



# THESSISMUN



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## **Council of International Maritime Organization (IMO)**

Topic Area A

Utilizing the immense potential of AI solutions in the maritime sector.



## COUNCIL OF THE INTERNATIONAL MARITIME ORGANIZATION (IMO)

### STUDY GUIDE

#### Topic Area A:

*“Utilizing the immense potential of AI solutions in the maritime sector.”*



## Table of Contents

<b>1. Welcoming Letter</b> .....	3
<b>2. Introduction to the Committee</b> .....	4
<b>3. Introduction to the Topic</b> .....	5
<b>4. Key Terms and Definitions</b> .....	6
<b>5. Legal Framework</b> .....	8
<b>5.1. United Nations Recommendation on the Ethics of Artificial Intelligence</b> .....	8
<b>5.2. European Union Act on Artificial Intelligence</b> .....	8
<b>5.3. IMO Resolution on E-Navigation</b> .....	9
<b>5.4. IMO Guidelines on the Maritime Single Window</b> .....	9
<b>5.5. IMO Guidelines on the Marine Environmental Protection and use of AI</b> .....	9
<b>5.6. IMO Guidelines on the Maritime Autonomous Surface Ships</b> .....	10
<b>6. Topic Analysis</b> .....	11
<b>6.1. Accessing Artificial Intelligence</b> .....	11
<b>6.1.1. Sensor Technology</b> .....	11
<b>6.1.2. Big Data and the Internet of Things</b> .....	11
<b>6.1.3. Augmented Reality Technology</b> .....	12
<b>6.1.4. Smart Ships and Efficiency</b> .....	13
<b>6.2. Maritime and Shipping Industry</b> .....	13
<b>6.2.1. Voyage Optimization</b> .....	13
<b>6.2.2. Route Forecasting and Facilitation</b> .....	15
<b>6.2.3. Machine Learning</b> .....	16
<b>6.2.4. Autonomous Shipping</b> .....	17
<b>6.3. Global Challenges</b> .....	18
<b>6.3.1. Deep Learning</b> .....	19
<b>6.3.2. Ethical Issues</b> .....	19
<b>6.3.3. Privacy and Personal Information</b> .....	20
<b>6.3.4. The Role of Education and Training</b> .....	21
<b>7. Conclusion</b> .....	22
<b>8. Points to be addressed</b> .....	23
<b>9. Bibliography</b> .....	24
<b>10. Further Reading</b> .....	27



## 1. Welcoming Letter

Distinguished Delegates,

We are delighted to welcome you to ThessISMUN 2023 and more specifically to the International Maritime Organization. As members of the Board, we are expecting a very fluid debate that will include passionate speeches and fiery exchange of viewpoints.

In this year's edition of ThessISMUN, the IMO will conduct its proceedings centered around the utilization of AI solutions in the maritime sector. As technology progresses throughout the years, it becomes evident that artificial intelligence has the potential to expand human capabilities and make the difference in many human sectors. That is also the case in the maritime sector. By the proper use of AI solutions, vessels can be navigated without human presence and voyages can be safely optimized for better performances and lower costs.

However, the ethical challenges stemming from the above endeavor, hold many states and companies back from accessing the true potential of artificial intelligence. Thus, the debate among the members of the IMO, should be centered around the proper use of AI solutions and the overall implementation of technology in the maritime sector through a safe and effective manner. We hope that this guide will serve as a starting point for your own research which might lead you to discover many interesting aspects about the member states that you will be representing. Nevertheless, this effort is not exhaustive and we rely on you to find intriguing questions and points that will make our conference even better.

On behalf of the Board, we would like to thank you for being a part of ThessISMUN 2023 and we are looking forward to seeing you at the proceedings. Until then, we are available at all times for any questions and inquiries that you may have about our committee or the conference in general.

At your disposal,

The Board of the International Maritime Organization,

Christos Kaltsas, President

Kostas Manikas, Vice President

Maria Mougiantsi, Vice President



## 2. Introduction to the Committee

The International Maritime Organization is a specialized agency of the United Nations with authority on matters related to international shipping such as safety, security and transparency in the maritime sector. It was founded in 1948 and its mandate is to promote an effective regulatory framework which states from all round the world will implement in their respective shipping industries. The aforementioned framework includes various aspects of international shipping such as ship design, maritime equipment, and adequate manning with the aim of creating a better maritime sector with more safety measures and environmentally friendly principles.<sup>1</sup>

Shipping is an essential component of any programme for future sustainable economic growth. Through IMO, the member states, civil society and the shipping industry are already working together to ensure a continued and strengthened contribution towards a green economy and development in a sustainable manner. The promotion of sustainable shipping and sustainable maritime development is one of the major priorities of IMO in the upcoming years. Energy efficiency, new technology and innovation, adequate education and training, maritime security, maritime traffic management and the development of necessary infrastructure are required today by the international community. The IMO sets the global standards covering these issues with the aim of providing a solid institutional framework that is required for a green and sustainable maritime transportation system.<sup>2</sup>

The organization is also actively working towards the 2030 Agenda for Sustainable Development and its associated goals. Most of the elements of the agenda can only be realized with a sustainable transport sector that will in turn support world trade and facilitate the global economy. Through the IMO's Technical Cooperation Committee, it has been formally approved that the goals of the organization are properly aligned with the standards set by the 2030 Agenda.<sup>3</sup>

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<sup>1</sup> "Brief History of IMO." International Maritime Organization. Accessed January 6, 2023. <https://www.imo.org/en/About/HistoryOfIMO/Pages/Default.aspx>.

<sup>2</sup> "Strategic Plan for the Organization." International Maritime Organization. Accessed January 6, 2023. <https://www.imo.org/en/About/Strategy/Pages/Default.aspx>.

<sup>3</sup> "Technical Cooperation." International Maritime Organization. Accessed January 6, 2023. <https://www.imo.org/en/OurWork/TechnicalCooperation/Pages/Default.aspx>.



Currently, the IMO has 175 member states as well as three associate members. The main bodies of the organization are the Assembly, where all the representatives voice their opinions and the Council which governs the organization and consists of 40 member states, as elected during the proceedings of the Assembly. Both of these bodies contribute to the amelioration of the debate among the ranks of the IMO.<sup>4</sup>

### 3. Introduction to the Topic

Maritime industry relies heavily on humans for decision making, work processing and operations. The application of using AI solutions and machine learning for navigating traffic could facilitate and improve productivity. Maritime industries have conducted several initiatives to explore new digital innovations. Shipowners would prefer to minimize human related activities if the financial operating cost is rational and the AI alternative can attain better productivity rates. AI enables the transformation to paperless and automated procedures. However, the maritime industries struggle when facing big data for analysis and implementation to enhance work efficiency. One of the most common issues is the lack of understanding of how AI can impact the business and the lack of cooperation and standards among partners. The latter influences the stakeholders in the maritime sector and sets obstacles in the adoption of AI solutions among the industries.<sup>5</sup>

After shipping, ports are the next logical recipients of the advantages of AI technology. There is plenty of potential optimization given the incredible number of key players involved combined with the large volumes of data associated with compulsory documentation, sensors, machinery and other related equipment. It is often the case that individual parties are not sufficiently interconnected and data is rarely exchanged using uniform digital standards. Much of the work going on in a port is therefore likely to be quite segregated with no requirement for data to be exchanged between the various companies involved.<sup>6</sup>

The huge potential offered by AI solutions is all the more apparent when talking about entire logistics chains that are associated with maritime services. Collecting machinery data and status updates is part of the daily routine within the maritime industry. In some cases, the traditional logbook still has its place. But monitoring machinery and systems digitally is commonplace within the ship's bridge and engine room nowadays. This basic level of monitoring is set to evolve into predictive maintenance in the coming

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<sup>4</sup> "Structure of IMO." International Maritime Organization. Accessed January 16, 2023. <https://www.imo.org/en/About/Pages/Structure.aspx>.

<sup>5</sup> "The Future of AI in the Shipping Industry | Smart Industry." Accessed January 6, 2023. <https://www.smartindustry.com/home/blog/11290794/the-future-of-ai-in-the-shipping-industry>.

<sup>6</sup> "How Can Ports Use Artificial Intelligence?" Port Technology International, May 5, 2021. <https://www.porttechnology.org/news/how-can-ports-use-artificial-intelligence>.

years. AI technology can use past data to determine maintenance intervals and most importantly predict the condition of individual parts or entire systems and assess what level of maintenance they will require.<sup>7</sup>

Without a doubt, the AI potential in the maritime sector can be characterized as massive. However, many stakeholders share their concern over many pressing issues concerning the AI transition. There are many ethical challenges such as, transparency, which many feel that is being overlooked in the swift attempt to implement AI solutions in the shipping industry. Also, many new technologies are deemed to be in a very early stage of development with plenty of R&D to be invested in them yet. These issues provide constructive feedback in the attempt to transition into the technology era. It remains to be seen, how this transition can be achieved in a sustainable and fluid manner.<sup>8</sup>

## 4. Key Terms and Definitions

**Artificial Intelligence:** The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making and translation between languages.<sup>9</sup>

**Autonomous Navigation:** The method which ships, to a varying degree, can operate independently of human interaction. It includes remotely operated and fully autonomous shipping technologies that do not require human interaction and activity.<sup>10</sup>

**Big Data:** Extremely large data sets that may be analyzed computationally in order to reveal patterns, trends and associations, especially relating to human behavior and interactions.<sup>11</sup>

**Blockchain Technology:** A system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the procedure. It essentially is a digital

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<sup>7</sup> “How AI Is Influencing the Shipping Industry.” Reveel, December 19, 2022. <https://reveelgroup.com/resources/how-ai-is-influencing-the-shipping-industry/>.

<sup>8</sup> “AI in Maritime Sea Technology Magazine.” Sea Technology magazine, August 26, 2022. <https://sea-technology.com/ai-maritime-report-i4-insight-lloyds-register>.

<sup>9</sup> “What Is Artificial Intelligence (AI)?” IBM. Accessed January 6, 2023. <https://www.ibm.com/topics/artificial-intelligence>.

<sup>10</sup> “Autonomous Navigation.” Autonomous Navigation - an overview | ScienceDirect Topics. Accessed January 6, 2023. <https://www.sciencedirect.com/topics/computer-science/autonomous-navigation>.

<sup>11</sup> “Big Data: What It Is and Why It Matters.” SAS. Accessed January 6, 2023. [https://www.sas.com/en\\_us/insights/big-data/what-is-big-data.html](https://www.sas.com/en_us/insights/big-data/what-is-big-data.html).



ledger of transactions that is duplicated and distributed across the entire network of computer systems on the same platform.<sup>12</sup>

**Deep Learning:** A subset of machine learning, which is basically a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain, albeit far from matching its ability and allowing it to learn from large amounts of associated data.<sup>13</sup>

**Machine Learning:** The use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyze and draw inferences from patterns in data.<sup>14</sup>

**Neural Network:** A method in artificial intelligence that instructs computers to process data in a way that is inspired by the human brain. It is a type of machine learning process, which requires deep learning and interconnected nodes in a layered structure that resembles the human brain activities.<sup>15</sup>

**Parameter:** A numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation. It is also a limit or boundary which defines the scope of a particular process or activity.<sup>16</sup>

**Variation:** A change or slight difference in condition, amount or level, typically within certain limits. Essentially a different or distinct form or version of something.<sup>17</sup>

**Vessel Optimization:** An innovative method of autonomous shipping that takes into account the enhancement of competitiveness by saving fuel resources, reducing running costs and avoiding lengthy GHG emissions.<sup>18</sup>

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<sup>12</sup> “Blockchain.” BuiltIn. Accessed January 6, 2023. <https://builtin.com/blockchain>.

<sup>13</sup> “What Is Deep Learning? How It Works, Techniques & Applications.” How It Works, Techniques & Applications - MATLAB & Simulink. Accessed January 6, 2023. <https://www.mathworks.com/discovery/deep-learning.html>.

<sup>14</sup> “What Is Machine Learning? A Definition.” expert.ai, July 4, 2022. <https://www.expert.ai/blog/machine-learning-definition/>.

<sup>15</sup> “Neural Network.” DeepAI. DeepAI, May 17, 2019. <https://deepai.org/machine-learning-glossary-and-terms/neural-network>.

<sup>16</sup> “Math Insight.” Parameter definition - Math Insight. Accessed January 6, 2023. <https://mathinsight.org/definition/parameter>.

<sup>17</sup> “Variation.” isixsigma.com, October 10, 2022. <https://www.isixsigma.com/dictionary/variation/>.

<sup>18</sup> “Art and Science of Ship Voyage Optimization: A Critical Review.” LinkedIn, February 13, 2021. <https://www.linkedin.com/pulse/art-ad-science-ship-voyage-optimization-critical-review-henry-chen>.





## 5. Legal Framework

### 5.1. United Nations Recommendation on the Ethics of Artificial Intelligence

In November 2021, 193 member states of the United Nations adopted the Recommendation on the Ethics of Artificial Intelligence, the very first global standard setting instrument on the subject. This landmark text defines values, principles and policies that would guide states in building legal frameworks to ensure that AI is deployed as a force for the common good. Among its salient points, the Recommendation stresses data protection, calling for more action from regulatory bodies. It bans as invasive the use of AI systems for social scoring and surveillance. It proposes tools to help countries assess the impact of AI systems on individuals and it also calls for AI that is utilized in an environmentally friendly way.<sup>19</sup>

The Recommendation mandates a production of an Ethical Impact Assessment and a Readiness Methodology, as well as policy analysis to advance implementation. While member states would be responsible for its application at a national level, the United Nations will support their implementation processes and require regular status reports on their policies and practices.<sup>20</sup>

### 5.2. European Union Act on Artificial Intelligence

The EU Artificial Intelligence Act is a regulation proposed on 21 April 2021 by the European Commission which aims to introduce a common regulatory and legal framework for AI. Its scope encompasses all sectors, with the notable exception of military, and to all types of artificial intelligence. The proposed regulation classifies artificial intelligence applications by risk and regulates them accordingly. The proposal also places prohibitions on certain types of applications, namely remote biometric recognition, applications that subliminally manipulate individuals and applications that exploit vulnerabilities of certain groups in a harmful way.<sup>21</sup>

The Act also proposes the introduction of a European Artificial Intelligence Board which will encourage national cooperation and ensure that the standards of the

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<sup>19</sup> Unesdoc.unesco.org. Accessed January 7, 2023. <https://unesdoc.unesco.org/ark:/48223/pf0000380455>.

<sup>20</sup> "Towards an Ethics of Artificial Intelligence." United Nations. United Nations. Accessed January 7, 2023. <https://www.un.org/en/chronicle/article/towards-ethics-artificial-intelligence>.

<sup>21</sup> "Home." The Artificial Intelligence Act, November 28, 2022. <https://artificialintelligenceact.eu/>.



regulation will be respected and upheld. The main motivation behind the aforementioned proposal is that potential adoption of it as a global standard, since there is a lot of ground to cover concerning AI and its development.<sup>22</sup>

### 5.3. IMO Resolution on E-Navigation

A number of circulars related to E-Navigation were approved in 2019 by the 101<sup>st</sup> session of IMO's Maritime Safety Committee. E-Navigation is defined by the IMO as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment". E-Navigation represents a huge leap forward by the organization in terms of achieving autonomous shipping, reducing running costs and optimizing voyage proficiency.<sup>23</sup>

### 5.4. IMO Guidelines on the Maritime Single Window

The Maritime Single Window constitutes a successful IMO project promoted by Norway to establish maritime cohesion and cooperation through a "single window". This initiative which was successfully tested in on 2019 in Antigua and Barbuda, enables all information required by public authorities in connection with the arrival, stay and departure of ships, people and cargo, to be submitted electronically via a single portal, without the requirement of duplication. This type of system is also recommended by the IMO's Facilitation Convention, the treaty which aims to reduce administrative burdens and make shipping and trade by sea more efficient. National stakeholders are encouraged and required to introduce electronic information exchange between maritime vessels and ports, in order for the single window to be able to exist and thrive among the sector.<sup>24</sup>

### 5.5. IMO Guidelines on the Marine Environmental Protection and use of AI

IMO under its Global Industry Alliance is working towards promoting the concept of Just in Time (JIT) arrivals of ships through the use of port specific data with the aim of reducing fuel consumption and GHG emissions in ports. The concept of JIT arrivals of

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<sup>22</sup> "A European Approach to Artificial Intelligence." Shaping Europe's digital future. Accessed January 7, 2023. <https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence>.

<sup>23</sup> "E-Navigation." International Maritime Organization. Accessed January 7, 2023. <https://www.imo.org/en/OurWork/Safety/Pages/eNavigation.aspx>.

<sup>24</sup> "Single Window for Ship Data Exchange to Become Mandatory." International Maritime Organization. Accessed January 7, 2023. <https://www.imo.org/en/MediaCentre/PressBriefings/pages/FAL-46-amendments.aspx>.



ships allows for ships to optimize their speed during the voyage in order to arrive at the Pilot Boarding Place (PBP) when the availability of berth, fairway, and nautical services is ensured. Therefore, since JIT arrivals allows the ship to adjust and optimize its speed during the voyage, it has been identified as a feasible opportunity to reduce GHG emissions from ships and support the goals of the initial IMO strategy.<sup>25</sup>

## 5.6. IMO Guidelines on the Maritime Autonomous Surface Ships

A Maritime Autonomous Surface Ship (MASS) is defined by the IMO as a ship which, to a varying degree, can operate independently of human interaction. IMO notes that the degrees of this autonomy are organized in the following categories:

- A) Ships with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
- B) Remotely controlled ships with seafarers on board: The ship is controlled and operated from another location with simultaneous presence of people on board.
- C) Remotely controlled ships without seafarers on board: The ship is controlled and operated from another location without the presence of people on board.
- D) Fully autonomous ships: The operating system of the ship is able to make decisions and determine actions by itself.

The organization has procured several guidelines which provide insight on the different management required for every category of ships. It is without a doubt, very common to handle ships operated by the human mind, but not so when it comes to fully operational Artificial Intelligence.<sup>26</sup>

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<sup>25</sup> “IMO and Its Role in Protecting the World's Oceans.” International Maritime Organization. Accessed January 7, 2023. <https://www.imo.org/en/MediaCentre/HotTopics/Pages/oceans-default.aspx>.

<sup>26</sup> “Autonomous Ships: Regulatory Scoping Exercise Completed.” International Maritime Organization. Accessed January 7, 2023. <https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx>.

## 6. Topic Analysis

### 6.1. Accessing Artificial Intelligence

Technology is in almost every sphere of our human lives. That is also the case for the maritime sector and the shipping industry. Improvements in shipbuilding, advanced materials, smart shipping, propulsion robotics and big data sensors are making the overall effort on international waters much easier. It is without a doubt very crucial for maritime companies and states to grasp the potential of AI solutions as they represent not only the future but also the present. Artificial intelligence has the means to end repetitive tasks and improve the quality of the shipping stakeholders. An AI-driven sector in logistics helps with route optimization, safety, decision-making and automation procedures. Above all, AI is also assisting with the distribution of goods between hundreds of vessels that are passing through ports and avoiding unnecessary traffic. It is of paramount importance for shipping companies to understand AI procedures and implement them safely in their associations.<sup>27</sup>

#### 6.1.1. Sensor Technology

One of the most advanced and well-developed technologies nowadays is sensor-oriented technology. Especially, this particular technology is mainly being used by maritime industries specialized in transportation. Sensor technology replaces many aspects of manual tasks and automates whole procedures of work load. Connecting all the machinery to sensors helps marine and ship technicians to do their jobs more efficiently. Through the use of wireless communication, keeps exact and accurate calculations on the functioning status of carriers and vessels. In result, they can analyze the necessary maintenance at regular intervals and the total operability aboard the carriers. Sensors can also connect with machine learning and AI. This means that they may link to remote facilities and analyze data while also sending out alerts if any of the ship's components need immediate maintenance. Calibrated correctly sensor technology can make the difference when it comes to ship efficiency and premium usage.<sup>28</sup>

#### 6.1.2. Big Data and the Internet of Things

Data analytics check the information that comes from large operation systems such as ships and ports. This is adhered to data about various container types, weight and potential destination. It can also be used to analyze ship data such as trim, stability, engine performance and communication. Big data on ships can give results about

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<sup>27</sup> "Maritime Industry to Spend \$931 MLN on AI Solutions in 2022." Offshore Energy, August 16, 2022. <https://www.offshore-energy.biz/maritime-industry-to-spend-931-mln-on-ai-solutions-in-2022/>.

<sup>28</sup> "Sensor Technology Applied in the Maritime Industry - Marpoint." Accessed January 7, 2023. <https://marpoint.gr/blog/sensor-technology-applied-in-the-maritime-industry/>.



historic container trends and ocean conditions. The ship in turn responds to various changing weather conditions while the analysis of different parameters and variations can help with better efficiency and overall performance. The Internet of Things (IoT) also enables control of some objects even on a remote basis. This technology works with a GPS and cloud-based database which stores all the data collected by devices on the maritime vessel. IoT can connect all the other devices and shipments like robots through a stellar wireless network. That way, they function in a premium speed and performance.<sup>29</sup>

### 6.1.3. Augmented Reality Technology

Augmented Reality (AR) is present in lots of maritime industries today. As one of the technological progressions, AR is mainly used by seafarers and shipping carriers. Thanks to AR technology, marine students can experience the reality of sea through witnessing real-life scenarios. AR can also help with efficient maintenance and vessel inspection. Plenty of the maintenance tasks can be done with the help of guidance software and tools which allow visualizing images. AR is also present in the shipbuilding and design process by the maritime industries. It simulated virtual projects and assists in the amelioration of many technical and expert issues. It essentially allows people to imagine the creation before moving on with the implementation. The new ship propulsion systems not only provide better control of the ship but also help the global ecosystem. The transition control of the propulsion systems to smart technology enables a device to make decisions and control the equipment with high levels of accuracy. Both the captain and the marine engineers can always monitor the status of the marine diesel engines. Software shows and ensures that they always remain within the acceptable operating regions of work. Ships have an unfavorable effect on global environment. The fuel, oil spills and waste effluents cause an increase in pollution and environmental damage. This is why investment in alternative energy management solutions is of paramount importance and can help in the reduction of the emissions of greenhouse gases such as carbon and sulfur. Recently maritime industries through the implementation of AI solutions construct their ships in a different manner. They tend to use more sustainable materials like fiber-reinforced plastic which helps to reduce traffic and carbon and also enables the carrying of large quantities of associated goods and precious cargo.<sup>30</sup>

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<sup>29</sup> “Big Data and Industrial Internet of Things for the Maritime Industry in ...” Accessed January 7, 2023. [https://www.researchgate.net/publication/281207105\\_Big\\_Data\\_and\\_Industrial\\_Internet\\_of\\_Things\\_for\\_the\\_Maritime\\_Industry\\_in\\_Northwestern\\_Norway](https://www.researchgate.net/publication/281207105_Big_Data_and_Industrial_Internet_of_Things_for_the_Maritime_Industry_in_Northwestern_Norway).

<sup>30</sup> “Research for Augmented Reality in the Maritime Industry.” Accessed January 7 2023. <https://maritimecyprus.com/2020/05/29/research-for-augmented-reality-in-the-maritime-industry/>.

## 6.1.4. Smart Ships and Efficiency

Considering the latest trends in the maritime industry and AI solutions, they are just a fraction of how the shipping sector is influenced and affected by rapidly changing technology. New technologies have a big impact on commercial shipping, especially in regards to ship design and operation. Integrating smart ship development helps industries to increase efficiency, associated research and also achieve cheaper alternatives for fuel. The maritime industry is a key element for many companies to provide goods, expand and develop the world economy. To ensure that trade services are efficient, ships and shipping industries have the obligation of focusing on AI practices and new technologies. Technology trends that appear in the shipping sector help to reduce greenhouse gas emissions and they also provide alternatives for fossil fuels. At the moment, they are the most common energy source used in vessels. The main role of technologies is to provide a safe and transparent environment as well as helping maritime companies to develop and function a better rate while also avoiding mistakes of the past.<sup>31</sup>

## 6.2. Maritime and Shipping Industry

The shipping sector is a vital part of the global economy, responsible for transporting goods and materials to and from different places of the world. It is a complex and challenging environment, where even minor improvements can result in significant benefits. In order to stay competitive, it is essential for maritime industries and shipping companies to invest in artificial intelligence solutions. AI can help in the automation of tasks, the optimization of operations and better decision-making in general. The presence of AI in the maritime sector has been increasingly visible in the recent years. Just like in the case of manufacturing, the potential of artificial intelligence in this field is very impressive. AI-powered solutions can streamline maritime transport through the use of smart and applicable devices.<sup>32</sup>

### 6.2.1. Voyage Optimization

Shipping goods is a fundamental aspect of globalized economy and growing stakeholder's expectations worldwide demand constant optimization in the maritime field. Essentially, AI is changing the face of the maritime industry in three particular ways. The first is by providing partial autonomy to the automatized units. The second is by evaluating processes and optimizing them and third, by forecasting future

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<sup>31</sup> "A Trend in Maritime, the Smart Ship." Maritime Professionals, October 26, 2022. <https://maritime-professionals.com/a-trend-in-maritime-the-smart-ship/>.

<sup>32</sup> "AI in Maritime Industry: How Artificial Intelligence Solutions Benefit the Shipping Sector." nexocode. nexocode, March 13, 2022. <https://nexocode.com/blog/posts/ai-in-maritime-artificial-intelligence-solutions-in-the-shipping-sector/>.



outcomes and trends. Taking advantage of all these three opportunities is a way to outperform the competition and reach sustainability goals. From forecasting to equipment automation, AI applications in the shipping sector are wide and vast. Predictive analytics enable shipping companies to optimize their vessel scheduling. These particular technologies use the port call data like destination, arrival time, trajectory and trip duration provided by the port community systems to manage voyages more efficiently. Through the use of data from vessel traffic, the maritime carriers schedule and reschedule arrivals so as to avoid delays and downtimes. More practically, machine learning assists them in dealing with unpredicted scenarios that are caused by emergencies and enforced route changes. Since vessel scheduling predictions depend on many input variables, machine learning is the best way to handle it, contrary to the traditional, rule-dependent algorithms.<sup>33</sup>

Granting partial autonomy to automated robotic equipment is one of the core functions of AI in the maritime industry. AI-fueled machinery can optimize the container positioning to make the best use of the available space. The machines position the containers using computer vision, making autonomous decisions after learning through unsupervised methods and practices. More practically, the monitoring devices transfer an image to the interpreting device that classifies the container, albeit recognizing said variables as size and shape. Afterwards, they evaluate the existing storage configuration to identify the most appropriate space for the new incoming container. Aside from that, it can also detect wrongly positioned containers based on already identified patterns and proceed to rearrange them. Depending on the carrier's preference, these delicate operations can be either supervised or autonomous.<sup>34</sup>

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<sup>33</sup> “How Can Ai Revolutionize Voyage Optimization?” Thetius, June 22, 2022. <https://thetius.com/how-can-ai-revolutionise-voyage-optimisation/>.

<sup>34</sup> “Vessel Pattern Knowledge Discovery from AIS DATA: A Framework for Anomaly Detection and Route Prediction.” MDPI. Multidisciplinary Digital Publishing Institute, June 4, 2013. <https://www.mdpi.com/1099-4300/15/6/2218>.

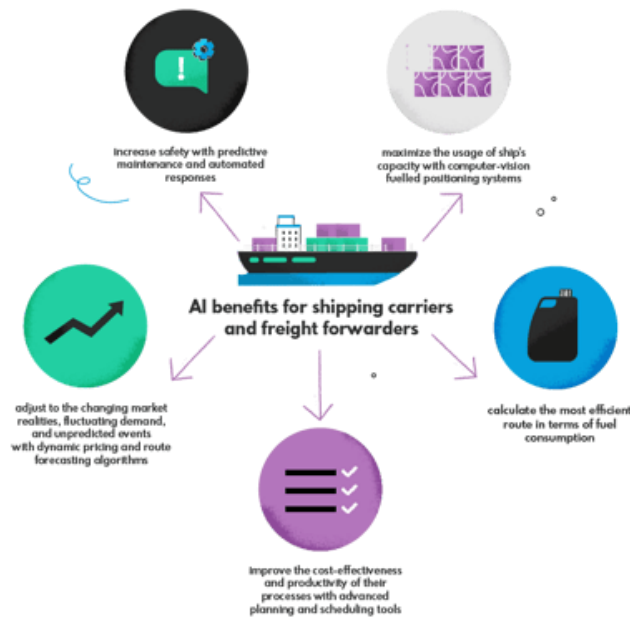


Figure 1

Accessed January 14, 2023: <https://nexocode.com/blog/posts/ai-in-maritime-artificial-intelligence-solutions-in-the-shipping-sector/>

## 6.2.2. Route Forecasting and Facilitation

Route forecasting based on real-time data enables companies to optimize their routes depending on variables like weather and react to unexpected events. When the most frequently maritime transport routes are entirely blocked, the shipping companies have to improvise and search for the shortest and most time-effective alternative. AI technology could provide them with extremely fast estimations. On the other hand, the COVID-19 pandemic has proven that even though the maritime sector has already gone through digital transformation, it requires further innovations in terms of route forecasting. To create the best possible optimized route, the AI algorithms need to consider the changing variables, including wave frequency, dangerous tides and winds. With a significantly reduced number of ships circulating globally, the data collection capabilities have lowered, resulting in inaccurate forecasts around the world. Relying on ships is not the most effective strategy for collecting data and on the other hand relying on satellites, which are relatively stable data sources, do not provide high frequency accuracies. Improving forecasts while keeping the data influx independent of the market fluctuations is possible with maritime data and virtual buoys that are becoming increasingly common at a global scale. Considering the dynamic growth of e-commerce, the demand for global maritime transport will be rising in the coming years. Thus, it is imperative that AI solutions facilitate the ship's carbon print reduction, such as route forecasting that involve the prediction of fuel consumption factors. Aside from lowering the emissions, these measures can help maritime carriers reduce their



overall polluting impact. In order to achieve these goals, many shipping industries migrate from linear to circular supply chain structures through the utilization of artificial intelligence.<sup>35</sup>

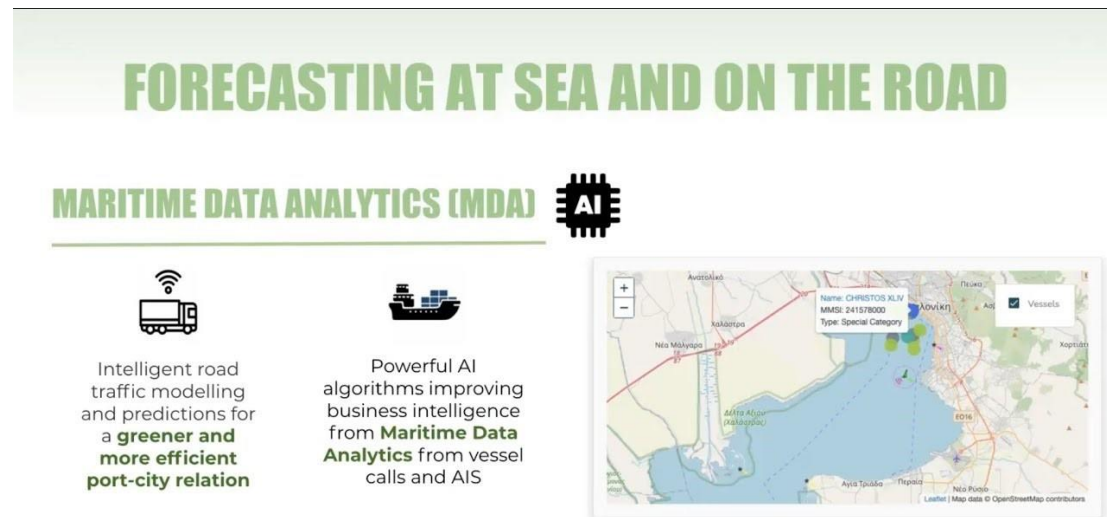


Figure 2

Accessed on January 14, 2023: <https://www.youtube.com/watch?v=qU7rHX0RyJw>

### 6.2.3. Machine Learning

Machine learning algorithms can generate moves of the automated machinery, thus enabling partial autonomy of the units like maritime vessels and ports. That particular fact makes them less susceptible to human errors and reduces workforce demand, cutting overall running costs as a result. Automated cargo processes are also faster, enabling carriers to save a lot of precious working time. The shipping companies can automatize the container vehicles, cranes and other elements that manage and direct the cargo output. The ports worldwide have already started using such equipment within their facilities with the aim of loading and offloading cargo and distribute the containers at a premium and efficient rate. Since the conditions in the maritime ports are rather stable, automating self-driving vehicles are also relatively easy to control. Contrarily to regular roads, there is no unpredictable traffic in port areas. At the same time, in such controlled conditions, the AI solutions that fuel automated vehicles deal with a limited set of predictable elements which in turn speed up the machine learning processes.<sup>36</sup>

<sup>35</sup> “Artificial Intelligence (AI) and Machine Learning (ML) in Maritime Logistics.” Marine Digital - ML-based platform for maritime logistics. Accessed January 8, 2023. [https://marine-digital.com/article\\_ai\\_and\\_ml](https://marine-digital.com/article_ai_and_ml).

<sup>36</sup> “Machine Learning Applied to the Maritime Sector: Navigating A Sea of Data.” PierNext, May 20, 2021. <https://piernext.portdebarcelona.cat/en/logistics/machine-learning-applied-to-the-maritime-sector-navigating-a-sea-of-data/>.

## 6.2.4. Autonomous Shipping

Autonomous shipping is another rapidly developing field in the maritime sector. The self-driving autonomous ship control systems reduce the likelihood of human error which is the most common cause of safety alerts and accidents. With the meteorological, oceanographic, satellite and proximity sensor-derived data, the self-aware machines handle the navigation procedures while also supporting the crew of the vessel in their respective decision-making. Just like in other cases of AI solutions, the shipping companies and port management authorities use machine learning algorithms for the purposes of predictive maintenance. The AI allows them to identify machinery issues before they finally escalate, causing downtimes and affecting the whole working supply chain. Predictive maintenance is crucial for the ships themselves due to the precarious nature of the maritime industry. AI-based predictive maintenance can identify the problems before the rout launch, thus saving the shipping industry many underlying expenses. Artificial intelligence allows the maritime carriers to react right on time instead of relying on traditional preventive measures and therefore extend machine life.<sup>37</sup>

The globalized world depends heavily on the shipping industry. Thus, the optimization of its processes is considered paramount for the maritime economies. Artificial intelligence can have a positive impact on all the stages of the shipping process, from containers distribution planning, through route forecasting, to unloading in maritime ports. The benefits of these measures are visible for all the stakeholders involved. The shipping carriers and freight forwarders improve the cost-effectiveness and productivity of their processes with advanced planning and scheduling tools. They also adjust to the changing market realities, fluctuating demand and unpredicted events with dynamic pricing and route forecasting algorithms. Another benefit is that they calculate the most efficient route in terms of fuel consumption and also increase safety with predictive maintenance and automated responses as well as maximizing the usage of ship's capacity with computer-vision fueled positioning systems. The port operators on the other hand are also benefitted by the use of AI solutions. First of all, they streamline their loading and offloading operations with the support of AI-managed cranes and other associated equipment. They also reduce the costs of hiring and training additional staff with robotic and automatic vehicles as well as reducing the risk of human errors with automated planning, positioning and calculation. Last but not least, they efficiently speed up the port scheduling and rescheduling with automation tools in addition to the

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<sup>37</sup> "Autonomous and Remotely-Operated Ships." DNV. Accessed January 9, 2023. <https://www.dnv.com/maritime/autonomous-remotely-operated-ships/index.html>.

automatic scan and separation of damaged cargo and shipments that sometime surface on port areas and premises.<sup>38</sup>

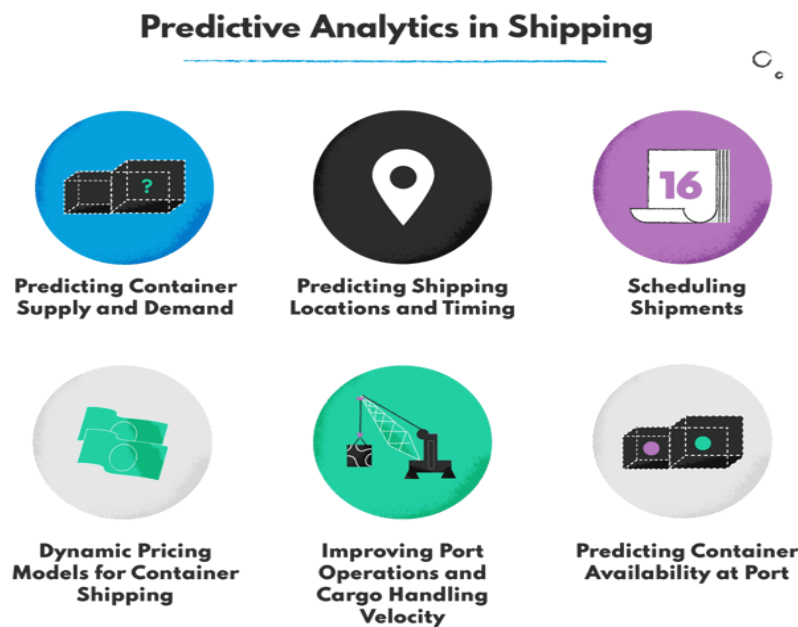


Figure 3

Accessed January 14, 2023: <https://nexocode.com/blog/posts/maritime-trends-ai-based-predictive-analytics-in-shipping-industry/>

### 6.3. Global Challenges

Even though the potential of AI is massive, there are still many issues that hold back people's perspectives about its use and utilization. The amount of power that these AI algorithms require is a factor keeping most of stakeholders at bay. Machine learning and deep learning are the stepping stones of artificial intelligence and they in turn demand an ever-increasing number of energy cores to work efficiently. Essentially, they require a huge amounts of computing power which have their own associated costs. Another cause of worry about the use of AI is the unknown nature of how deep learning models can predict the output. The understanding for most people of Ai is very limited and therefore a trust deficit exists among stakeholders when it comes to implement such technology inside their projects and initiatives.

<sup>38</sup> "Artificial Intelligence to the Rescue: Assisting the Shipping Container Crisis." Ship Technology, December 8, 2021. <https://www.ship-technology.com/features/artificial-intelligence-to-the-rescue-assisting-the-shipping-container-crisis/>.

### 6.3.1. Deep Learning

Many advocates also share the fact that deep learning procedures cannot be compared with human level calculations on sensitive issues. For a deep learning model to perform a similar human performance, it would require unprecedented finetuning, hyperparameter optimization, large dataset and a well-defined and accurate working algorithm along with robust computing power, uninterrupted training data and the appropriate testing on test data. The main factor on which all of the AI models are based on is the availability of data and resources to train them. There is a possibility, since big data is composed by the collective knowledge of millions of users, that data leakages are happening without the systems being able to spot them. However, some industries have already started working innovatively to bypass these barriers. This includes training of the data on smart devices and hence it is not sent back to the original servers and only the training model is sent back to the parent organization.<sup>39</sup>

The good or bad nature of an AI system really depends on the amount of data that they are trained on. Hence, the ability to gain good data is the solution to good AI systems in the future. However, in reality, the everyday data collected by stakeholders and organizations is poor and holds no significant value whatsoever. This is explained as this particular data is biased and can only somehow define the nature and specifications of a limited number of people with common interests that are typically based on religious practices, ethnicity, gender, community and other racial biases. The aforementioned issue could be tackled only through the creation of algorithms that can efficiently track these problems and provide failsafe for biased databases. The data is a very crucial aspect of AI and labeled data is used to train machines to learn and make accurate predictions. Some industries are attempting to innovate new methodologies and are focused on creating AI models that can give point to point results despite the scarcity of solid data. However, the trouble of biased information is always present and in the event of accessing biased data, then the systems is characterized as flawed and requires reconstruction.<sup>40</sup>

### 6.3.2. Ethical Issues

Many stakeholders are alarmed by the code of ethics that surrounds the use of AI solutions. AI ethics are a set of moral principles to guide and inform the development

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<sup>39</sup> “Using Deep Learning to Forecast Maritime Vessel Flows.” MDPI. Multidisciplinary Digital Publishing Institute, March 22, 2020. <https://www.mdpi.com/1424-8220/20/6/1761>.

<sup>40</sup> “How AI Is Influencing the Shipping Industry Today (Updated).” Protective Polymer Coatings. Advanced Polymer Coatings, August 16, 2022. <https://www.adv-polymer.com/blog/artificial-intelligence-in-shipping>.



and use of artificial intelligence technologies. Because AI does things that would normally require human intelligence, it also requires moral guidelines as much as human decision-making. Without ethical AI regulations, the potential for using this technology to perpetuate misconduct is extremely high. Many maritime industries use AI heavily and due to its ever-growing utility in so many sectors, AI technology has far-reaching implications for every aspect of the world and therefore needs to be regulated. By determining the top ethical concerns of artificial intelligence, consulting examples of ethical conduct and considering best practices for an ethical use, it can be ensured that the involved industries are on the right track in terms of their activities.<sup>41</sup>

Almost every technological innovation in history has been accused of replacing human jobs and activities. However, as advanced as AI may seem, it cannot replace humans on their works in the near future. AI is required to do many processes at a premium speed but the most complicated queries still require a human agent's intervention. AI powered automation procedures may be limited in some ways, but the impact can be immense and make a huge difference. The future of AI is realistically one in which humans and AI powered bots work together, with the latter handling simple tasks and the former focusing their attention on more complex and trickier procedures. Nevertheless, perhaps the most valid concern about ethics in AI is the respect of privacy.

### 6.3.3. Privacy and Personal Information

Privacy is recognized as a fundamental human right in the United Nations Declaration of Human Rights and various AI applications may be used in a harmful way. The challenge in creating ethical privacy regulations around AI is that people are generally willing to give up some personal information to get some level of personalization. This personal data helps the artificial intelligence deliver timely, personalized content that most stakeholders desire. Still however, without proper data sanitization protocols, there is a risk that this data will be processed and sold to third-party industries and used for unintended purposes. Somewhat ironically, AI is a great solution for data protection. AI's self-learning capabilities mean that AI-powered programs can detect malicious patterns that often lead to security breaches. The aforementioned fact implies that by implementing AI solutions, organizations can proactively detect attempts at data leaks or other type of data security attacks before the crucial information can be stolen.<sup>42</sup>

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<sup>41</sup> "Ethical Concerns Mount as AI Takes Bigger Decision-Making Role." Harvard Gazette. Harvard Gazette, December 4, 2020. <https://news.harvard.edu/gazette/story/2020/10/ethical-concerns-mount-as-ai-takes-bigger-decision-making-role/>.

<sup>42</sup> "Artificial Intelligence Design Must Prioritize Data Privacy." World Economic Forum. Accessed January 12, 2023. <https://www.weforum.org/agenda/2022/03/designing-artificial-intelligence-for-privacy/>.



Using AI to perpetuate misinformation is another major ethical issue. Machine learning models can easily generate factually incorrect text, meaning fake instructions and summaries can be created in seconds and distributed through the same channels as the normal procedure. AI is also capable of creating false audio recordings as well as synthetic images where someone in an existing image may be replaced with someone else. This phenomenon is known as deepfake where false similarities can be extremely persuasive. When the AI is used to intentionally deceive in this way, it puts the onus on individuals to discern what is real or not and whether due to lack of skill or will, it is commonly observed that humans are not always able to determine what is real fact or not.<sup>43</sup>

#### **6.3.4. The Role of Education and Training**

With all the challenges that artificial intelligence brings, there are many stakeholders who work tirelessly on ways to mitigate the risk when implementing AI solutions in their organizations. Most importantly, they start by educating their industries on what are the capabilities, challenges and limitations of AI procedures. Rather than completely ignore the potential of unethical use of AI, it is better making sure that all parties involved are able to understand the risks and how to mitigate them with regards to installing and operating artificial intelligence technologies and measures. The next step would be to create a solid set of ethical guidelines that the organization must adhere to. This is intertwined with the constant and regular check regarding the achievement of goals and processes that need to be followed extensively.<sup>44</sup>

When AI is involved in data collection or storage, it is imperative to educate the human resources on both ends about how their data is being processed, what is it going to be used for and what are the benefits that are derived from sharing it. This transparency is essential to building trust with the receivers and stakeholders. In this way, adhering to an ethical AI framework can be seen as creating positive sentiment for the maritime industry rather than cultivating restrictive regulation and unnecessary drawbacks. Several impartial third-parties have recognized the need to create guidelines for the ethical use of AI and ensure better safety and transparency. AI assisted maritime technology is increasing voyage optimization which in turn gives industries a better output on long maritime operations and initiatives. Many examples exist in the maritime

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<sup>43</sup> “Protecting Privacy in an AI-Driven World.” Brookings. Brookings, March 9, 2022. <https://www.brookings.edu/research/protecting-privacy-in-an-ai-driven-world/>.

<sup>44</sup> “Why We Need to Raise Awareness on the Issues of AI Now:” What Next For UN? What Next For UN? December 1, 2020. <https://www.whatnext4un.org/post/why-we-need-to-raise-awareness-on-the-issues-of-ai-now>.



sectors which prove that with the right combination human and artificial intelligence can coexist and thrive inside the global community and among human society.<sup>45</sup>

## 7. Conclusion

Artificial Intelligence is an essential tool for future technological development in the maritime industry. The maritime transport sectors are emerging with the rapid advancement of AI. Many work processes have yet to adopt these new innovations and machine learning. As the maritime sector navigates many complexities of sustainable shipping, a digitalization and a good talent pool of data engineers and scientists is required to tackle pressing engineering and operation issues. Besides extensive computation capability, supervised machine learning essential to AI still needs many human efforts to label the training data correctly. People need to understand how the decision is made and how fairly the decision is made without any bias. This fact implies that the associated engineers need to be both multidisciplinary and proficient in coding and legality of AI. All in all, the potential of AI solutions in the maritime sector is immense and it is up to the stakeholders of the shipping industry both to understand it properly and safely implement it in their ships and in their maritime cultures.

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<sup>45</sup> “Why Is It So Important to Raise Public Awareness of the Risks and Rewards of Artificial Intelligence?” LinkedIn, May 6, 2020. <https://www.linkedin.com/pulse/why-so-important-raise-public-awareness-risks-rewards-tania-duarte>.



## 8. Points to be addressed

1. How can states cooperate with the IMO in terms of promoting the use of autonomous shipping methods and practices?
2. In which ways can maritime stakeholders ensure the safe procurement of vessels that are functioning with deep learning procedures?
3. How can the IMO further promote the use of E-Navigation and its associated procedures?
4. What could be done in terms of utilizing the Maritime Single Window and how could it affect the international seas and ports?
5. In which ways can maritime port authorities monitor Just in Time (JIT) arrivals and effectively upgrade shipping efficiency?
6. How could the IMO collaborate with states with the aim of achieving vessel optimization and the reduction of running costs?
7. What can be done with regards to safeguarding transparency and accountability when it comes to AI solutions and the removal of human interaction?
8. In which ways could the IMO utilize blockchain technology in terms of protecting sensitive maritime data and shipping classified specifications?
9. How can maritime industries promote big data processes and the necessary machine learning procedures among their human and ship resources?
10. How could the IMO further promote the use of AI related activities on international and regional ports as well as crucial sea crossroads?



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