizational knowledge management systems and effective leadership as the strategic management literature proposes.

Specifically, based on the analyzed literature it is concluded that knowledge management systems constitute critical resources for implanting successful change in the organizations. In addition, the Dissertation examined two models to integrate dynamic innovation as a core pillar of strategic management. The first is the sequential model which utilizing existing strategy as a foundation for future innovation. The second is the simultaneous model which proposes that strategic performance is driven by continuous innovation and dynamic capabilities. Based on the examination of these models it is concluded that establishing a knowledge sharing culture and implementing its supporting systems presents complex challenges, that requires effective leadership.

As Dissertation highlighted the emergence of AI has changed the organizational dynamics, calling into question established approaches to leadership and strategic governance. Nowadays, effective leadership requires moving beyond a basic understanding of how AI works toward the strategic coordination of these technologies within the organization. In this context, the Dissertation concluded that transformational leadership, which is closely associated with leaders' ability to communicate a clear vision for digital change and encourage others to work towards it, is an effective model for the successful integration of AI.

In addition, as it is illustrated in the Dissertation another important leadership model is the distributed or shared leadership. This finding is particularly significant for the maritime sector because shipping organizations have traditionally operated within hierarchical management structures. Finally, the Dissertation emphasized that technological change cannot be understood independently of the organizational and human environments in which it occurs. For leadership, this means that should ensure that job roles, the personnel skills and organizational culture evolve in parallel with the adoption of AI systems.

Concerning the challenges, that shipping companies face, when adopting AI at the strategic level, the Dissertation identified two main areas of challenges: technological challenges and challenges related to organizational resistance. Concerning technological challenges, it was found that the adoption of AI requires a re-evaluation of business models and processes. This is because AI implementation requires a combination of well-designed IT systems, cloud technologies, IoT and other specialized software. However, as it was highlighted in the Dissertation the maritime industry, which is traditionally more conservative in technology investments, faces significant delays in these areas.

Concerning organizational challenges the research findings demonstrated that the resistance to change can slow down the change process, increase implementation costs and in some cases, prevent successful adoption. In cases of technological innovation, such as AI adoption, resistance arises from fears of job loss, lack of understanding of technology, and concerns about the replacement of human judgment by algorithms. These challenges are associated with employee attitudes toward change, organizational culture and trust in technology. At the same time, the lack of digital skills is another significant barrier and thus organizations, that do not invest in employees' training to upgrade their skills, face many difficulties when integrating AI into their strategic processes. Therefore, it is concluded that the successful integration of AI requires the development of training programs.

5.3 Practical Recommendations and Limitations

In this section based on the conclusions of this study, specific recommendations are proposed for the management of shipping companies concerning the integration of AI in their strategic decision-making process. Firstly, maritime organizations should prioritize the systematic adoption AI decision support systems, particularly within port operations, fleet coordination and logistics planning. This recommendation is grounded in the finding, that AI significantly enhances operational efficiency through vessel allocation and fuel consumption. Secondly, it is recommended that maritime companies should prioritize the establishment of formal AI governance frameworks that ensure transparency, data protection and cybersecurity resilience. Specifically, in terms of cybersecurity the integration of encryption protocols and multi-factor authentication systems is critical.

Third, maritime organizations should prioritize transformative leadership practices and workforce training programs to facilitate the effective integration of AI technologies. These initiatives can help reduce employee resistance to technological change by improving their digital competencies and strengthening trust in AI systems. Besides, transformational leadership is particularly important in creating a vision concerning AI adoption within the maritime organizations.

As with any research study this thesis has certain limitations. First of all, the analysis was based on secondary data (academic articles, books and reports). Therefore, no primary research was carried with questionnaires or interviews. Although the use of a literature methodology is appropriated for providing answers to various types of research questions, it limits the possibility of understanding experiences of practitioners in the field. Secondly, due to the fact that the Dissertation lacks empirical findings from Greek academic literature, the findings may not represent accurately the specific challenges faced by Greek shipping companies.

5.4 Recommendations for Future Research

It is recommended that future researchers especially in Greece should conduct empirical studies that examine the effectiveness of AI integration in maritime strategic decision-making across. This could be achieved through case study research, as case studies are appropriate for in-depth exploration of various organizational dimensions including management structures, leadership styles and technological capabilities.

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