



**CHALMERS**



# Understanding AI Adoption in Onshore Maritime Logistics in Sweden

Bachelor thesis for the International Logistics Program

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CHALMERS UNIVERSITY OF TECHNOLOGY  
Göteborg, Sweden, 2025



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Artificial Intelligence, digitization and digitalization in the Maritime sector. AI-Generated  
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Department of Mechanics and Maritime Sciences  
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Göteborg, Sweden 2025

## **PREFACE**

This bachelor's thesis was conducted during the spring of 2025 at the Department of Mechanics and Maritime Sciences at Chalmers University of Technology, within the International Logistics Programme. The thesis scope corresponds to 15 ECTS credits and represents the final element of the undergraduate degree.

This report investigates the status of implementation of artificial intelligence (AI) technologies in onshore maritime logistics operations while examining sustainability aspects, operational efficiency, and regulatory compliance. The research involved joint work with industry experts from a worldwide container shipping company, a Swedish ship management organization operating in Gothenburg, a port organization, and an AI researcher.

We appreciate the participating companies for their willingness to share their valuable time and knowledge.

We express our appreciation to Wengang Mao for his ongoing support, feedback, and encouragement that he provided throughout the project.

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## SAMMANDRAG

Den maritima logistikbranschen upplever digital transformation genom implementering av artificiell intelligens (AI) i sin lands-verksamhet. Den här forskningen vill förstå de strategiska AI-implementeringen för att öka den maritima logistikens hållbarhet samtidigt som den förbättrar operativ effektivitet och regelefterlevnad. Forskningen ägde rum vid Chalmers tekniska högskola med hjälp av två företag i Göteborgsregionen, inklusive ett globalt containerrederi, ett svenskt fartygsförvaltningsbolag och en hamn samtidigt som man fick input från en AI-forskare.

Forskningen kombinerar semistrukturerade intervjuer med en grundlig litteraturgenomgång för att studera AI-tillämpningar inom ruttoptimering och prediktivt underhåll samt ESG-dokumentation och cybersäkerhet. Forskningen visar att AI ger bättre prestanda och efterlevnad, men att dess införande möter hinder från kulturellt motstånd och oklara regler och begränsningar av cybersäkerhet. Studien visar att organisatoriskt lärande tillsammans med ledarskapsengagemang fungerar som väsentliga faktorer för att uppnå framgångsrik AI-implementering.

**Nyckelord:** artificiell intelligens, maritim logistik, hållbarhet, cybersäkerhet, ruttoptimering, ESG-rapportering, prediktivt underhåll, digital transformation, Göteborg, kvalitativ forskning

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## **ABSTRACT**

The maritime logistics industry is experiencing digital transformation and integrating AI technologies into its onshore operations. This research aims to understand the strategic AI implementation to boost maritime logistics sustainability while improving operational efficiency and regulatory adherence. The research took place at Chalmers University of Technology using three Gothenburg region companies, including a global container shipping firm, a Swedish ship management company, and a port, while obtaining input from an AI researcher.

The research combines semi-structured interviews to study AI applications in route optimization and predictive maintenance, as well as ESG documentation and cybersecurity. The research shows that AI provides better performance and compliance, but its adoption faces barriers from cultural resistance and unclear regulations, and cybersecurity limitations. The study reveals that organizational learning, together with leadership engagement, serves as an essential factor for achieving successful AI implementation.

**Keywords:** artificial intelligence, maritime logistics, sustainability, cybersecurity, route optimization, ESG reporting, predictive maintenance, digital transformation, Gothenburg, qualitative research

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## ACRONYMS AND TERMINOLOGY

AI	Artificial Intelligence
ECAs	Emission Control Areas
ESG	Environmental, Social and Governance
ETA	Estimated Time of Arrival
IEEE	Institute of Electrical and Electronics Engineers
IMO	International Maritime Organization
ISO	International Organization for Standardization
ML	Machine Learning
RUL	Remaining Useful Life
SMHI	Swedish Meteorological and Hydrological Institute

# 1. INTRODUCTION

Maritime logistics and shipping services have existed and flourished in human societies for centuries, serving as a crucial driver of the global economy and sustained globalization. Moreover, the maritime industry facilitates the transportation of approximately 90% of the world's goods, including raw materials, foodstuffs, manufactured items, and energy products, making the entire sector integral to today's emissions challenges (Durlík, Miller, Kostecka, Łobodzińska, et al., 2024).

The estimated amount of greenhouse gas emissions that the shipping industry is responsible for corresponds to about 3% of the world's CO<sub>2</sub> emissions (Hellström et al., 2024). To add, Hellström (2024) emphasizes how many other policies and private initiatives have been put forward to reduce the air emissions of shipping because of apparent disappointment in the actions taken by the International Maritime Organization (IMO). This consequently constitutes a challenge for the industry as the demand for shipping services continues to increase with world trade.

There are five different segments within the shipping industry: dry bulk, tankers, containers, general cargo, and passengers. These segments can include further distinct subsegments, for instance, LNG carriers, ro-ro, offshore wind, offshore oil and gas, and cruise shipping (Malmquist & Munim, 2024). In this study, the authors will try to find solutions to everyday onshore operations problems within the different segments, including terminal and port operators, and how Artificial Intelligence (AI) can help solve these hurdles.

This takes us to a new age of technology, referred to as the start of the 4th revolution, that is, AI. AI is being more frequently integrated into various technologies, including smart devices, and has increasingly, together with machine learning (ML), taken the world and companies by storm and become quite popular. What AI can do in short that makes it so popular and favorable is its ability to identify patterns and trigger actions that humans might overlook. Other reasons why AI and ML have become so popular include cost efficiency, the ability to accomplish more work in less time, and a reduction in errors (Farzadmehr et al., 2024).

The growth of both the maritime industry and AI has come forth for a reason, and that is to incorporate one into the other. The best example of this would be autonomous ships that would be able to complete voyages across borders with minimal assistance of crewing and others. Or it could be a helpful AI in the office that corrects mistakes in algorithms, deals with customer

relations, and helps with cost reduction calculations. The possibilities with AI are endless, and with this work, which will try and teach the different applications of AI in day-to-day operational work and is structured in a way where interviews are conducted to ensure that the research is as relevant as possible.

For the other parts like ports, that play a crucial role in logistics where their main framework is to connect the sea to land through complex operations, communication and relationships. Port operations are complex, and some of the costs are unmeasurable and to help companies today, they should incorporate new age technologies to help interact with terminals and other operators to ensure maximum economic efficiency. For now, port operations face challenges that, if they are solved, will benefit the economy of the local region (Farzadmehr et al., 2023).

Further terminals that work in relation to port operators and shipping companies play as vital a role as the others in a flourishing maritime future and will also, for the sake of the industry, be covered in this thesis.

To be able to achieve a consistent and reliable service level in shipping, which is the optimum, companies involved within the sector need highly educated and hands-on operations teams to manage sustainability in all aspects. Just as the ports had to overcome old stigmas and adapt new technologies, so must these maritime companies embrace and adapt these technologies to be as efficient as currently possible and for the betterment of their own futures in this ever-changing world of economies and businesses.

## **1.1 Background**

The research took place in spring 2025 at Chalmers University of Technology, within the Department of Mechanics and Maritime Sciences, through a partnership with three regional actors: a global container-shipping company, a Swedish ship-management firm, a port operator, and an independent AI researcher. The organizations function as essential nodes in the Swedish maritime logistics network, making them suitable for studying digitalization in land-based operations.

Despite the EU Emissions Trading System (EU-ETS) and upcoming FuelEU Maritime regulation companies have still not succeeded in eliminating manual operations and unconnected data systems from onshore processes despite their strong regulatory requirements and growing operational efficiency needs. The adoption of advanced AI tools faces challenges because of weak data integration and limited internal expertise, and unclear cybersecurity frameworks. The complete realization of solutions for route optimization and predictive

maintenance and automated ESG documentation, and threat-detecting cybersecurity remains unachieved.

The research objective focuses on determining Swedish maritime onshore logistics AI technology maturity levels while identifying main obstacles and possibilities, and explaining the industry's practical efforts to bridge the gap between technological capabilities and actual deployment.

## **1.2 Aim of the Report**

This study aims to understand how AI can be strategically integrated into onshore maritime logistics operations to enhance sustainability, efficiency, and regulatory compliance. Through the qualitative interviews with maritime industry professionals in the Gothenburg region, the study seeks to identify practical applications, organizational challenges, and the perceived future potential of AI within this traditionally conservative sector. The goal is to provide both conceptual understanding and actionable knowledge that supports maritime firms in navigating the technological transition toward smarter and more sustainable logistics operations.

## **1.3 Research Questions**

- In what ways is AI currently applied in onshore maritime logistics, and which operational areas show the most progress and potential?
- How can AI contribute to improving environmental sustainability and supporting compliance with maritime regulations such as EU-ETS and Fuel EU Maritime?
- What organizational, cultural, and regulatory barriers affect the adoption and effective use of AI in the maritime logistics sector?

## **1.4 Delimitations**

This research will be done with data from interviews from three companies in the maritime, ports, and technology industries. Any other population in the form of transport companies, rail, road, or air, would not be beneficial to our study.

AI is still a relatively new technology in the logistics market, thus limiting the availability of specific data. However, this research will focus on data from recent years and any additional data that can be obtained. That data includes studies and articles found through Chalmers Library, where no other sources for data will be used for ease of transactions.

Other limitations of this thesis include that strictly onshore maritime industries and one exception will be analyzed, and that the sole purpose is to estimate the future impact of AI for

the region of Gothenburg. That is because all interviewed individuals will have their base of operations in the Gothenburg metropolitan area.

The reason for how our thesis is structured lies in the fact that we used a conventional template that was prepared by Chalmers University of Technology beforehand.

## 2. THEORY

With the world moving towards a 4th revolution with new technologies in the likes of AI shaping this trajectory forward has unleashed a flood of investments into these new areas, including the maritime industry. Where the maritime industry still takes a back seat when it comes to change, many today consider the possibilities of change with technologies. This part of the thesis will serve as a guide for understanding these new-age technologies as well as give a thorough review of the applicability of AI in the maritime sector.

### 2.1 Artificial Intelligence

AI is a new-age technology that develops and researches theories, methods, and technologies applicable to systems that can simulate, extend, and expand human intelligence (Liu, 2024).

Joshi A (2020), “Alan Turing defined AI as follows: *“If there is a machine behind a curtain and a human interacting with it (by whatever means, e.g., audio or via typing, etc.) and if the human feels like he/she is interacting with another human, then the machine is artificial intelligence”* which is an outdated definition on AI because, in today’s age, AI has the possibility of being superior in intellect to a human being. Joshi (2020) continues to elaborate on how Turing saw AI more from the human behavior side of things rather than the intelligence side (Joshi, 2020).

It is interesting to note that the primary objective of AI is to build an intelligent machine using machine learning and deep learning, and the second goal or objective is to find out about the nature of intelligence. Further: “As per modern perspective, whenever we speak of AI, we mean machines that are capable of performing one or more of these tasks: understanding human language, performing mechanical tasks involving complex maneuvering, solving computer-based complex problems possibly involving large data in a very short time and revert back with answers in a human-like manner, etc.” (Joshi, 2020).

Moreover, there are two aspects of AI as viewed from a human-like behavior standpoint. One is where a machine is intelligent and is capable of communication with humans but does not have any locomotive aspects. HAL is an example of such AI. The other aspect involves having physical interactions with human-like locomotion (ability to move from one place to the other) capabilities, which refers to the field of robotics (Joshi, 2020).

Robotics and likewise fields will not be covered in this work.

As mentioned by Phuong Nguyen (2024), AI has the potential to revolutionize several aspects of many sectors, such as the maritime industry, energy, transportation, manufacturing, and agriculture (Phuong Nguyen et al., 2024). Despite the growing recognition of AI’s potential in enhancing maritime operations and sustainability, significant gaps remain in both the scientific and practical literature (Durlík, Miller, Kostecka, Łobodzińska, et al., 2024). Durlík (2024) keeps emphasizing how previous studies often focus on isolated applications of AI, such as fuel optimization or autonomous navigation, without addressing the comprehensive integration of AI technologies across maritime operations. Which is something this work will help solve.

When it comes to the maritime industry and shipping, AI can optimize routes, reduce fuel consumption, and improve operational efficiency by analyzing data gathered from sensors, weather reports, and historical travel records (Phuong Nguyen et al., 2024).

However, the adoption of AI is not devoid of challenges. The research analyzed by Ismanov (2024) has delved into the barriers faced by organizations, including the high initial costs of AI implementation, the complexity of integrating AI with existing systems, and the scarcity of skilled personnel to manage AI technologies. The studies call for a balanced approach to adopting AI, emphasizing the need for strategic planning, training, and investment in infrastructure to fully leverage AI's potential in cost management (Ismanov et al., 2024).

Table 1 - Challenges and solutions with AI

Challenges	Solutions
High initial implementation cost	Government incentives and subsidies for AI adoption
Complex integration with existing systems	Gradual implementation with hybrid AI-human systems
Lack of skilled personnel	Investment in AI education and workforce training
Ethical and regulatory concerns	Developing standardized regulations and ethical AI frameworks
Data privacy and security risks	Enhancing cybersecurity measures and data protection laws

Source: (Ismanov et al., 2024)

### 2.1.1 AI Regulations

As AI technologies advance, the absence of robust regulatory frameworks and ethical guidelines has become increasingly problematic. The global regulatory landscape remains fragmented, with different countries and industries adopting varying approaches to AI governance. The European Union's AI Act, the U.S. Executive Order on AI, and other sector-specific initiatives illustrate attempts to regulate AI (Kulothungan, 2024).

The regulation of AI has evolved significantly over the past several decades, reflecting the increasing sophistication of AI technologies and growing awareness of their societal impacts. This evolution can be divided into four key phases: early awareness, the emergence of ethical guidelines, the development of initial regulatory frameworks, and the current acceleration toward global governance. Kulothungan (2024), understanding this historical progression is essential for identifying both the achievements and shortcomings of AI regulation today (Kulothungan, 2024).

In 2014, the European Parliament passed one of the first legislative efforts to address AI, adopting a resolution on "Civil Law Rules on Robotics" <sup>1</sup> This was followed by the U.S. government's 2016 report, "Preparing for the Future of AI," which called for proactive measures to ensure AI safety and ethical use. Around the same time, the Institute of Electrical and Electronics Engineers (IEEE) launched its "Ethically Aligned Design" initiative, which laid out principles for the ethical development of autonomous systems (Shahriari & Shahriari, 2017). These early guidelines, while not legally binding, represented a growing recognition of the need to manage AI's risks responsibly (Kulothungan, 2024).

The European Union has led in the efforts of legislating AI with the introduction of its AI Act, which is set to take effect in 2024. The Legislation is groundbreaking and adopts a risk-based approach, categorizing AI systems based on their potential impact and imposing proportionate regulatory measures. Similarly, the United States has intensified its regulatory focus, with the issuance of the 2023 Executive Order on "Safe, Secure, and Trustworthy Development and Use of AI," which emphasizes safety and security standards for AI applications (Kulothungan, 2024).

Table 2 - History of AI regulations

Phase	Key Developments
Early Awareness (Pre-2014)	Initial discussions on AI risks and ethics.
Ethical Guidelines Emerge (2014–2016)	<ul style="list-style-type: none"> <li>- EU: Civil Law Rules on Robotics (2014).</li> <li>- US: Preparing for the Future of AI (2016).</li> <li>- IEEE: Ethically Aligned Design initiative.</li> </ul>
Initial Regulatory Frameworks (2017–2022)	<ul style="list-style-type: none"> <li>- Increased focus on AI ethics and risk management.</li> <li>- Industry-specific regulations developed.</li> </ul>
Global Governance Acceleration (2023-Present)	<ul style="list-style-type: none"> <li>- EU AI Act (2024): Risk-based regulatory approach.</li> <li>- US Executive Order (2023): AI safety and security standards.</li> </ul>

Source: (Kulothungan, 2024)

## 2.2 AI in the Maritime Industry

Maritime transportation plays a crucial role in logistics and supply chains, as roughly 90% of all goods are transported by sea. At the same time, maritime transportation deals with some risks and challenges, such as human errors, climate change, and variable sea conditions, which could cause collisions, spills, etc. Not only is safety compromised, but these errors are also highly costly for companies, humans, and the environment. All these errors also put human life and the environment on board at risk, and companies are now more than ever interested in using AI to decrease risks and overcome those challenges (Durlík, Miller, Kostecka, & Tuński, 2024).

When it comes to the applicability of AI in the maritime industry, it is important to distinguish between onshore/offshore operations and port operations in shipping affairs. The scope of AI in the marine sector is broad and consists mainly of the effects of optimization of transport routes, loading, delivery time and costs, autonomous ships/ports/terminals, customer relations, marketing, purchasing, cybersecurity, decision-making, predictive maintenance, navigation, as well as fleet management. By using machine learning algorithms, AI can monitor fleet costs and performance, analyze data on fuel consumption, vessel health, and data from weather reports, and likewise best optimize the route for cost and fuel savings (Phuong Nguyen et al., 2024; Raźniewska, 2024).

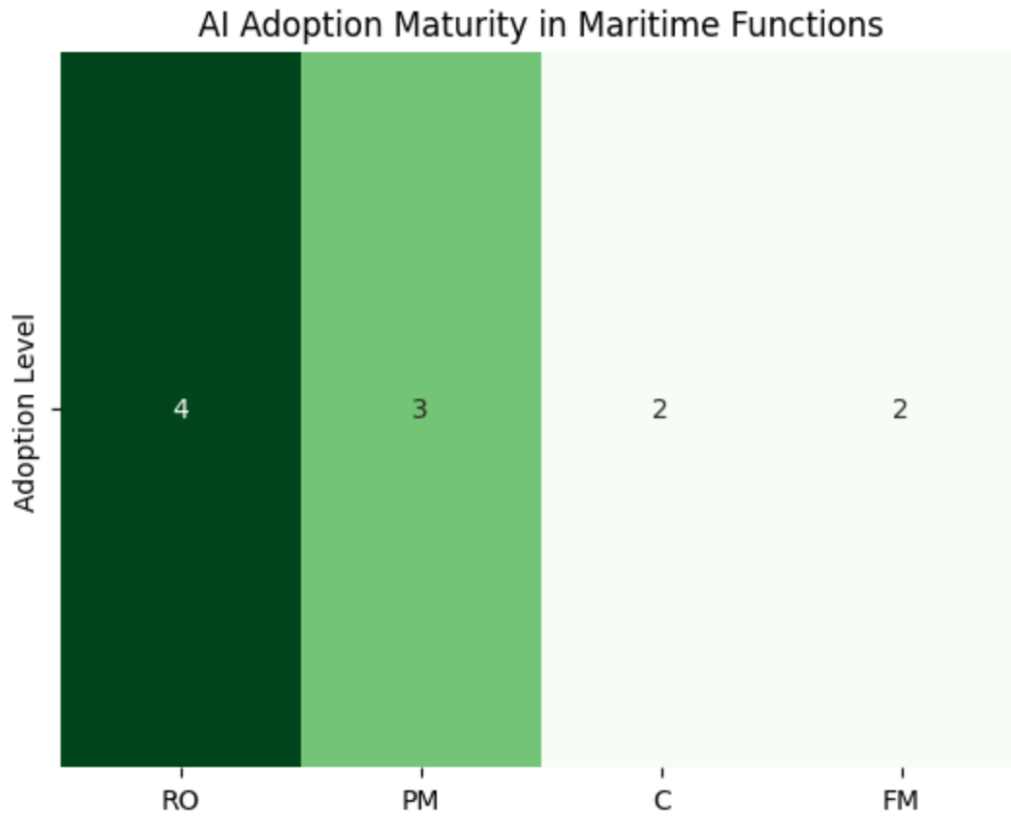


Figure 1 - Heatmap of AI's Adoption Maturity in Maritime Functions.  
 Source: (Phuong Nguyen et al., 2024; Raźniewska, 2024).

RO = Route Optimization

PM = Predictive Maintenance

C = Cybersecurity

FM = Fleet Management

### 2.2.1 AI in Optimization of Routes and Loading

Optimization of transport routes can be defined as an act of taking customer orders and considering the available resources, the canal network, and operational constraints, and determining the combination of routes and stops that best meet the company's objectives. Many of the traditional approaches to route optimization may involve the use of historical data, which may not be so helpful to real-life situations. That is why a feature of the dynamic AI-routed algorithm optimizes the delivery routes depending on traffic, weather, and other factors in real time. According to a study by Royappa (2024), these algorithms could decrease delivery time by 20 percent and greatly decrease fuel usage (Royappa et al., 2024). The same research also shows that AI has the capability of making the sustainability of logistic operations by decreasing the carbon footprint.

One of the most important elements within logistics is load optimization, which has been positively influenced by using AI techniques. Royappa (2024) noted that a load can be balanced by using AI algorithms such as size, weight, and destination of a shipment. In terms of load optimization and reduction in the number of necessitated trips to impact operational cost and vehicle utilization rate, the study analyzed by Royappa (2024) proved that this could be made possible through the application of AI with a packet increase of up to 30%. The authors also explained that this approach also reduces the implications of the environment from logistics operations since fuel consumption and emissions will drastically be reduced (Royappa et al., 2024).

Shipping fuels have the highest cost for every company, but also the most environmental impact, and they cause many environmental issues, such as climate change. By making small changes, shipping companies can save up to 25% on fuel. There are many ways to help the ships use less fuel, such as choosing the best routes or having the perfect speed. The weather has a huge impact on fuel usage, and finding the best routes through the weather becomes more important. Predicting the weather and the best routes by mathematical calculations can take time and might not be very accurate. In this case, AI and ML can be extremely useful, as AI has the capability to perform calculations in minimal time, while ML enables AI to continuously improve over time (Durlík, Miller, Kostecka, & Tuński, 2024).

### **2.2.2 Smart Ports/Terminals**

Autonomous ports, or rather smart ports, are an ever-growing phenomenon where the digital transformation of ports allows traditional manual terminals to evolve into automated ones, addressing issues like labor shortages. Automated container-moving vehicles, capable of precise navigation within the port, replace manpower-driven trucks, thus enhancing productivity and reducing congestion. Integrating technologies such as AI and others alongside upgrading traditional gantry cranes, yard trucks, and external trucks to meet current port conditions can facilitate intelligent interaction between automated port machinery and horizontal transportation equipment. This integration creates a smart, safe, and environmentally friendly port environment, offering a comprehensive solution for automated horizontal transportation. The automation of ports not only improves efficiency and competitiveness but also reduces environmental impacts and stimulates the development of surrounding economies. This new, digitally driven model presents both opportunities and challenges for the future of ports (Chen et al., 2025).

Table 3 - Comparison between Automated and Traditional Ports

Port	Automated	Traditional
Productivity	High	Medium
Environmental impact	Low	High
Operational costs	Low	High
Safety	High	Medium

Source: (Chen et al., 2025)

### 2.2.3 AI for Relationship Management

Further, the use of AI has an impact on improving reactivity and flexibility, which allows companies to quickly respond to changes, failures, or non-standard situations. This allows companies to be more flexible and adapt to changing conditions quickly and effectively while increasing their market competitiveness. According to Razniewska (2024), in terms of return shipment and complaint management, AI can identify products, manage returns, and handle complaints. This allows companies to deal with problems and maintain a good relationship with the customer quickly and accurately. AI can analyze customer data, including purchase history and preferences, to create a more personalized transaction experience. AI-driven chatbots can provide instant support and enhance response times and availability. AI can also adjust pricing in real time based on demand, customer behavior, and competitor pricing. AI can also track and analyze customer interactions across multiple channels, omnichannel, and help to enhance relationship management (Razniewska, 2024).

As mentioned before, AI can help reduce fuel costs/consumption and optimize routes, but it could also be a vital player in improving operational efficiency through predictive maintenance. As Phuong Nguyen put it, “*These three factors must interact for the marine industry to be viable over the long run. For instance, AI can help integrate renewable energy sources and alternative fuels*” (Phuong Nguyen et al., 2024).

### 2.2.4 AI as a Cybersecurity Mitigation

The threat of cyberattacks is great and growing. In fact, relevant organizations such as the IMO have declared the ‘urgent need to raise awareness on cyber-risk threats and vulnerabilities, to support safe and secure shipping, which is operationally resilient to cyber-risks’ encouraging ‘administrations to ensure that cyber-risks are appropriately addressed in safety management systems, no later than the first annual verification of the company’s Document of Compliance after January 1, 2021 (Maritime Organization, n.d.).

AI has emerged as a transformative force in cybersecurity, offering unparalleled capabilities in threat detection, incident response, and risk management. With its ability to process vast amounts of data in real-time, AI systems can identify cyber threats with unprecedented speed and accuracy, predicting vulnerabilities and enhancing overall security. However, the rapid integration of AI into cybersecurity also raises significant ethical and regulatory concerns. These concerns include privacy violations, bias in AI-driven decision-making, lack of transparency, and diminished human oversight (Kulothungan, 2024).

Only 55 cyberattacks were analyzed from August 2022 to March 2023. A simplified explanation of how sensors work is that they analyze the position of the ship and hindrances from inside and outside of it and pass the data on to the AI Model. AI Model analyzes the gathered data in real-time and determines how the ship can operate with stability (Yoo & Jo, 2023).

Now, if attackers succeed in accessing the dataset of the ship, there will be some scenarios of what can happen. The attacker can change the planned route or plan an accident or collision, access the control system and make the ship inoperable, or input wrong data to force the ship to make unsafe decisions. In Figure 2, you can see the ship dataset intended for use in a data poisoning attack simulation (Yoo & Jo, 2023).

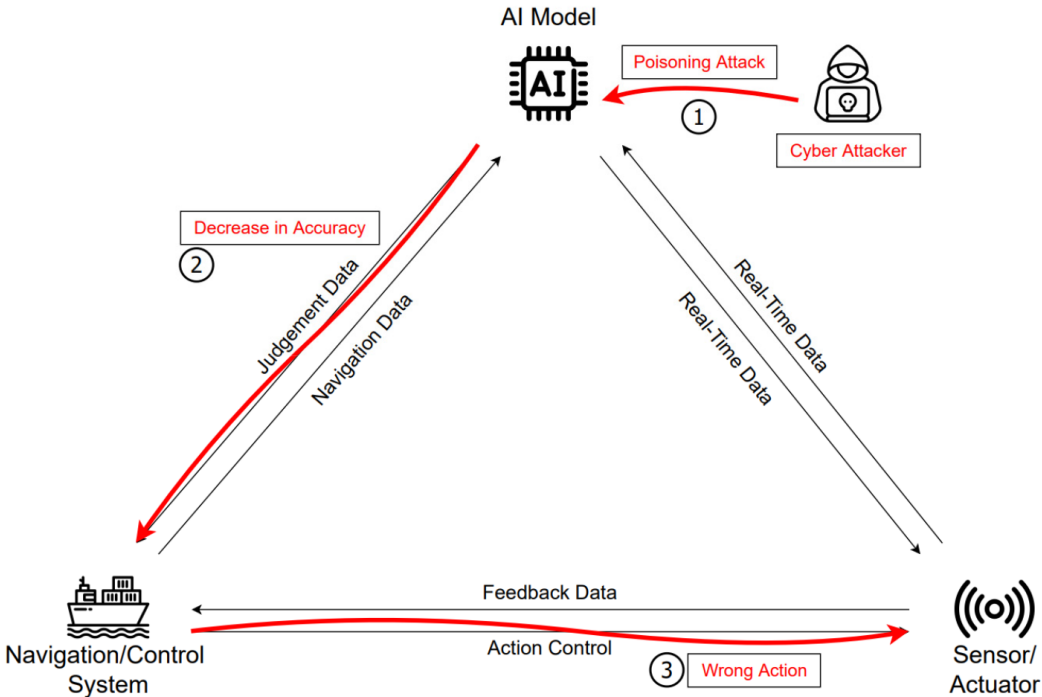


Figure 2 - The Ship Dataset is Intended for a Data Poisoning Attack Simulation. Source: (Yoo & Jo, 2023). CC-BY

There can be many ways for shipping companies to stop or overcome these cyberattacks. By thinking that there will be happen a cyberattack at some point will help the companies to build more secure software from the beginning, testing the software continuously and fixing its bugs before the hackers find it will stop them from accessing the system, and running fake cyberattacks will help the shipping companies to find out their software's weakness and in result, they can make it more secure in case to stop hackers (Yoo & Jo, 2023).

### **2.2.5 Predictive Maintenance**

In the maritime industry, predictive maintenance (the use of historical time series and failure data to predict the future potential health of equipment and to anticipate problems in advance which enables businesses to optimize maintenance scheduling and improve reliability) has gained significant importance due to the complexity and scale of naval operations. The objective is to optimize maintenance activities by analyzing data provided by the system, thus enhancing operational efficiency and safety. Predictive maintenance involves transmitting operational data from sensors to storage units, where the onboard monitoring and control system triggers alarms and protections. Maintenance teams evaluate the received data, respond to alarms, and take appropriate actions to restore system functionality (Simion et al., 2024).

AI and ML have become indispensable in improving predictive maintenance. Traditional maintenance strategies, such as corrective and preventive maintenance, are increasingly insufficient to meet the stringent safety and efficiency standards required by the maritime industry. AI-based learning systems, which simulate the state of industrial processes or components using available measurement data, are widely adopted in maintenance engineering. These systems help increase equipment availability, reduce maintenance costs, and enhance system reliability by predicting potential failures before they occur (Simion et al., 2024).

Simion keeps addressing how ML plays a critical role in analyzing large volumes of multidimensional data, enabling operators to predict system failures and estimate Remaining Useful Life (RUL). By learning from historical operational data, ML applications can identify patterns and trends that signal potential equipment failures. This is especially important in maritime operations, where incidents often result from a chain of risky events. By applying ML techniques and AI technologies, maintenance teams can detect faults more accurately and quickly, improving overall system safety and operational efficiency (Simion et al., 2024).

## **2.2.6 The Use of AI in Fleet Management**

Fleet management encompasses the systems, processes, and tools needed to ensure an organization's fleet of business vehicles is maintained throughout its entire lifecycle. It also involves the management of fleet drivers, optimization of fleet operations, and improvement of asset utilization. The complex nature of fleet management in maritime logistics involves highly interdependent decision processes, which lead from a list of product transportation requirements specified by the production division to a corresponding set of fully configured ship missions capable of meeting such transportation requirements in a cost-effective way. In particular, the information pertaining to each product transportation requirement includes the monthly product quantity and the corresponding port plants of origin and destination. The fully configured ship missions are specified in terms of product aggregations, transportation routes, resources (ships) allocation, and estimated departure times (slots) for each of the ports involved in the mission. While several approaches can be pursued for the optimization of the entire product transportation network (e.g., AI techniques, Linear Programming, Simulation, etc.), none of them can address the whole problem alone (Yucesan et al., 2002).

## **2.3 Using AI for More Sustainable Shipping**

The evolution of green shipping and sustainability policies throughout history has been defined by a growing understanding of environmental concerns, the establishment of sophisticated standards, and a shared determination to limit the ecological effects of the maritime sector. Concerns about the environmental impact of the shipping sector first surfaced in the later part of the 20th century, when the roots of environmentally aware maritime legislation can be traced back to its beginnings. Nguyen (2024) keeps emphasizing that the increase in pollution, oil spills, and rubbish dumping in seas has been a concern for environmentalists and governments worldwide (Phuong Nguyen et al., 2024).

### **2.3.1 Green Shipping**

Green shipping or sustainable shipping is defined as the balance between economic, social, and environmental performance (Ong et al., 2022). With the growing emphasis on sustainable development for the blue economy (sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem), sustainable shipping has been putting great attention as one of the biggest sustainable-related challenges in the 21st century. The increase of international regulations such as the Energy Efficiency Design Index, Ship Energy Efficiency Management Plan, and Ballast Water Management System aims

to enforce innovative solutions for sustainable management of the oceans, including but not limited to combating pollution and loss of habitats and biodiversity from ship operations (Ong et al., 2022).

Additionally, shipping companies are increasingly enforcing self-regulatory or market-driven initiatives, technologies, and measures, such as International Organization for Standardization (ISO)14000, ISO 26000, slow-steaming, cold-ironing, biocide-free paints, and renewable fuel alternatives, to reduce operating costs, create value-added services, and reduce the negative impact of their operations on society as well as the environment. Hence, sustainable shipping plays a critical role in sustainably managing and preserving the marine ecosystem by reducing significant adverse impacts from ship operations. It requires shipping companies to strengthen their resilience, act for restoration, and achieve a balance in their economic, social, and environmental performances (Ong et al., 2022).

### **2.3.2 AI applicability**

AI has the potential to assist in achieving and exceeding the stringent criteria in the industry. The Baltic and North Seas are two examples of areas recognized as Emission Control Areas (ECAs), designated with more rigorous emission regulations. Because ships operating in these locations are expected to comply with higher limitations on emissions, the utilization of technology driven by AI to monitor and regulate emissions is becoming increasingly vital. A significant number of countries have enacted their very own laws and regulations concerning emissions, pollution, and environmentally responsible shipping operations. The use of AI is highly advantageous since it enables inter alia warships to satisfy a wide variety of needs that are constantly evolving (Phuong Nguyen et al., 2024).

Nguyen (2024) states that AI integration within the framework of the mentioned policies and regulations involves the utilization of AI for:

- Strategies for monitoring and reducing emissions. Implementing predictive maintenance to optimize vessel performance and minimize operational interruptions.
- Optimization of vessel routes to achieve fuel efficiency and minimize emissions.
- Improved safety is achieved by utilizing AI-powered autonomous navigation systems.

- The integration of AI in the maritime sector addresses environmental concerns and facilitates compliance with regulations. Furthermore, it offers potential for enhancing the industry's sustainability, efficiency, and safety.
- AI's capacity to foster innovation and promote environmental responsibility in maritime operations is increasingly acknowledged by policymakers and stakeholders.

### **3. METHODOLOGY**

The methodology segment of this thesis encompasses the methods used in this work. Research on AI and the maritime industry was conducted through a methods approach, where different qualitative information collection methods were used. These methods include multiple structured, semi-structured, and unstructured interviews, providing sufficient data on the subject.

#### **3.1 Planning of Thesis**

The planning of the thesis was done through a process of discussion between the authors on what subject to research and write about. After a couple of discussions, the authors landed on AI and its implications on the maritime sector, specifically onshore operations. The reason for that was that it went in line with the author's experiences and interests. Following the decision of the topic, a gant-schedule was done, which served as a checklist for the thesis. After the schedule was done, the following research questions were found:

- In what ways is AI currently applied in onshore maritime logistics, and which operational areas show the most progress and potential?
- How can AI contribute to improving environmental sustainability and supporting compliance with maritime regulations such as EU-ETS and Fuel EU Maritime?
- What organizational, cultural, and regulatory barriers affect the adoption and effective use of AI in the maritime logistics sector?

When choosing which methods to use, the authors looked at the available data on the subject. They decided to approach the task with semi-structured interviews.

#### **3.2 Search Strategy**

As a search strategy, the primary database used for this thesis was Chalmers Library, and the research was conducted in a way of first gathering basic knowledge on keywords from Wikipedia on AI. After knowledge had been gained, the search began. To ease our search, the following keywords were used in combination with other Boolean operators:

The table below shows each keyword that was separately used in the searching process for this thesis.

Table 4 - Keywords used in the searching process.

- |                                 |                               |                                  |
|---------------------------------|-------------------------------|----------------------------------|
| • Artificial intelligence       | • AI in the maritime industry | • AI and fleet management        |
| • Machine learning              | • AI and route optimization   | • AI for relationship management |
| • Big data                      | • AI and cost reduction       | • AI in marketing                |
| • AI regulations                | • AI and cost efficiency      | • AI in purchasing               |
| • EU AI act                     | • Autonomous vessels          | • AI and cybersecurity           |
| • AI and maritime industry      | • Autonomous ports            | • Predictive maintenance         |
| • AI and predictive maintenance | • Autonomous terminals        | • Etc.                           |

What is included in the theory is purely data and information from peer-reviewed articles, books, and magazines, and excluded are all other data not related to the research topic.

### 3.2.1 Selection and Evaluation of Sources

When selecting the relevant research for this thesis, the authors began to use the keywords in the Chalmers library database and scoured hundreds of studies by reading the abstracts and skimming through the texts to find relevance to their own work. After thorough searching, they found suitable data for each chapter and began building their theory part. No tools or frameworks were used when evaluating the studies, because they were already peer-reviewed, the authors put their trust in the professionals and kept using the data they found available. Furthermore, when articles, books, and magazines in line with the research topic were found, the relevant information had to be extracted from the literature and reviewed. This information included the use of AI in the maritime sector and its different applications for the betterment of shipping operations.

### 3.3 Interviews

The authors chose to base their results on interviews due to the exploratory nature of the research topic and the limited availability of existing data on AI in the maritime logistics sector. A preliminary review of the literature revealed a notable gap in empirical studies, particularly those focused on AI integration in onshore maritime operations. Given this knowledge gap, and the context-specific, experience-driven character of AI adoption, the use of a qualitative method was deemed most appropriate.

Quantitative approaches, such as surveys or statistical analysis, were considered during the initial planning phase. However, it quickly became evident that such methods would not provide the depth or flexibility required to capture the nuances of organizational behavior, cultural resistance, and strategic decision-making that characterize AI implementation in this field. Consequently, the authors opted for a qualitative approach using semi-structured interviews, which allowed for both consistency in key themes and adaptability in exploring unexpected insights.

The interview questions were designed collaboratively by the authors, with iterative discussions and brainstorming sessions used to refine the focus and ensure alignment with the study's aim and research questions. Some interview was conducted in Swedish and some in English. To enhance the depth and clarity of the questions, the authors also consulted ChatGPT as a brainstorming and language-polishing tool. This assisted in shaping questions tailored to the unique position of each participant.

Because companies differ in their organizational structure, market role, and degree of digital maturity, it was concluded that some variation in interview protocols was necessary. Question sets were adjusted based on each company's operational area (e.g., vessel management, terminal logistics, port coordination) and the scale of their regional influence. The interview design aimed to balance comparability with contextual relevance.

Once finalized, the interview guides were submitted to the thesis supervisor for review and approval. After approval, the interview questions were distributed to participants in advance, ensuring transparency and giving them time to reflect on the themes. This was particularly important given the open, discussion-based nature of the interviews, which sought not only to extract data but to foster a mutual learning experience for both participants and researchers.

Ultimately, the interviews were intended to serve as a platform for knowledge exchange, capturing real-world perspectives while also informing and educating participants, authors, and future readers. This approach supports the overarching goal of generating “thick data”: insights that are rich in context and grounded in the lived experiences of industry professionals.

### **3.3.1 Participation Selection**

Before initiating the interview phase, it was essential to identify a suitable sample population aligned with the study’s focus. This included companies involved in onshore maritime operations, such as those managing vessel logistics, sales, port calls, terminals, or port operations. Once organizations fitting this profile were identified, they were contacted to identify potential participants.

Selection criteria prioritized individuals with practical experience and insight into maritime operations, combined with a foundational understanding of emerging technologies. Preference was given to interviewing both higher management and IT personnel, ideally from the same organization, to ensure rich, multifaceted data. This approach was designed to capture diverse perspectives across functional roles and operational domains, thereby generating “thick data” from multiple internal viewpoints within each company.

### **3.4 Analysis of Interviews**

To analyze the collected interview data, a thematic analysis approach was applied. This method is well-suited for identifying, analyzing, and reporting patterns (themes) within qualitative data and allows flexibility while maintaining transparency and traceability in the analysis process.

Table 5 - The Analysis Followed These Structured Steps

Steps	Description
<b>Transcription and Familiarization</b>	All interviews were transcribed manually, and the transcripts were read multiple times to ensure familiarity with the data and to capture contextual nuances. This stage helped establish an initial sense of emerging patterns.
<b>Initial Coding</b>	Segments of the text were coded using a mix of deductive (theory-driven) and inductive (data-driven) approaches. Deductive codes were informed by the study’s research questions and theoretical framework (e.g., AI use, sustainability, organizational barriers), while inductive codes emerged directly from the interviewees’ expressions.
<b>Theme Development</b>	Related codes were clustered into broader themes reflecting recurring concepts across both interviews. Examples of developed themes include <i>Cultural Resistance</i> , <i>Predictive AI Applications</i> , <i>Cybersecurity Constraints</i> , and <i>Sustainability through AI</i> . These themes became the basis of the results chapter structure.
<b>Review and Refinement</b>	Themes were reviewed and refined to ensure internal coherence and distinction from one another. Some overlapping codes were merged, while others were separated into subthemes to reflect their specific relevance.
<b>Interpretation in Context</b>	Final themes were interpreted in relation to the research questions and theoretical literature. Quotations from participants were selected to illustrate core insights and support claims made in the analysis.

This method allowed the study to move beyond surface-level observations to uncover deeper patterns in attitudes, practices, and expectations surrounding AI integration in the maritime logistics sector.

### **3.5 Ethical Concerns**

Before starting the interviews, the participants had been reached out to beforehand, where they got informed on our study, our goals with the interview and the questions that were going to be asked, and asked for their consent for participation, well informed of their rights to withdraw at any time during the interview. When the participant has consented to being interviewed, they should sign a written agreement, afterwards being asked if the authors are allowed to record their conversation. If yes, they record; if no, they take notes. Further, the interviewees were asked if they wanted to be anonymous with their company or say who they represented.

The theory was conducted in a way where the Chalmers Library was the source and database used for all peer-reviewed articles, journals, and books. The ethical consideration of the theory is irrelevant because no personal data was obtained from individuals during the process of writing the theory chapters.

### **3.6 Limitations**

The limitations of the methods used are that only relevant articles of at most ten years of age should be used in the theory, and that no other sources of articles and books shall be used except the database Chalmers Library. As for the interviews, the limitations are that the companies are going to operate in the Gothenburg metropolitan area, and research beyond that region will not be conducted.

# 4. RESULTS

This chapter presents the results of qualitative interviews conducted with two senior executives from two maritime logistics companies (see Appendix 1), a PhD student/co-teacher in the AI research area (see Appendix 2), and a port operations manager (see Appendix 3). From the logistics companies, one is a global container shipping firm, and the other is a Sweden-based ship management company. The aim was to understand how AI is being integrated into maritime operations, particularly onshore processes, and to explore associated opportunities, challenges, and strategic implications. Thematic analysis was used to code responses and identify recurring themes that reflect AI’s current and future role in the sector. All interpretations are directly grounded in the interview data.

## 4.1 Visual Summary of AI Application Trends

The table below presents thematically coded examples drawn from the four interviews.

Table 6 - Summary of AI Applications in Interviewed Maritime Companies

Function	Examples from Interviews	Usage Level	Comments
Route Optimization	Dynamic route planning using weather and port data through the Swedish Meteorological and Hydrological Institute (SMHI)	High	Common in large shipping firms; key for efficiency
Predictive Maintenance	Component replacement based on usage hours	Moderate	In development, adoption hindered by regulatory constraints
Document Automation	ESG reports, contract review using AI models	Growing	Increasing use in compliance and admin support

Cybersecurity	AI-driven phishing detection, policy enforcement	High	Strong security, but creates workflow friction onboard
Customer Communication	AI support for meeting prep and documentation	Low	Personal interaction still central to customer relationships

## 4.2 Interview Themes

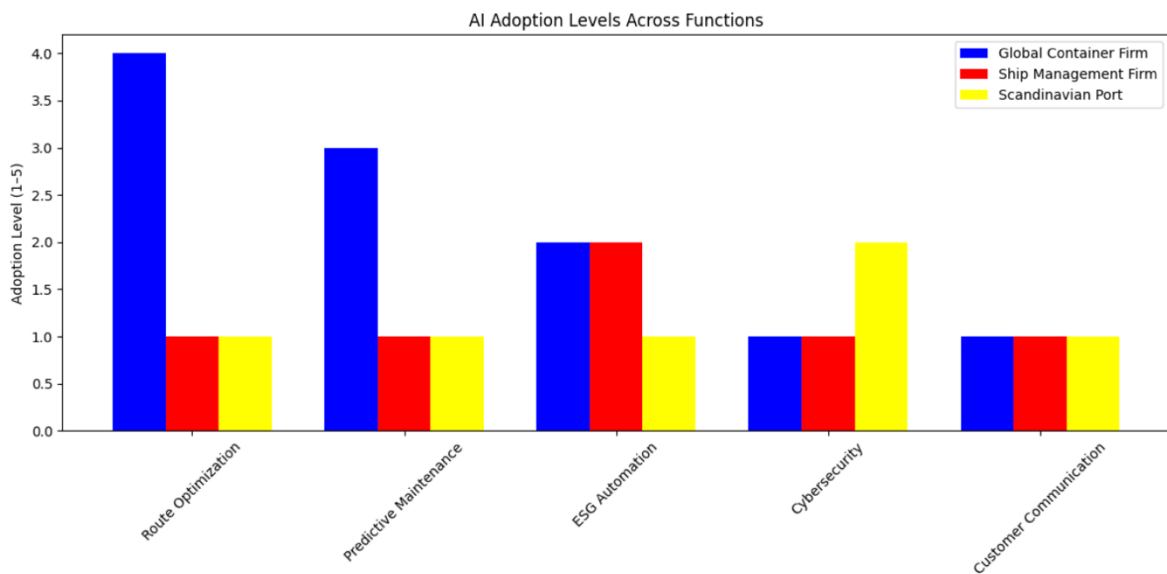


Figure 3 - Graph Showing the Adoption of AI Across Different Functions.

### 4.2.1 Hesitation and Lack of Knowledge

The main obstacle to implementing AI successfully was cultural resistance. The CCO of the container logistics firm observed that employees had different levels of readiness for AI adoption between those who accepted the technology and those who feared job replacement. The widespread belief that AI adoption leads to higher job replacement rates intensifies this fear. The ship management firm CEO shared similar concerns because maritime industry members tend to view new technologies as short-term fads instead of essential strategic tools. The port representative stated that the port does not possess a well-developed internal AI knowledge base which restricts its capability to create and expand digital solutions internally. The AI researcher stated that poor AI understanding throughout organizations stands as the main obstacle to quick implementation of basic AI tools. All interviewees agreed that internal knowledge development and positive attitude promotion through structured education and

leadership support are essential to overcome cultural challenges. The company identified reskilling as a crucial requirement for workers whose duties could become automated.

#### **4.2.2 AI for Route Optimization and Predictive Planning**

The container company applies AI technology to optimize routes and combine weather information with fuel usage analytics and predicted arrival time predictions. The application holds exceptional importance for mega-vessels because precise operations determine both cost efficiency and regulatory compliance. The company employs AI to process real-time data for suggesting the most suitable port arrival periods. The port authority implemented AI-based systems which improved port call coordination and reduced waiting times to fulfill environmental and logistical requirements. The ship management firm depends on traditional weather services from the Swedish Meteorological and Hydrological Institute (SMHI) for their decision-making process but has not adopted predictive routing models. Predictive maintenance has started to become more popular in both organizations. The container firm employs AI technology to trigger alerts and perform preventive component replacements, but the ship management firm is currently testing manual versions of this system. Predictive maintenance methods face ongoing resistance from regulatory bodies which prevents their widespread adoption.

#### **4.2.3 Cybersecurity and Operational Limitations**

Every interview participant identifies cybersecurity as their main concern. The container firm established improved security measures after the major cyberattack through phishing simulation training and tightened access authorization procedures. The ship management company implements security measures which include internet restrictions and external port deactivation on ships to stop breaches. The port authority operates its data systems through a closed system called CoPilot which excludes public platforms including ChatGPT. The implemented security measures result in additional expenses. All organizations stated that their security restrictions lead to operational delays while making it hard for frontline staff to obtain real-time information. The AI researcher stated that security and efficiency tradeoffs present a difficult challenge which needs industry-wide discussions about risk tolerance and creative security solutions for operational flexibility.

#### **4.2.4 Document and ESG Automation**

AI technology demonstrates rising capabilities to enhance documentation processes while supporting sustainability goals and compliance requirements. The container firm uses AI technology to enhance ESG reporting optimization and contract scanning and internal record management. Legal reviews require human participation to achieve their completion. The ship management firm is currently testing ChatGPT along with other tools for creating policy documents and ESG summaries, although their technological capabilities remain limited. The company maintains ongoing development of its “sustainability agent” AI system which monitors new regulations and assists with ISO certification because compliance demands extensive administrative work. The digital emissions dashboard at the port gathers vessel and port call information to enable immediate emission tracking. The tool enables organizations to create reports and evaluate their performance against EU standards while advancing their sustainability goals. All interview participants confirmed that AI documentation tools boost operational speed and reduce important compliance errors.

#### **4.2.5 Human vs. Machine Roles in Communication**

The development of AI technology has not eliminated the need for human interaction when dealing with stakeholders. All interview participants agreed that human decision-making abilities together with relationship development are essential for negotiations and client service and strategic discussions. The use of AI technology continues to expand its applications in supporting operations that occur in the background. The container firm and the port authority leverage AI tools to enhance their meeting preparation and internal communication processes by drafting emails and summarizing reports and filtering incoming information. The AI researcher explained that natural language processing tools help professionals save time on repetitive work so they can concentrate on complex tasks. The interviewees did not consider AI as a substitute for human communication in maritime logistics operations.

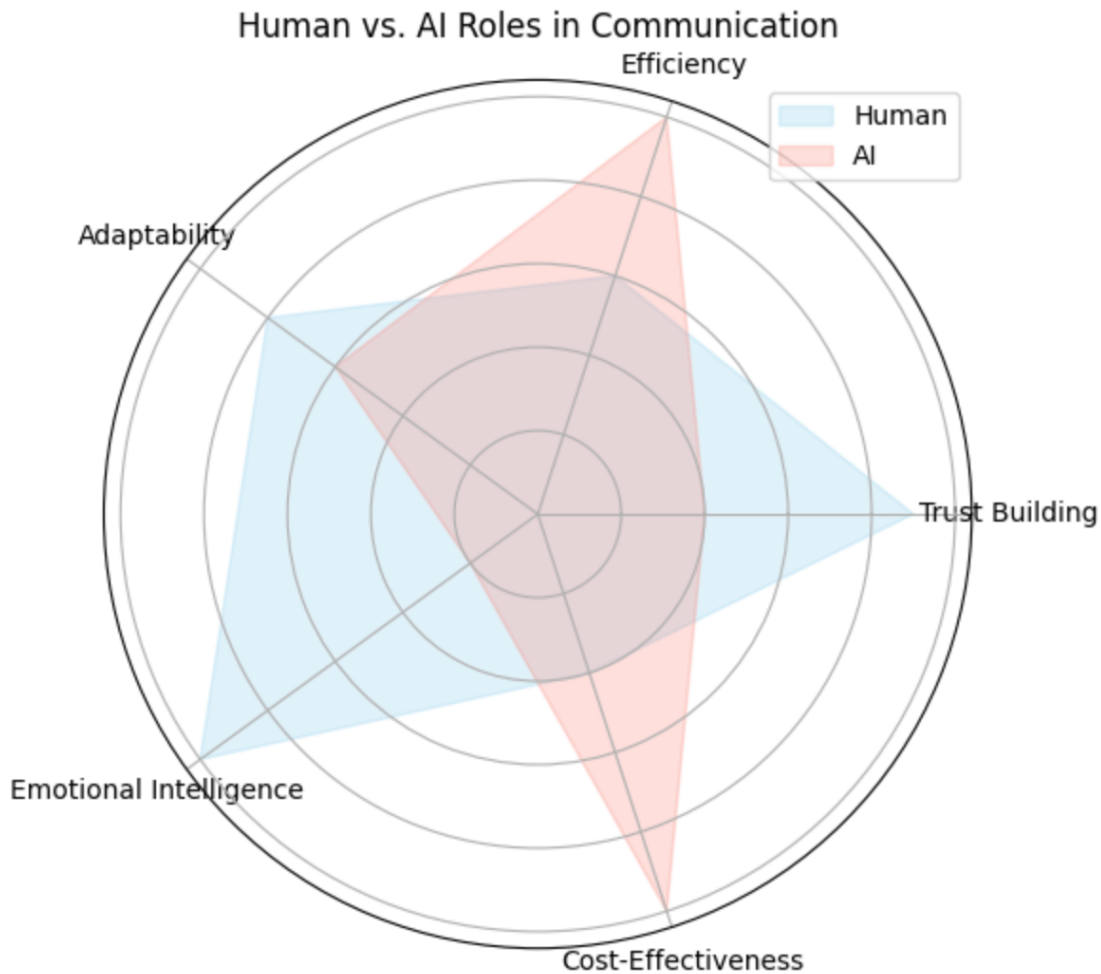


Figure 4 - Human vs AI Roles in Communication.

#### 4.1.6 Organizational Digitization and Learning Culture

The container shipping firm highlighted the presence of an internal "Learning Center," which supports employee development in leadership, sustainability, and AI. With over 180,000 employees, the firm has institutionalized digital transformation as a learning priority, collaborating with Boston Consulting Group for AI training. This shows a strong top-down initiative toward future readiness. In contrast, the ship management firm has not yet formalized its AI training, reflecting a more cautious approach. The AI researcher suggested that companies must view AI not as a product but as an evolving system that requires ongoing learning and feedback loops to improve. All participants agreed that digital literacy, leadership commitment, and the ability to share and standardize data across departments are essential for long-term digital transformation.

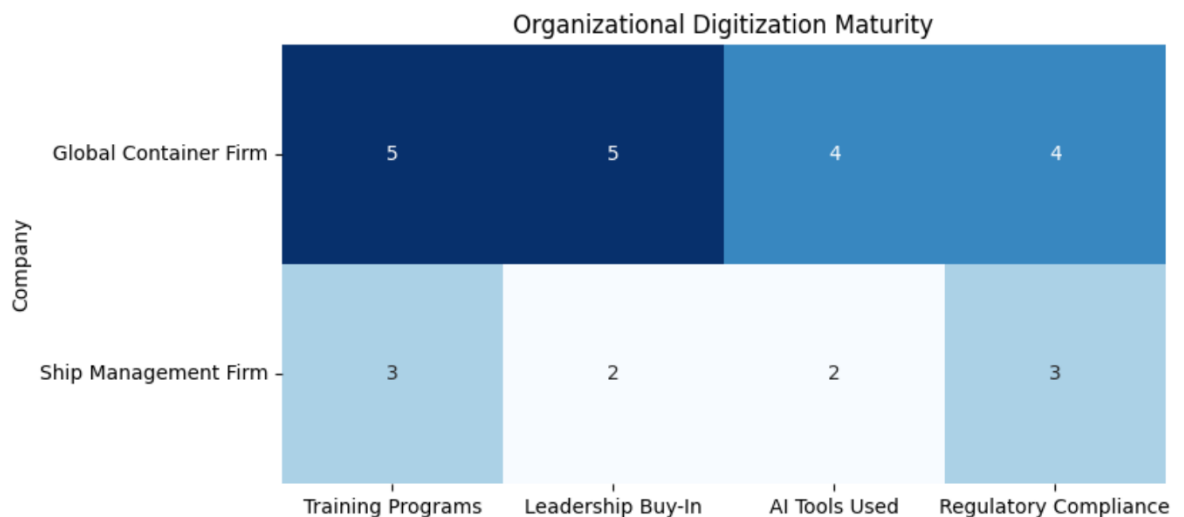


Figure 5 - Organizational Digitization Maturity.

### 4.3 View of an AI researcher

The interviewee explained that AI identifies patterns in data to define a problem and search for an optimal solution. Nonetheless, he noted that finding the correct solution is often challenging because of a lack of data volume and quality. He therefore argued that AI should be regarded as an assistive tool rather than a full replacement for human labour, since it cannot yet be trusted to replicate human judgment entirely. In AI research, chat-based systems are described as performing “retrieval-based approximation,” meaning that their responses should not be treated as definitive facts.

According to the interviewee, a task that previously required five people working full-time for a month can now potentially be completed by one person in five days with AI support. Firms, therefore, need fewer resources to resolve a single issue and can reallocate staff to other challenges. He also observed that many companies could cut personnel and save costs with the implementation of AI. While AI is expected to have a major impact across most industries and to automate certain tasks soon, the interviewee strongly recommended that 70-80 percent of the current workforce be retained because AI remains a machine and cannot yet substitute entirely for human employees.

The interviewee characterised the coming decade as critical. AI has already presented new challenges for governments, businesses, and society at large. Although development is currently progressing at an exponential rate, some theorists warn that AI could eventually collapse, leaving dependent companies vulnerable. In his view, however, the probability of such

a collapse is presently low. The most pressing difficulty, he suggested, lies in sustaining and training AI systems, given their considerable cost.

He concluded that AI's advancement is exponential, and the next decade will be crucial, yet the technology's future trajectory remains impossible to predict because of the rapid pace of its development.

#### **4.4 Sustainability and Compliance through AI**

The maritime industry now recognizes AI as a fundamental technology to support sustainability efforts. The container firm implements AI to optimize routes and track emissions while automating warehouse operations which supports its ESG goals. The ship management firm has readjusted its operations to comply with new emissions regulations and shows interest in implementing AI solutions for these efforts. The port demonstrates AI's effectiveness in emission reduction through its digital dashboard system and coordination tools that minimize vessel idling times. The interviewees stated that AI serves as an essential tool for legal compliance and environmental improvement, but sustainability targets require additional measures.

#### **4.5 Perceived Future Potential and Strategic Value**

All interviewees recognize AI as strategically valuable, but they have different expectations about its implementation. The container firm predicts AI will boost workforce efficiency and help with strategic decision-making processes. The ship management firm shows cautious optimism about AI because it sees value in cost management and operational control but wants to see clearer returns before expanding investment. The port representative highlighted AI's role in the broader transition to electrification and smart infrastructure while indicating that AI will support their sustainability strategy instead of driving it. The AI researcher determined that AI delivers its maximum value through process friction reduction and human decision enhancement when organizations introduce it with clear goals and responsible implementation.

#### **4.6 Summary**

The analysis of data from all four interviews reveals diverse perspectives about AI preparedness and its implementation in maritime logistics operations. The container firm shows advanced proactive behavior regarding AI implementation, but the ship management company remains at an experimental beginning stage. The port authority offers practical insights about how

infrastructure and legacy systems determine the speed of digitalization while the AI researcher provides technical and philosophical perspectives on upcoming challenges and opportunities. All organizations face common challenges because of their limited cybersecurity capabilities and insufficient internal AI expertise and inconsistent regulatory frameworks. All participants in the study agree that AI technology will boost operational efficiency while improving sustainability and regulatory compliance. The complete realization of AI potential requires future development to focus on data quality improvement and workforce development alongside the establishment of cross-sector standards and ethical integration strategies. The results show AI functions as a system-enabling technology which produces substantial change through strategic planning and organizational learning and shared responsibility.

## **5. DISCUSSION**

The chapter analyzes research findings through the lens of study objectives and research inquiries while evaluating methodological aspects and theoretical frameworks, and social and ethical implications. The analysis moves beyond summarizing previous chapters to investigate the complete implications of the findings for AI adoption in the maritime sector according to the established theoretical framework.

### **5.1 Significance of the Study and Its Contributions**

The research shows that AI has transitioned from theoretical concepts to become an essential practical tool that maritime logistics needs today. The implementation of AI applications including optimization, compliance, documentation, and predictive functions has become standard in onshore operational settings, according to Section 2.2. The research results support earlier studies by Phuong Nguyen et al. (2024) and Simion et al. (2024), which demonstrate AI's ability to transform route planning and fuel optimization, and emissions tracking.

The research adds value through its discovery of how organizational context, particularly cultural openness to change and digital maturity, affects the speed and nature of AI adoption. The findings support Ismanov's (2024) argument that technological integration depends on both technical feasibility and organizational willingness, structural readiness, and training capabilities. The study extends AI applicability by including port operations analysis, which demonstrates that infrastructure-level stakeholders now view AI integration as essential for their strategic operations.

### **5.2 Reflection on Research Questions**

The results provide strong evidence to support the three research questions presented in Chapter One. The current implementation of AI technology exists in multiple functional domains, which include route optimization, cybersecurity, predictive maintenance, and ESG documentation. The actual applications of AI in the field confirm the literature's statement that AI functions best within structured data-intensive environments (Nguyen and Raźniewska, 2024).

The research demonstrates that AI tools provide substantial assistance to organizations in their efforts to monitor emissions and maintain regulatory compliance. The port demonstrates how theoretical models become operational through its implementation of digital dashboards for real-time emissions monitoring (Ong et al., 2022). The research supports the general prediction

that AI systems will play a crucial role in making maritime operations compliant with EU-ETS and FuelEU Maritime regulatory standards.

The study demonstrates that the identified obstacles to AI adoption match the challenges which the theory chapter described. The study identifies change resistance and skills deficits and fragmented data systems and cybersecurity concerns as recurring problems which match academic research findings. The maritime industry faces additional barriers because its organizations tend to be risk-averse and show reluctance to invest in untested technologies.

### **5.3 Methodological Considerations**

The research applied thematic analysis as its qualitative method to enable a thorough examination of recurring themes. The study included diverse viewpoints from shipping, ship management, port operations, and academic perspectives, which provided a complex view that reflects real-world scenarios. The research design follows qualitative research recommendations for technology adoption studies as described by Braun and Clarke (2006).

The research contains various advantages, yet it demonstrates certain constraints. The research sample consisted of a limited number of participants who were located only in the Gothenburg area which restricts the study's generalizability. The study's internal validity remains strong because the research findings match established literature and the interviewees' responses show consistent patterns. Future research should build upon this foundation through the addition of more case studies and quantitative methods to enhance generalizability.

### **5.4 Broader Implications: Society, Environment, and Ethics**

The research results indicate AI can help society decrease administrative tasks while creating better planning systems and helping current workers develop new skills. The concerns about job replacement and data dependence expressed by Kulothungan (2024) match the findings of this study. The ethical deployment of AI demands clear system transparency, together with human supervision and decision-making processes that include all stakeholders to stop misuse and prevent overreliance.

AI demonstrates powerful capabilities to support sustainable practices in environmental terms. Real-world applications demonstrate AI's capabilities through emissions dashboards and optimized routing and AI-assisted port call coordination. The developed solutions match the

strategic vision presented in Section 2.3.2 which positions AI as a tool to support green shipping.

The research results show that stakeholders express ethical concerns about how algorithms make decisions, particularly when these decisions affect safety and regulatory requirements. The port representative's warning about excessive dependence on external AI tools demonstrates the requirement for systems that operate locally and provide explainable and ethically governed functionality. Maritime stakeholders need to build their internal capabilities while investing in secure infrastructure to protect operational data from dependency risks.

## **5.5 Patterns, Surprises, and Strategic Insights**

The research revealed three main patterns which showed AI controls administrative operations and compliance tasks while leadership backing remains essential and strategic partnerships serve as an enabling force. The trends support the systemic integration model which Simion et al. (2024) introduced by requiring AI implementation to reach beyond IT departments into HR and operations and compliance functions.

The study revealed two unexpected findings: how strict cybersecurity protocols disrupted operations and how AI started being used for leadership development and internal communication support. The philosophical examination of maritime education's future through AI's impact on traditional professional skills provides a forward-looking perspective to the study's findings.

Organizations that treat AI as an organizational-wide enabler instead of a departmental tool will achieve better success in their AI integration efforts. The findings support the requirement of cross-functional governance together with shared data infrastructure to enable scalable AI solutions.

## **5.6 Final Reflections**

The research combines theoretical knowledge with practical data to establish that AI functions through multiple adaptive layers instead of providing universal solutions. The system demonstrates its power through three main functions which enhance human capabilities by supporting decisions and performing automated tasks and discovering patterns.

Organizations that link their AI deployment to strategic objectives and dedicate resources to ongoing learning and establish robust ethical standards will achieve the most benefits. The

maritime industry stands at a critical digital transformation stage which demands the shift from experimental projects to complete system integration. The development of policies should promote innovation through safe measures that protect operational reliability and data integrity and human oversight.

The discussion shows that maritime logistics can achieve AI's promise through strategic planning and collaborative governance and strong theoretical and practical alignment. The study establishes a research and implementation path for the field by connecting academic and industry knowledge to these developments.

## 6. CONCLUSION

The research explored how AI deployment in onshore maritime logistics operations leads to better sustainability alongside operational efficiency and enhanced regulatory compliance. Senior professionals from three maritime organizations and an AI researcher provided key findings through interviews, which showed:

1. Route optimization and predictive maintenance, along with documentation automation, ESG reporting, emissions monitoring, and cybersecurity practices, have adopted AI solutions in their operational sectors. The research proves significant progress through route optimization and predictive analytics since real-time data integration enhances logistical performance.
2. Organizations implementing AI solutions face their main barriers from cultural and organizational issues instead of technological barriers. The implementation of AI systems depends on digital employee literacy as well as leadership dedication and corporate cultural receptiveness. Organizations that both provide employee training programs and foster cultural openness alongside leadership support will achieve superior AI adoption results.
3. The implementation of AI technology faces substantial limitations because cybersecurity issues function both as positive and negative factors. The research demonstrates that operational safety depends on strong security measures, yet these protocols reduce operational adaptability and creative potential according to the study findings. Organizations must strike an appropriate balance between cybersecurity protection of their systems and operational performance.
4. The deployment of AI systems creates better environmental sustainability along with improved regulatory compliance. AI helps maritime operations meet regulatory standards and environmental goals through its application of dynamic route planning, emission tracking dashboards, and automated ESG reporting documentation, which fulfills EU-ETS and FuelEU Maritime regulations.

5. The broad deployment of predictive maintenance remains limited because of ambiguous regulations and employee hesitation toward adopting new methods. One maritime logistics company recognized predictive maintenance benefits yet struggled to achieve full implementation because of confusing regulatory rules and internal organizational opposition.
6. The management of complex operational judgments as well as client relationships, and strategic decision-making processes requires human involvement for their proper administration. The primary goal of AI tools involves enhancing human decision processes while organizations succeed through human-machine collaboration.
7. Organizations need to establish connections between AI projects and company-wide objectives and develop strong data governance systems to achieve successful AI integration. Organizations achieve superior operational performance when they recognize AI as an organizational strategic force rather than treating it as a technical solution.

AI technology demonstrates extensive potential to transform maritime logistics operations into sustainable and efficient systems. The full potential of these benefits requires organizations to solve cultural and organizational barriers as well as regulatory challenges through complete solutions. Future strategic initiatives should focus on digital literacy growth and organizational flexibility development, and a clear regulatory framework to enhance AI adoption rates.

## **7. RECOMMENDATIONS FOR FURTHER RESEARCH**

The research presents a qualitative overview of AI implementation in onshore maritime logistics by analyzing interviews from two maritime firms, together with an AI researcher. The research revealed multiple areas that need additional investigation. Research in the future should include regulators and terminal operators as stakeholders to achieve a systemic understanding of AI adoption. The generalizability of research findings would increase when researchers use larger sample sizes with diverse participants to enable cross-country and company-type comparisons. The use of quantitative surveys would enable researchers to validate qualitative findings while measuring specific AI effects on cost savings and efficiency, and emissions reduction.

Research following participants over time would show how maritime firms develop their digital maturity while observing organizational learning and technology integration dynamics. Technical research should continue to investigate the accuracy and operational robustness of AI systems, which include routing and predictive maintenance and cybersecurity applications. Research focused on regulatory alignment and ethical concerns and workforce implications would enhance the understanding of AI's socio-technical dimensions in maritime logistics.

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# APPENDIX 1

## Interview Questions for The Global Container Firm and Ship Management Firm

Var hade du klassat er bolagsverksamhet i den globala sjöhandeln?

Kan du kort beskriva din roll och dina ansvarsområden i företaget?

Vilka är de största operativa utmaningarna du möter i ditt dagliga arbete?

Vilka är de största utmaningar ert arbetslag stöter på?

Hur bekant är du med AI och dess tillämpningar inom maritim logistik och hamnverksamhet?

Hur arbetar er hamn/verksamhet idag med att minska energianvändning, utsläpp?

På vilket sätt tror du att AI kan användas för att optimera fartygsschemaläggning, lastning/lossning och trafikflöden för att göra hamnar mer hållbara?

Har ni utforskat eller investerat i teknologier som autonoma containertransportfordon eller AI-drivna portalkranar? Om ni har det, vilka fördelar eller utmaningar har uppstått?

Använder ni AI eller avancerad dataanalys för att mäta och minska koldioxidavtryck?

På vilket sätt skulle AI kunna användas för att minska driftskostnader och resursförbrukning i hamnar och landbaserade operationer?

Vilka hinder ser du för att implementera AI-lösningar för hållbarhetsoptimering?

Hur stor utmaning är cybersäkerhet för er verksamhet idag?

Tror du att AI kan bidra till att förbättra övervakning av säkerhetsrisker, upptäckt av bedrägerier eller efterlevnad av miljöregler?

Hur arbetar ni idag med att hantera relationer och kommunikation med leverantörer, kunder och hamnmyndigheter?

Tror du att AI-driven automatiserad dokumenthantering, chatbots eller realtidsdataanalys kan förbättra samarbetet mellan aktörer i den maritima industrin?

Hur ser du på nuvarande och framtida regleringar kring AI i den maritima sektorn (t.ex. EU AI Act, IMO:s riktlinjer)?

Vilka etiska utmaningar ser du med AI inom sjöfarten? (Exempel: jobb som ersätts av automatisering, dataskydd, beslutsfattandets transparens).

Vilka hållbarhetsutmaningar i maritima landbaserade operationer tror du att AI skulle kunna lösa mest effektivt?

Om ditt företag kunde implementera en AI-lösning idag för att förbättra hållbarheten, vilken skulle det vara och varför?

Tror du att AI kommer att vara en avgörande del av hållbarhetsstrategin för maritima företag inom de kommande 5-10 åren? Varför eller varför inte?

## APPENDIX 2

### Interview Questions for The AI Researcher

What is your main employment?

Our thesis defines AI as systems that “simulate, extend, and expand human intelligence; How would you refine or extend this definition based on your own theoretical perspective?

What do you see as the key trade-offs between data volume, data quality, and model performance?

How should future methods address issues of bias and privacy in large-scale AI systems?

What are the main challenges in making complex AI models interpretable, and why does interpretability matter?

How might we build theoretical guarantees around an AI system’s safety and reliability?

How do you balance adaptability (real-time learning) with the need for stable, predictable behavior?

Which metrics best capture AI’s long-term value to businesses and economies?

How should economists model AI’s effects on job markets and productivity over the next decade?

What governance principles are most important for responsible AI development worldwide?

Looking ahead, what ethical frameworks would you like to see entrenched in future AI systems?

What theoretical barriers must we overcome to trust fully autonomous AI systems?

How can AI be theoretically framed to maximize positive environmental impact across industries?

What role should AI play in enforcing and monitoring global environmental regulations?

Which emerging theoretical advances do you predict will revolutionize AI research in the next five years?

What do you see as the biggest disconnect today between AI theory and real-world practice?

How might AI’s evolving capabilities reshape research priorities in academia and industry over the coming decade?

What is your most optimistic—and your most cautious—vision for AI’s societal role by 2035?

From your perspective as an AI specialist, what core AI techniques hold the greatest promise for transforming maritime operations, such as navigation, asset monitoring, or port logistics, and why?

Looking ahead over the next 10–15 years, what key breakthroughs or shifts do you predict will drive the most significant advances in maritime AI, and how might they reshape the industry’s safety, efficiency, and environmental impact?-

# APPENDIX 3

## Interview Questions for The Scandinavian Port

Var hade du klassat er bolagsverksamhet i den globala sjöhandeln?

Kan du kort beskriva din roll och dina ansvarsområden i företaget?

Vilka är de största operativa utmaningarna du möter i ditt dagliga arbete?

Vilka är de största utmaningar ert arbetslag stöter på?

Hur bekant är du med AI och dess tillämpningar inom maritim logistik och hamnverksamhet?

Hur arbetar er hamn/verksamhet idag med att minska energianvändning, utsläpp?

På vilket sätt tror du att AI kan användas för att optimera fartygsschemaläggning, lastning/lossning och trafikflöden för att göra hamnar mer hållbara?

Har ni utforskat eller investerat i teknologier som autonoma containertransportfordon eller AI-drivna portalkranar? Om ni har det, vilka fördelar eller utmaningar har uppstått?

Använder ni AI eller avancerad dataanalys för att mäta och minska koldioxidavtryck?

På vilket sätt skulle AI kunna användas för att minska driftskostnader och resursförbrukning i hamnar och landbaserade operationer?

Vilka hinder ser du för att implementera AI-lösningar för hållbarhetsoptimering?

Hur stor utmaning är cybersäkerhet för er verksamhet idag?

Tror du att AI kan bidra till att förbättra övervakning av säkerhetsrisker, upptäckt av bedrägerier eller efterlevnad av miljöregler?

Hur arbetar ni idag med att hantera relationer och kommunikation med leverantörer, kunder och hamnmyndigheter?

Tror du att AI-driven automatiserad dokumenthantering, chatbots eller realtidsdataanalys kan förbättra samarbetet mellan aktörer i den maritima industrin?

Hur ser du på nuvarande och framtida regleringar kring AI i den maritima sektorn (t.ex. EU AI Act, IMO:s riktlinjer)?

Vilka etiska utmaningar ser du med AI inom sjöfarten? (Exempel: jobb som ersätts av automatisering, dataskydd, beslutsfattandets transparens).

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