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THE LEGAL SYSTEM FOR SMART SHIPS

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Abstract:

This research examines the legal framework for autonomous ships, addressing the legal and legislative challenges associated with integrating this technology into the global maritime system. The study highlights the extent to which traditional maritime laws align with the concept of autonomous vessels and the possibility of granting them independent legal personality. It also discusses the legal liability arising from the operation of autonomous ships, whether in terms of tort liability or strict liability. Furthermore, the research explores a hybrid legal model that accommodates technological advancements in this field. Legislative solutions are proposed, including the establishment of a specialized digital maritime court, the development of clear standards for maritime cybersecurity, and ensuring a balance between technological innovation and legal obligations

Keywords: Autonomous ships, artificial intelligence in navigation, legal liability, legal personality of ships, maritime cybersecurity, traditional maritime law, digital maritime court, hybrid liability, autonomous maritime operations, smart maritime arbitration.

INTRODUCTION

1. Essence of the Research Idea: The emergence of (Maritime Autonomous Surface Ships, MASS) represents a revolutionary shift in the maritime transport sector, as these ships have become capable of navigation and managing maritime operations without direct human intervention, relying on (Artificial Intelligence, AI), (Advanced Sensor Systems), and (Inter-Vessel Communication Systems). This development has sparked profound legal debates regarding the status of these ships within traditional legal frameworks and their ability to comply with international maritime laws, particularly those governing (Legal Liability), (Maritime Safety), and (Marine Insurance).

This research seeks to study the legal nature of these ships and analyze the adequacy of existing legal rules to keep pace with this technological development, in addition to proposing appropriate legislative solutions.

2. Importance of the Topic and Reasons for Its Selection: The importance of this research stems from the increasing impact of technology on the maritime sector, as many countries and international organizations, such as the (International Maritime Organization, IMO), have begun developing regulatory frameworks for (Maritime Autonomous Surface Ships, MASS). Since these ships raise unprecedented legal issues, such as the possibility of granting them independent (Legal Personality) and determining legal liability in case of accidents, the need for an in-depth study of this subject becomes even more critical.

Additionally, the impact of (Maritime Autonomous Surface Ships, MASS) on the future of maritime navigation, in terms of reducing the need for human crews and enhancing (Maritime Safety), makes it essential to analyze the legal, economic, and social implications of this advanced technology.

3. Research Problem: The use of (Maritime Autonomous Surface Ships, MASS) raises complex legal issues regarding their compatibility with traditional legal frameworks of maritime law, particularly concerning the (Liability Principle). Existing laws assume that a ship is operated by a human crew responsible for its decisions and actions. With the absence of human involvement in the operation of these ships, questions arise about the determination of legal liability—whether it falls on the (Shipowner), the (Maritime Operator), or the (Manufacturers of Autonomous Systems and Software).

Furthermore, (Maritime Autonomous Surface Ships, MASS) present a challenge regarding their potential recognition as an independent legal entity and whether they can bear civil and criminal liability for their actions, similar to commercial corporations.

4. Research Questions: The research seeks to answer a set of fundamental questions, the most prominent of which are:

- What is the current legal framework governing the operation of (Maritime Autonomous Surface Ships, MASS)?
- Can (Maritime Autonomous Surface Ships, MASS) be considered an independent legal entity?
- How is legal liability determined in the event of maritime accidents or environmental damage?
- What is the position of international and national legislations regarding this category of ships?

- How can effective legal frameworks be developed to ensure (Maritime Safety) and legal liability for (Maritime Autonomous Surface Ships, MASS)?

5. Research Methodology: This research relies on the (Comparative Analytical Method) by analyzing international maritime laws, such as the (United Nations Convention on the Law of the Sea, UNCLOS), and the (International Convention for the Safety of Life at Sea, SOLAS), and comparing them with national legislations that have begun regulating (Maritime Autonomous Surface Ships, MASS), such as the legislation issued by the United Kingdom, among others. The research also employs the (Inductive Method) to analyze the practical applications of these ships in the maritime transport sector and assess the success of initial trials of this technology.

6. Scope of the Research: This research covers the following aspects:

- The legal definition of (Maritime Autonomous Surface Ships, MASS), their technological and legislative development.
- The feasibility of granting these ships independent (Legal Personality of Autonomous Ships).
- An analysis of the potential legal responsibilities of the various stakeholders involved in operating these ships, such as the (Operator), (Shipowner), and developers of (AI-Based Navigation Systems).
- A study of comparative legislative models adopted by some countries in this field and providing suggestions for the development of the international legal framework for (Maritime Autonomous Surface Ships, MASS).

7. Structure of the Research: The research consists of two main chapters, preceded by an introduction and followed by a conclusion. The first chapter will address the concept of (Maritime Autonomous Surface Ships, MASS), and the second chapter will discuss their legal provisions.

Chapter One
The Concept of Autonomous Ships

Autonomous ships (Maritime Autonomous Surface Ships, MASS) are ships that operate without direct human intervention, relying on Artificial Intelligence (AI), Machine Learning, and Advanced Sensor Systems. The International Maritime Organization (IMO) has defined levels of autonomy for these ships, ranging from partial human control to full autonomy. Their use raises legal challenges, such as Civil Liability and Legal Personality[1], which require the development of specialized regulatory frameworks. Furthermore, these ships affect the future of traditional seafarers and the maritime economy, raising questions about the need for new legislation that aligns with this technological advancement.

Clarifying the concept of autonomous ships requires dividing this chapter into two sections: the first discusses the definition of autonomous ships, while the second focuses on the characteristics of autonomous ships.

Subsection One
The Definition of Autonomous Ships

The definition of autonomous ships requires dividing this subsection into two parts. The first part addresses the definition of autonomous ships, while the second part focuses on explaining their autonomy.

Part One
Definition of Autonomous Ships

Autonomous ships (Maritime Autonomous Surface Ships - MASS) are vessels that operate using Artificial Intelligence technologies without direct human intervention. Given the evolving nature of this technology, some countries and international organizations have started to provide legal definitions for these ships, along with attempts to amend traditional maritime legislation to accommodate them.

First: Legislative Definitions of Autonomous Ships

The United Nations Convention on the Law of the Sea (UNCLOS, 1982) does not include a direct definition of autonomous ships. Article 94 assumes that every ship must have a responsible captain, which contradicts full autonomous operation. However, the International Maritime Organization (IMO) provided a general definition in its report on autonomous ships, defining them as: "Vessels that can operate independently or semi-independently, with reduced or no need for human crew onboard, by using autonomous control systems or remote operation[2].

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[1]) Muhammad Irfan, The Legal Status of Personal Robots and Liability: A Comparative Foundational Study, published in The Journal of the Global Law College, Sixth Year, Issue 4, Serial Number 24, 2018, p. 111.

[2]) Ships which can operate without a crew on board, either fully or partially, using autonomous control systems or remote operation, Note the Foresight Report on the Maritime Regulation of Autonomous Ships discussed and adopted at the 101st session of the Committee of the International Maritime Organization (IMO). In 2018, the IMO defined four levels of automation for ships:

1. Level 1 (Partial Assistance): Ships that have automatic decision support systems but still require a human crew on board.
2. Level 2 (Remote Operation - Partial): Ships that can be remotely operated with a human crew on board.

has included a definition of them in the[3] *"Merchant Shipping (Autonomous and Remote Operation) Bill, 2022"*, where autonomous ships are defined as: ships capable of performing maritime duties without human intervention or those that can be remotely operated using intelligent systems or remote control technologies.

In the European Union (European Union), efforts are underway to develop a new legal framework for the operation of autonomous ships, particularly within the context of the AUTOSHIP project under the Horizon 2020 program. According to the European Union definition, autonomous ships are[4]: ships equipped with operating systems capable of making decisions and determining actions independently.

Despite the significant technological advancements, traditional maritime laws still face difficulties in accommodating the concept of autonomous ships. In the absence of a globally unified definition, some countries such as the United Kingdom, Norway, the United States, and the European Union have begun to develop new legal frameworks. However, many legal challenges remain, requiring updates to international agreements, particularly UNCLOS[5].

Secondly: Doctrinal Definition

The definitions provided by scholars for autonomous ships vary, and we do not wish to delve into them due to their similarities in meaning. Therefore, we define autonomous ships as:

A type of ship that uses Artificial Intelligence, Sensors, Navigation, and Communication technologies to carry out maritime tasks independently, without the need for direct human intervention in its operations. These ships are designed to be capable of making decisions based on the data they collect from their surrounding environment, using complex Algorithms (Complex Algorithms) to enable them to navigate, avoid obstacles, and interact with changing maritime conditions.

To clarify the characteristics of this definition, we divide the explanation as follows:

1. **Autonomy**: This is one of the main characteristics of autonomous ships, representing their ability to operate without the need for direct human intervention or a crew of sailors on board. These ships rely on a set of advanced technological systems that enable them to perform their maritime tasks effectively and accurately. This includes self-navigation (Self-navigation), sensing (Sensing), and communication (Communication) technologies, which provide continuous data about the environment surrounding the ship and use it to make real-time navigational decisions. The components of autonomy are:

A. Self-navigation (Self-navigation): Autonomous ships rely on Artificial Intelligence (AI) Algorithms to determine the optimal route and navigate through the waters. These algorithms are not limited to a fixed course; instead, they interact with changes in the marine environment such as wave movement, currents, and fluctuating weather conditions. Self-navigation enables the ship to independently adjust its course and avoid obstacles[6].

B. Sensing (Sensing): Ships rely on advanced sensing systems such as Radar, Cameras, and Underwater Sensors to collect real-time environmental data. These systems enable the ship to detect changes in its surroundings (Environmental Changes), such as the approach of other ships or the presence of water obstacles, which helps in making appropriate decisions to prevent accidents[7].

C. Autonomous Response (Autonomous Response): Based on the data collected through *sensing*, the ship can make real-time decisions (Real-time Decisions) such as course alteration (Course Alteration), speed reduction (Speed

3. Level 3 (Remote Operation - Full): Ships that are remotely operated without the need for a human crew on board.
4. Level 4 (Fully Autonomous Operation): Fully autonomous ships that operate without any human intervention or crew on board.

[3]) ART. 2: Ships that operate without the need for a captain or human crew onboard, controlled through an autonomous or remote electronic system

[4]) Ships that rely on artificial intelligence and autonomous navigation technologies to conduct maritime operations without direct human intervention, while complying with international safety standards

[5]) Article 11/1 of the Federal Maritime Commercial Law of the United Arab Emirates, Law No. 26 of 1981, defines a ship as: "Any establishment that usually operates or is intended for operation in maritime navigation, without regard to its power, tonnage, or the purpose of its navigation."

[6]) Note on the Uses of Artificial Intelligence Based on Algorithms: Stuart Russell, Artificial Intelligence: A Guide for Humans to Ensure Machines Do Not Dominate the World, 2nd Edition, translated by Mustafa Mohamed Fouad and Osama Ismail Abdel-Alim, Hindawi Publishing, United Kingdom, 2017, p. 124.

[7]) R. Glenn Wright, ship sensors, 1st, taylor & francis, UK. 2024, P. 95.

Reduction), or even docking (Docking) automatically. These decisions depend on the continuous analysis of the data the ship receives directly[8].

D. Communication (Communication): Despite their autonomy, autonomous ships do not operate in isolation from the outside world. They use advanced communication systems such as *Marine Networks* to communicate with other ships or shore stations. This allows for the instant exchange of data regarding ship movements or weather, enhancing the efficiency of the decision-making process[9].

Despite the advancements in autonomy technology, significant challenges remain in applying these systems within legal maritime contexts. For example, although the ship can make decisions automatically in emergency situations, legal responsibility in the event of an accident may still be unclear as we will see. Should the responsibility lie with the human operator (Human Operator) if there is a supervisor overseeing the system? Or should the manufacturer (Manufacturer) bear the responsibility if the failure is due to a technical defect in the system? These questions still need legal answers and clarification.

With the advancement of Artificial Intelligence (AI) and Machine Learning (Machine Learning) technologies, autonomous ships could witness significant growth in their ability to self-learn (Self-learning) by analyzing their environments more deeply and accurately. This will allow them to continually improve maritime operations (Continuous Improvement in Maritime Operations) and reduce reliance on human intervention even further in the future. Therefore, the autonomy feature in autonomous ships is not merely a technological advancement (Technological Advancement) but rather a paradigm shift (Paradigm Shift) in the way maritime operations are managed.

2. Safety Feature (**Safety**): This is one of the most prominent features of autonomous ships, representing the ability to operate the ship safely without endangering the lives of passengers, crew, or the marine environment. Safety in autonomous ships relies on a combination of advanced technological systems and software specifically designed to handle emergencies and unforeseen events. The components of safety in autonomous ships are:

A. Advanced Sensing Systems (Advanced Sensing Systems): Sensing systems are essential elements to ensure safety in autonomous ships. These systems include Radar, Cameras, Underwater Sensors, as well as Optical Sensing technologies. These systems continuously monitor the ship's surroundings, allowing for early detection of potential hazards such as Collisions or Obstacles, which contributes to making immediate decisions regarding Course Alteration (Course Alteration) or Emergency Stop (Emergency Stop) at the right moment[10].

B. Artificial Intelligence (Artificial Intelligence) and Decision Models (Decision Models): Algorithms (Algorithms) and Machine Learning Systems (Machine Learning Systems) are used to provide the ship with the ability to make decisions independently based on the data collected by the sensing systems. For example, in the case of an Approaching Vessel (Approaching Vessel) or Strong Currents (Strong Currents), the algorithms calculate the best options to avoid collisions. The systems also monitor the situation in real-time (Real-time Monitoring) to ensure that there are no threats or malfunctions[11].

Emergency Response Procedures (Emergency Response Procedures): In certain emergency situations, such as an Oil Spill (Oil Spill) or a Fire on Board (Fire on Board), autonomous ships rely on integrated systems for rapid response, such as Automatic Engine Shutdown (Automatic Engine Shutdown) or Emergency Signaling (Emergency Signaling). These systems also include Automated Protocols (Automated Protocols) to interact with other maritime systems, such as emergency notifications for nearby ships or shore stations[12].

C. Remote Control (Remote Control): There may be a need for human intervention to ensure safety. Autonomous ships offer remote control capabilities by operators on the shore or on other ships. This can be crucial in situations where the ship requires human guidance in unusual environments or in harsh maritime conditions[13].

D. Compliance with International Standards: To ensure the safety of autonomous ships, they must comply with the safety standards set by organizations such as (IMO) and (International Maritime Organization). These standards include clear instructions on the safe operation of ships and provide clear mechanisms for handling maritime incidents, as we shall see.

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[8]) Tafsir Matin Johanson, jon A. Skinner, autonomous vessels in martime affairs, 1st, springer nature, Switzerland, 2023, P. 400.

[9]) KOUROSH KOUSHAN, empirical prediction of ship resistance and surface area using artificial neural networks ,research publishes at paractical design of ships and other floating structures, v. 1, Elsevier, Netherlands, 2001, p. 510.

[10]) Xiongfei shan, depeng zhao, mingyang pan, deqiang wang, lining zhao, sea-sky line its nearby detection bases on the motion attitude of visible light sensor, remote sensing in vessel detection and navigation (journal) , MDPI, Switzerland, 2020, p. 141.

[11]) Rifaat M. Abdalla, revolutionizing earth observation, 1st, BOB BOOK ON DEMAND, UK. 2024, P. 154.

[12]) The dictionary of maritime, entrepol, 2023, P. 572.

[13]) Lima S., Dara Editions, Mine Sweepers, Corvettes, and Supply Ships, Translated by: Dr. Mohammed Salehi, Dr. Said Sebai'a, 1st Edition, Al-Obikat Library, Riyadh, 2002, p. 23.

Despite these advanced systems, autonomous ships still face security challenges related to (Legality) and (Liability) in the event of accidents. It is difficult to determine responsibility accurately when the ship encounters an incident due to a (System Failure) or a (Programming Error), as many legal systems still need to be updated to consider these modern technologies. With the advancement of (AI) and (Self-sensing) technologies, autonomous ships can become safer over time, and this includes the ability to learn from (Learning from Previous Experiences), which helps improve safety strategies and interact with environmental variables more effectively.

Interaction with the environment in the context of autonomous ships represents a complex and multifaceted process, which involves the ship's response to environmental stimuli through the use of modern technologies, such as (Advanced Sensing Devices), (Artificial Intelligence), and (Machine Learning), to guide the processes that affect the ship's movement and its interactions with its marine environment[14]. Its components are:

A. Environmental Sensing: Advanced sensing systems are the cornerstone of environmental interaction, as autonomous ships use technologies such as (Radar), (Cameras), (LiDAR), and (Infrared Sensors). These systems monitor everything around the ship in real-time, such as (Marine Obstacles), (Other Vessels Movement), (Weather Conditions), (Marine Currents), and (Geographic Conditions).

B. Data Processing: After collecting environmental data through sensing systems, this data is processed by artificial intelligence and machine learning systems, enabling the ship to interpret and respond to environmental information (Environmental Information) in real-time. Artificial intelligence can analyze this data and recognize patterns, allowing the ship to make independent and safe (Safe) navigational decisions (Navigational Decisions), such as changing course (Course Change) or adjusting speed (Speed Adjustment).

C. Interaction with Other Vessels: Autonomous ships need continuous communication with other vessels in their vicinity to avoid collisions. Technologies such as (Collaborative Navigation Systems) are used, which allow ships to share information about their locations and courses to coordinate maritime movement. The ship can use this data to analyze crossing paths and avoid collisions or make course adjustments based on data received from other ships[15].

D. Th. Environmental Safety Enhancement: Autonomous ships are also more capable of monitoring the environmental impacts (Environmental Impacts) that may result from their operations, such as carbon emissions or pollution caused by oil spills. By using smart systems, the ship can optimize fuel consumption, reduce emissions, and contribute to the overall preservation of the marine environment. The ship can be programmed to take preventive actions such as checking marine pollution levels (Pollution Detection) or sending alerts in case of a spill (Spill Detection and Alerts)[16].

Despite the significant development in environmental interaction technologies for autonomous ships, there are still many challenges. One of the main challenges is dealing with unpredictable environmental conditions (Unpredictable Environmental Conditions), such as sudden storms or sea ice. Moreover, legal and regulatory frameworks must be developed to ensure the safety of ships in interaction with the marine environment and to define responsibilities in the case of environmental damage or maritime collisions. The ability of autonomous ships to interact with the marine environment is a key element that contributes to improving the safety and efficiency of maritime transport. Through the use of smart systems and automatic interaction with the environment, ships can enhance their performance and reduce risks associated with changing maritime conditions. As AI and machine learning technologies advance, environmental interaction will become more accurate and effective, enhancing the potential for sustainable and safe operation of these ships.

3. **Interoperability in the context of autonomous ships:** Refers to the ability of ships to communicate and coordinate with other ships, maritime infrastructure, and control systems through advanced information and communication technologies. This communication aims to improve safety, avoid collisions, and ensure effective navigational operations in a complex maritime environment. Interoperability is implemented using integrated communication systems (Integrated Communication Systems), which include Global Positioning Systems (GPS), Automatic Identification Systems (AIS), as well as Satellite Communication Systems (Satellite Communication Systems), as follows:

A. Inter-Vessel Communication: At sea, where traditional terrestrial communication networks are unavailable, ships need advanced systems to stay in constant contact. The Automatic Identification System (AIS) is widely used in autonomous ships, allowing the ship to send and receive data about its location, speed, and the direction it is heading. This communication allows other ships in the area to know the course of the autonomous ship, which helps avoid collisions (Collision Avoidance) and organize ship traffic in crowded areas[17].

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[14]) Report of the General Fisheries Commission for the Mediterranean, 44th Session Online Report, 2-6 November 2021, Food and Agriculture Organization of the United Nations, p. 195.

[15]) Haiwen Zhang, Yao Huang, Lijuan Xing, unscrewed vessels and international law, 1st, BRILL. 2024, P.131.

[16]) Nauja Bianco, Reducing risks and increasing environment security in arctic waters, Nordic council of ministers, 2020, P. 53.

[17]) Adam WEINTRIT,Tomasz Neumann, information communication and environment marine navigation and safety of sea transportation, 1st, CPC Press, UK, 2015, P. 40.

B. Infrastructure Communication: In addition to communication between ships, autonomous ships must be able to communicate with maritime infrastructure, including smart ports (Smart Ports). The ship can send and receive information about arrival schedules (Arrival Schedules), available facilities (Available Facilities), weather conditions (Weather Conditions), and information about access or exit zones (Access/Exit Zones). Internet of Things (IoT) technologies are used here to synchronize the ship's data with integrated systems in the port, facilitating loading, unloading, and navigation operations[18].

C. Control Center Communication: Autonomous ships need to communicate with ground control stations (Ground Control Stations) or operation centers (Operation Centers). These stations remotely control the ship and monitor all of its operational data. Through them, commands are issued to guide the ship or adjust its course based on environmental changes or unexpected events. This communication relies on high-speed networks to ensure real-time data transfer (Real-time Data Transfer). Despite the vast capabilities of interoperability, significant challenges arise in this context, such as interference issues (Interference Issues) between different systems, cybersecurity (Cybersecurity) to maintain data confidentiality and protect against attacks, and compatibility between different technologies (Compatibility between Different Technologies), especially with the diversity of companies and manufacturers working in this field. Any malfunction in these systems could pose serious threats to the safety of the ships and their surrounding environment[19].

The Second Requirement
The Legal Nature of Autonomous Ships – Can They Be a "Legal Person"?

Autonomous ships (Maritime Autonomous Surface Ships - MASS) present an unprecedented legal challenge[20], requiring a reconsideration of the traditional legal foundations of maritime law, particularly with regard to concepts of liability, sovereignty, registration, and oversight. Here, a fundamental question arises about whether these ships are merely technical tools, or if they should be granted a form of legal personality that makes them independently responsible for their actions. Legal discussions swing between three main directions: the first is that autonomous ships are owned objects with no legal independence; the second is that autonomous ships are partial legal entities that can bear limited responsibilities; and the third is that autonomous ships are independent legal personalities, like commercial companies. To elaborate on this matter, we will break it down into the following sections:

First: Analyzing the Legal Nature According to Traditional Legal Theories:

The traditional theory in maritime law is based on the concept that the ship is merely a physical tool, meaning it does not possess legal personality and is considered just an object owned by natural or legal persons (companies or maritime entities). According to this view, any legal responsibility arising from the ship's actions should be attributed to its owner, operator, or the responsible captain. This theory is based on a set of legal principles established through international maritime law agreements and national legislations, forming a main foundation for regulating the responsibilities and rights associated with maritime navigation. With the emergence of autonomous ships (Maritime Autonomous Surface Ships - MASS), fundamental challenges have arisen for this theory, as there are now ships operating without a human crew, raising the question of how traditional rules should be applied to them[21].

1- **Legal Foundations of the Traditional Theory**: There are several principles, including the following:

A. Principle that the Ship is Not an Independent Legal Person: Traditional maritime laws stipulate that ships are not independent legal entities; rather, they are treated as objects (Res) subject to private ownership. For this reason, a ship cannot bear legal responsibility or sue or be sued in its own name. Any obligations or liabilities arising from the ship's activities are attributed to its owner or legal operator. Additionally, the ship does not have legal capacity to act independently in legal transactions, such as contracting or bearing criminal responsibility[22].

B. The Principle of Liability of the Captain and Ship Owner: According to international agreements such as the United Nations Convention on the Law of the Sea (UNCLOS 1982) and the International Convention for the Safety of Life at Sea (SOLAS 1974), it is emphasized that every ship must have a legally responsible captain, who bears the responsibility for navigation decisions and compliance with maritime laws. Additionally, the ship's owner, whether an individual or a company, is considered the ultimate legal party responsible for the actions of the ship. With the

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[18]) Mayada omer, resilience of networked infrastructure systems: the analysis and measurement, vol. 3, world scientific, USA, 2013, P. 4.

[19]) Hiroaki Kobayashi, techniques for ship handling and bridge team management, 1st, routledge UK, 2020, P. 69.

[20]) **Note in Details:** Dr. Amer Ghanem Alwan, Alla Maan Mohamed Hassan, "The Basis of Civil Liability for Damages Caused by Autonomous Vehicles Under Traditional Liability Rules," published in Al-Qadisiyah Journal of Law and Political Science, Issue (2), Volume 1, Volume (15), 2024, pp. 497-522.

[21]) Responsible research council, division on earth and life studies, bboard on life sciences, 2010, P. 134.

[22]) Note on the Civil and Criminal Liability of the Captain: Bouchema Aya, Aissaoui Nabila, "The Legal System of the Ship," Master's Thesis, 2023, p. 36 and the following.

emergence of autonomous ships, this rule faces a significant issue, as there is no actual captain on board to make decisions, raising the question of who should be held accountable: Should the responsibility fall on the ship's owner as in traditional ships? Or should the responsibility extend to the software development company that controls the ship? And how can responsibility be assigned if navigation decisions are made by artificial intelligence rather than a human?
C.The Principle of Registration and Flag State Jurisdiction: Maritime laws require that every ship be registered under a specific country, making it subject to that country's authority regarding maritime regulations and oversight. According to the traditional theory, every ship must have a flag state (Flag State) whose maritime laws apply. The country whose flag the ship flies bears the responsibility for regulating its operations and ensuring its compliance with international maritime laws. The flag state imposes clear operational rules, such as the requirement for a human crew, which becomes a point of contention in the case of autonomous ships(23)Here, the challenges facing this principle with autonomous ships are: How can a ship without a human crew be registered according to traditional legal requirements? Do autonomous ships still need a flag state, or can a new digital system be developed to manage them through an international cloud-based system? And how can maritime law compliance be enforced on a ship operated by artificial intelligence systems remotely?

2- Criticisms and Challenges Facing the Traditional Theory: These can be summarized as follows:
A. The Absence of a "Responsible Captain" and Its Impact on Legal Responsibility: The traditional theory assumes that there is a human captain legally responsible for operating the ship. However, in autonomous ships, decisions are made by artificial intelligence systems, not by a human who can be held directly legally responsible. If a maritime accident occurs, it is unclear who can be held accountable: the ship owner, the manufacturing company, the software programmer, or the remote system operator? Furthermore, current maritime laws do not recognize artificial intelligence as a legal entity that can be held accountable.
B. The Issue of Sanctions and Criminal Liability: Penalties can be imposed on the captain, crew, or ship owner if laws are violated, but in the case of autonomous ships, there is no human who can be directly held criminally responsible. How can fines or penalties be imposed on an "artificial intelligence program" if it makes a navigational decision error that leads to an accident? Will responsibility shift to the manufacturing company, potentially changing the nature of traditional maritime liability?
Thus, autonomous ships present a fundamental challenge to the traditional theory in maritime law, as this theory relies on the presence of a responsible human element, which is in direct contrast to the nature of autonomous ships operated by artificial intelligence. While some countries are working to update their legislation to accommodate this technology, the question remains open: Can the traditional theory be modified to include autonomous ships, or does the world need an entirely new legal model that redefines maritime liability from scratch?

Secondly: Analysis of Legal Nature According to the Partial Legal Personality Theory: The Partial Legal Personality Theory seeks to offer a compromise between the traditional theory, which considers the ship merely as a "thing" (Res), and modern theories that advocate granting autonomous ships full legal personality. This theory is based on granting the ship a form of legal autonomy, but in a limited manner, so that ultimate responsibility remains with human entities such as the owner, operator, or manufacturing company. This theory is inspired by other legal models, such as limited legal personality granted to trust funds or certain forms of non-profit organizations. It is based on the idea that autonomous ships may have some legal rights and obligations, but within a framework that does not rise to the level of full legal personality, as is the case with corporations(24).
1. Legal Basis of the Partial Legal Personality Theory: There are different levels of legal personality that entities can have in the legal system according to this theory. For example, a commercial company enjoys full legal personality, meaning it can litigate, contract, own assets, and bear responsibility. Similarly, trust funds also possess a limited form of legal personality(25)In some legal systems, a limited form of legal personality is granted, allowing entities to own assets but under the management of another party. According to this theory, autonomous ships could have an intermediate legal status between a "thing" and a "person, where they possess a partially independent financial status

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23) Donald R. Rothwell, Alex OUDE ELFERINK, KARENN SCOTT, TIM STEPHENS, the oxford handbook of the law and sea, 1st, oxford university press, UK, 2015, P. 10.
24) David j. gunkel, person, thing, robot, a moral and legal ontology for the 21 st century and beyond, by-nc-nd, 2023, P. 127.

25) Investment Funds or Trust Funds: Investment funds or trust funds refer to "an investment vehicle aimed at providing investors with the opportunity to collectively invest in the fields outlined in this regulation." Refer to the Executive Regulation of the Egyptian Capital Market Law No. 95 of 1992 as amended, which is managed by an investment manager for a fee.
Refer to: M. D. Saif Hadi Abdullah Al-Zouini, "A Comparative Approach to the Formation of Investment Funds in Iraqi Legislation," published research in Al-Farabi Journal of Human Sciences, Issue 2, Volume 2, 2023, pp. 115-128.

and limited capacity for legal obligations, but they remain subject to the oversight and supervision of a responsible human entity.

2.The concept of "partial financial liability" for autonomous ships introduces the idea that an autonomous ship could have a partial financial status. This means it could have a dedicated bank account used solely for operational and maintenance expenses. The ship could be held liable for certain financial obligations, such as environmental fines or port fees, without directly involving its owner. However, it would not be fully accountable for contracts or legal matters that require a "human legal will[26].

3.Under this theory, legal responsibility is shared between the autonomous ship and its operator. The first party, the ship itself, would bear limited responsibility for certain financial obligations (such as operating fees or fines). It could be registered as a partial legal entity in some maritime legal systems and could gain limited legal rights, such as the right to enter certain ports in accordance with international standards. The second party is the operator or owner, who remains responsible for key decisions related to navigation and safety. The operator would be held accountable in the event of maritime accidents or serious legal violations and would be the primary party in any legal contracts or long-term obligations[27].

4- The possibility of registering autonomous vessels as limited legal entities: Instead of registering autonomous vessels as merely "property" owned by a company, they can be registered as partial legal entities, allowing them to operate independently in certain cases. This may require the development of a special legal registry for autonomous vessels (Autonomous Vessel Registry).

The theory of partial legal personality offers a middle ground between treating autonomous vessels merely as "owned objects" and granting them full legal personality like corporations. However, there are still legal and philosophical challenges that must be addressed before this theory can be widely applied. In the future, a mixed legal framework may be developed that allows autonomous vessels to enjoy limited rights and responsibilities while maintaining human oversight to ensure compliance with international maritime laws. With the increasing reliance on artificial intelligence in maritime navigation, this theory could become the cornerstone for updating maritime laws to align technology with the law.

Thirdly: The Theory of Independent Legal Personality – Ships as a New Legal Entity: The theory of independent legal personality (Independent Legal Personality Theory) presents a new perspective on the status of autonomous vessels in maritime law. This theory advocates granting them independent legal personality similar to that granted to commercial companies. It is based on the idea that, due to artificial intelligence technologies and autonomous systems, the vessel is no longer merely an "object" (Res) subject to the authority of its owner or operator. Instead, it has become capable of operating with a degree of operational and financial independence, which necessitates recognizing it as an independent legal entity. This concept is inspired by other legal experiences, such as modern legal ideas related to artificial intelligence and smart robots.

1. The General Concept of Independent Legal Personality: Independent legal personality means that an autonomous vessel can be a legal entity with rights and obligations separate from its owner or operator. In other words, this vessel can own assets and financial resources, enter into contracts with other parties without the need for a human intermediary, bear legal responsibility in the case of violations or damages, and litigate or file lawsuits before maritime courts[28].
2. The Legal Foundations for Applying the Theory in Maritime Law: The theory of legal personality in civil law, such as for corporations and non-human entities, grants legal personality despite the fact that these are not human beings. So, why not extend this idea to autonomous vessels? With the rise of unmanned ships, it has become difficult to assign responsibility to traditional individuals (captain, crew, owner), which calls for the search for a new legal entity to bear the responsibility. Additionally, there are ongoing discussions about granting robots and artificial intelligence their own legal personality, which may provide a legal precedent that can be applied to autonomous vessels[29].
3. Legal Characteristics of the Independent Legal Personality of Autonomous Ships: These include:
    A. Independent Financial Status: According to this theory, the autonomous ship can have its own bank account, managed by artificial intelligence systems or specific regulatory bodies. It can collect revenues (such as shipping fees or logistics services) and spend money on maintenance and operations. In the case of a maritime violation, it can pay fines from its own funds rather than holding the owner directly responsible.

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[26]) Gabriel Hallevy, liability for crimed involving artificial intelligence systems, 1st, springer natural, Switzerland, 2014.

[27]) In international agreements such as SOLAS 1974 and UNCLOS 1982, a ship is defined as an entity subject to the authority of the Flag State. According to the Partial Legal Personality Theory, this principle can be maintained, but with the recognition that autonomous ships may have operational independence within a certain scope. Countries could amend their maritime laws to include a new category of "smart ships," which would have limited legal rights and responsibilities.

[28]) Samir chopra, LAURENCE F. WHITE, a legal theory for autonomous artificial agents, 1st, university of Michigan press, USA, 2011, P. 159.

[29]) Visa AJ. Kurki, theory of legal personhood, oxford university press, UK., 2019, P. 149.

B. Legal Responsibility: The ship itself becomes legally responsible for accidents or damages it causes, without the need to place direct blame on the owner or manufacturer. It can face direct legal penalties, such as being detained in ports or being prohibited from sailing, similar to how companies are fined for violating commercial laws. The ship could be held accountable in specialized maritime courts, where legal disputes are settled as with commercial companies.
C. Contracts and Dealings: The autonomous ship can sign shipping and maritime trade contracts on its own, using smart contracts based on blockchain technology. It can directly interact with ports, paying fees without the need for human intervention(30)
D.The relationship between the ship and the state: registration and flag. Under current laws, every ship must be registered under the flag of a specific state(31)With independent legal personality, autonomous ships could become independent entities not directly tied to a specific state, which may lead to a new legal status similar to the legal domicile of corporations(32).
The theory of independent legal personality presents a revolutionary solution for the status of Maritime Autonomous Surface Ships (MASS) in maritime law. However, it faces significant legal and philosophical challenges. If recognized, this could lead to a complete restructuring of the global maritime legal system, with its impact possibly extending to other fields such as artificial intelligence, robotics, and autonomous systems in land and air transport as well. In the future, we may see a gradual evolution toward adopting this theory, with the creation of hybrid legal frameworks that integrate traditional legal personality and the independent liability of smart ships, which could constitute a legal revolution in the world of maritime transport.

Chapter Two
Regulations of Autonomous Ships in the Context of Artificial Intelligence

The statement of the regulations of Maritime Autonomous Surface Ships (MASS) in the context of artificial intelligence requires dividing this chapter into the following sections:

Section One
Autonomous Ships Between Technological Transformation and Legal Challenge

The entry of Maritime Autonomous Surface Ships (MASS) into the maritime legal system represents a historic moment that reshapes our understanding of concepts like responsibility, accountability, and autonomy in actions that have legal consequences. This innovation raises a deep philosophical debate about the legal nature of machines and their place within the traditional legal framework, which always assumes a human actor responsible for making maritime decisions. The fundamental question here is: Should we redefine the concept of legal responsibility to align with technological advancements, or should we adapt the technology to fit the traditional legal rules? This necessitates dividing this section into the following subsections:

Subsection One
Responsibility of (Autonomous Ships) and the Confrontation Between (Law) and (Technology)

Traditional (maritime law) is based on the assumption that (legal liability) is attributed to a human element responsible for the ship, whether it is the (shipowner), the (captain), or the (operator). This principle is reflected in key international conventions, such as the (United Nations Convention on the Law of the Sea) (UNCLOS 1982), which requires that every ship must have a (flag state) that bears the responsibility for regulating and overseeing the ship(33)And the SOLAS 1974 (International Convention for the Safety of Life at Sea): which requires the presence of a captain responsible for navigational safety(34)The UK Merchant Shipping Act 1995: which requires the presence of a captain on board the ship who is responsible for the actions resulting from it(35).
However, these legal texts reflect an anthropomorphic legal system, where the ship is assumed to be a non-independent entity exclusively operated by humans. But what if there is no human in charge? Can responsibility be assigned to a non-human entity? The explanation of this requires further detail as follows:
First: Shipowner's Liability: The liability of the shipowner is one of the most important legal issues facing maritime law, as the traditional legal system relies on holding the shipowner responsible for damages resulting from the operation of the ship, whether caused by the actions of the captain and crew or maritime accidents. With the

30) Shilpa Karkeraa, unlocking blockchain on Azure, 1st, springer nature, new York, 2020, P. 41.
31) This principle was established in the Chicago Convention of 1944 and is enshrined in the amended Iraqi Civil Aviation Law No. 148 of 1974.
32) The definition of domicile is mentioned in Article 42 of the Iraqi Civil Code No. 40 of 1951.

33) Refer to Article 94 of the United Nations Convention on the Law of the Sea, 1982
34) "SOLAS 1974: which requires a captain responsible for navigational safety."

35) "UK Merchant Shipping Act 1995: which requires a captain to be onboard the ship who is responsible for the actions resulting from it."

development of Maritime Autonomous Surface Ships (MASS), new legal challenges have emerged that require reassessment of this traditional framework, including the legal basis for the shipowner's liability in traditional maritime law, where the shipowner is held legally responsible under one of two basic principles[36]:

1- Direct Liability: The shipowner bears direct responsibility if they are involved in the error or negligence that led to the damage. This principle applies when it is proven that the shipowner failed to comply with legal rules related to maintenance, supervision of the ship, or employing a qualified crew.

2- Vicarious Liability: The shipowner bears responsibility for the actions of the captain and crew, even if they were not personally involved, according to the principle of "Respondeat Superior"[37], which assumes that the actions of employees fall under the responsibility of their employer. This principle is reflected in several maritime conventions, such as the 1910 Brussels Convention on Maritime Collisions, which requires the shipowner to pay compensation for any damage resulting from a collision, even if the captain is the actual responsible party for the incident. The shipowner's liability varies from country to country, but it is based on a number of international conventions and regulations, most notably the UNCLOS 1982, which obligates the flag state to supervise the ship but does not exempt the shipowner from civil and criminal liability resulting from its operation, as outlined in Article 94.

Second: Ship Operator's Liability**:** The liability of the maritime operator (Maritime Operator Liability) is one of the complex legal issues that intertwines traditional responsibility with technological developments in the maritime transport sector, especially with the emergence of autonomous ships. The maritime operator is the entity responsible for managing and operating the ship, either directly through a human crew on board or remotely via intelligent control systems. Therefore, the scope of their responsibility is determined by the legal rules governing ship operation, their compliance with internationally recognized technical and navigational standards. Historically, the responsibility of the maritime operator has been based on the principle of due diligence, which obliges them to take all necessary measures to ensure navigational safety, protect cargo, and preserve the marine environment. International conventions, such as the SOLAS 1974 and the CLC 1969, have established clear obligations for the maritime operator, including ensuring the ship's seaworthiness, providing a trained crew, and complying with environmental and navigational regulations[38].

However, with the entry of autonomous ships into the maritime scene, the operator's responsibility has become more complex. The operation is no longer solely dependent on human factors but is now linked to artificial intelligence systems and advanced software. This raises fundamental legal questions: If an accident occurs due to a programming error or a malfunction in the autonomous navigation system, should the operator bear full responsibility? Or should the responsibility be shared between them, the software manufacturer, and the entity responsible for maintenance?

Current laws still rely on the idea that the maritime operator bears responsibility even if not directly involved, based on the principle of "vicarious liability." Even if the ship operates entirely autonomously, the operator remains responsible for overseeing it and ensuring its compliance with international standards. For example, in British maritime legislation under the Merchant Shipping Act 1995, the operator is considered responsible for any damages caused by the operation of the ship, even if those damages are due to independent automated technologies[39].

However, there is an emerging legal trend calling for a redefinition of the maritime operator's liability in the context of smart ships, where liability is distributed among multiple parties according to the nature of the fault or error. There are proposals to adopt a "Shared Liability Model," where the operator is held responsible for faults related to oversight and management, while the manufacturers of the smart systems are responsible for technical errors, and the ship owner is held accountable for administrative and organizational aspects[40].

From an insurance perspective, maritime operators face significant challenges, as most current insurance systems are designed to cover traditional accidents where the fault is clear and can be attributed to human crew or mechanical failure. However, in the case of autonomous vessels, the fault may be indeterminate, necessitating the development of new maritime insurance contracts that account for the complexities of autonomous operations.

As a result, some countries have begun adopting new legal frameworks to regulate the liability of maritime operators under autonomous operation. For example, in the UK's Merchant Shipping (Autonomous and Remote Operation) Bill 2022, rules were proposed to define the operator's liability based on the degree of control exercised over the vessel. If there is remote human oversight, the operator remains responsible as if the crew were on board, while if the ship operates with fully independent artificial intelligence, responsibility may be shifted to the entity that developed the technology.

The future of maritime operator liability is heading toward restructuring legal rules to align with technological advancements, with flexible legal frameworks that allow responsibility to be assigned to the active parties based on the nature of the fault and the predictability and preventability of it. While current laws still rely on traditional principles, the urgent need for new legislation is increasing with the growing reliance on smart technologies in

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[36]) Xia chen, limitation of liability for maritime claims, 1st, Kluwer law international, the Netherlands, 2001, P. xiii.

[37]) Lliana christodoulo-varotsi, Dmitry a. pentsov, maritime work law foundamentals: responsible shipowners, reliable seafarers, 1st, springer nature, new York, 2007, P. 374.

[38]) Wang Hui, civil liability for marine oil pollution damage, 1st, wolters Kluwer, UK., 2011, P.84.

[39]) SEE MORE: Paula Giliker, vicarious liability in tort, 1st, Cambridge university press, UK., 2010.

[40]) ANDRE NOLIKAEMPER ILIAS PLAKEFALOS, The practice reponsbility in international law, 1st, Cambridge university press, 2017, P. 289.

maritime navigation, which could ultimately lead to a legal revolution that redefines the role and liability of the maritime operator in the digital age.

Third: Manufacturers & AI Developers Liability

Should software be treated as a product (Product)? With the rapid advancement of maritime technology (Maritime Technology) and the emergence of Maritime Autonomous Surface Ships (MASS), manufacturers of systems and software developers (Manufacturers & AI Developers) have become key players in the maritime transport sector (Maritime Transport Sector). Their role is no longer limited to developing supportive navigation systems (Supportive Navigation Systems); instead, they are now responsible for technologies that fully operate ships (Technologies That Fully Operate Ships) without direct human intervention (Human Intervention).

This development raises complex legal issues (Complex Legal Issues) regarding the extent of their legal liability (Extent of Their Legal Liability), particularly in cases where malfunctions or software errors (Malfunctions or Software Errors) lead to maritime accidents (Maritime Accidents)[41].

1- The Legal Basis for Manufacturers' Liability Under Traditional Maritime Law

Under traditional maritime law (Traditional Maritime Law), legal liability (Legal Liability) was primarily focused on the ship operator (Ship Operator) and shipowner (Shipowner), as they were considered responsible for operation, maintenance, and safety (Operation, Maintenance, and Safety). However, technological advancements (Technological Advancements) have necessitated a reassessment of the manufacturers' role (Reassessment of the Manufacturers' Role), leading to the incorporation of principles from other legal frameworks (Principles from Other Legal Frameworks), most notably:

A. Product Liability (Product Liability): According to various legal systems (Legal Systems), such as the EU Product Liability Directive 85/374/EEC, manufacturers (Manufacturers) bear liability (Liability) if defects in their products (Defects in Their Products) cause damage, even in the absence of direct negligence (Direct Negligence). This principle applies when software (Software) or systems used in ships (Systems Used in Ships) are defective and result in accidents (Accidents), thereby holding manufacturers legally accountable (Manufacturers Legally Accountable) even without direct human intervention (Direct Human Intervention)[42].

B. Traditional Maritime Law (Traditional Maritime Law): Maritime law (Maritime Law) did not originally contain clear provisions (Clear Provisions) regulating manufacturers' liability (Manufacturers' Liability), as the focus was primarily on shipowners (Shipowners) and operators (Operators). However, with the development of smart ships (Smart Ships), there are increasing legal demands (Legal Demands) **to** update maritime conventions (Update Maritime Conventions), such as the Convention on Limitation of Liability for Maritime Claims (LLMC 1976)**,** to expand the scope of manufacturers' liability (Expand the Scope of Manufacturers' Liability)[43].

2- Scope of Manufacturers' Liability in Operating Maritime Autonomous Surface Ships (MASS):

A. The liability of manufacturers of artificial intelligence systems and maritime software (Manufacturers of AI Systems and Maritime Software) is determined through three main dimensions:

A. Defective Manufacturing Liability: If there is a defect in navigational hardware (Navigational Hardware) or sensor systems (Sensor Systems) on which the ship relies, such as radar systems (Radar Systems) and LIDAR (LIDAR), the manufacturer may be held liable for any accident caused by these defects. For example, if the autonomous collision avoidance system (Autonomous Collision Avoidance System) fails to detect a nearby object due to a programming error (Programming Error), the manufacturer may be held liable under product liability laws (Product Liability Laws)[44].

B. Software Liability: In Maritime Autonomous Surface Ships (MASS)**,** navigation operations rely entirely on complex software (Complex Software), making them vulnerable to software bugs (Software Bugs) that could lead to incorrect navigational decisions. If the software contains inaccurate algorithms (Inaccurate Algorithms) or lacks the necessary safety protocols (Safety Protocols), manufacturers may be considered legally responsible for any damages resulting from such errors[45]

C. Cybersecurity Liability: One of the growing risks in smart ships (Smart Ships) is their exposure to cyberattacks (Cyberattacks), which can alter their course or disrupt navigation systems. If manufacturers (Manufacturers) fail to incorporate adequate security measures (Security Measures) into their systems, they may be held liable for any damages resulting from software breaches or exploited vulnerabilities (Exploited Vulnerabilities).

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41) Zhijiu Ai, Xiaodong Zhang, Yun-Hae Kim, Prasad Yarlagadda, DVANCED MANUFACTURING SYSTEM, 1ST, Trans tech publication ltd, 2011, P. 10.

42) Chong-ju chae, maritime autonomous surface ships mass –Regulation technology and policy, 1st, springer nature, Uk., P.213.

43) Hannes Descamps, Robin Slabbinck, Hubert Bocken, international documents on environment liability, 1st, springer nature, Uk, 2008, P. 227.

44) Scott Baldwin, Francis H. Hare, JR. Francis E. McGOVERN, PRODUCT LIABILITY CASE DIGEST EDITIONil, 1st, wolters Kluwer, USA, 2019, P.280.

45) Nicolae burnete Bogdan ovidiu varge, proceedings of the 4th international congress of automotive and transport engineering AMMA 2018, 1ST, SPRINGER, UK., 2018, P. 810.

According to the International Maritime Organization (IMO) guidelines, particularly MSC.428(98) on Maritime Cybersecurity, ship operators must ensure that navigational systems (Navigational Systems) are protected against cyber intrusions. This may impose new obligations on manufacturers (Manufacturers) to guarantee the cybersecurity of Maritime Autonomous Surface Ships (MASS)[46].

In the event of a maritime incident (Maritime Incident) caused by software failure (Software Failure) or a flaw in intelligent systems (Intelligent Systems), a legal challenge arises regarding the party responsible for compensation. This leads to three main scenarios:

1.Holding Manufacturers Fully Liable: In some legal systems, such as U.S. product liability law (Restatement (Third) of Torts: Products Liability), manufacturers may be held fully liable if it is proven that the software (Software) or systems (Systems) used in the ship contain a fundamental defect (Fundamental Defect) that was not corrected despite its foreseeable occurrence.

2. Shared Liability Between Manufacturer and Operator: If the error (Error) results from failure to update (Failure to Update) the software (Software) or improper configuration by the operator (Operator), liability (Liability) may be shared between both parties. For example, under the Merchant Shipping (Autonomous and Remote Operation) Bill 2022 in the United Kingdom, a shared liability system (Shared Liability System) was proposed, requiring operators (Operators) to ensure that the ship's systems (Systems) function correctly. This may limit manufacturers' liability (Manufacturers' Liability) in certain cases.

3. No Liability for the Manufacturer if the Error is Beyond Their Control: If the incident (Incident) results from misuse (Misuse) of the intelligent systems (Intelligent Systems) by the operator (Operator) or owner (Owner), the manufacturer (Manufacturer) may be exempt from liability (Exempt from Liability). This scenario is similar to cases involving self-driving car manufacturers (Self-Driving Car Manufacturers), such as Tesla, where manufacturers argue that the human operator (Human Operator) remains responsible for overseeing the systems (Systems).

The liability of manufacturers of systems and software in autonomous ships represents a new legal challenge that necessitates reconsideration of traditional maritime law principles. With the advancement of smart technologies (Smart Technologies), it becomes essential to adopt legal frameworks (Legal Frameworks) that balance consumer protection (Consumer Protection) and the encouragement of innovation (Encouragement of Innovation) in the maritime transport sector. While most legal systems (Legal Systems) still rely on product liability principles (Product Liability Principles), the need for more detailed regulations (Detailed Regulations) is increasing with the growing prevalence of smart ships (Smart Ships), requiring an update (Update) of maritime legislation to keep pace with this technological transformation (Technological Transformation).

Section Two

Newly Developed Models for Restructuring Legal Liability

Discussing the models proposed by modern jurisprudence for restructuring civil legal liability arising from damages caused by autonomous ships necessitates dividing this section into the following paragraphs:

First: Hybrid Liability Model (Hybrid Liability Model)[47]: Its details are as follows:

The General Framework of the Hybrid Model: The Hybrid Liability Model embodies a profound evolution in the understanding of traditional legal frameworks in light of technological innovations. This model involves an integration between the traditional liability of human parties (such as the ship owner or human operator) and the liability arising from the technology of autonomous ships. Autonomous ships require a new definition of the responsibilities of the involved parties, as there is no physical person operating the ship on a daily basis. This may create a legal gap that must be filled through cooperation between traditional legal parties (ship owner, operator, maritime authorities) and technological developers who provide the autonomous systems controlling the ship's operations. The interaction between human and technological systems could radically alter the traditional mechanism for distributing legal liabilities. For example, if an autonomous ship is involved in an accident due to a failure in the autonomous system, the court may need to determine the liability of the technological developers as well as the maritime operators. This model requires complex classifications of liability, where the human operator no longer fully bears traditional liability due to the changing roles in this new technological context[48].

1- Shared Liability**:** Shared liability in the Hybrid Liability Model focuses on dividing roles and responsibilities among multiple parties. First, the owner remains responsible for maintaining the ship and ensuring its readiness for operation in accordance with international standards, such as the SOLAS Convention (Safety of Life at Sea). Second, the maritime operator remains responsible for overseeing the operation of the technological systems and supervising the performance of the autonomous ship. Manufacturers of smart systems may also bear liability in case of a technical error that leads to an accident. The hybrid model divides liability into multiple levels, where no party bears full responsibility. For example, if a software error is the cause of an accident, the manufacturer may be held responsible for design shortcomings. However, if the error resulted from failure to update or maintain the system properly, the

[46]) Chong ju chae ,ibid, P.232.

[47]) See more: chris mi and m. adul masrur, hybrid electric vehicles, 2ed, wily, UK, 2017.

[48]) Dimitrios Ziakkas, Anastasios Plioutsias, artificial intelligence and human performance in transportation, 1sr, CRC press, 2024, barograph 4.1.5.

maritime operator may bear part of the responsibility. This division helps provide more just and accurate legal solutions for determining liability in the complex contexts associated with autonomous ship technology[49].

Second: Establishing an "Autonomous Ship Legal Entity" (Autonomous Ship Legal Entity - ASLE): Granting autonomous ships an independent legal entity requires addressing many new legal issues that arise within the traditional system. Autonomous ships are unmanned vessels that rely on artificial intelligence systems to carry out their operations without direct human intervention. These ships may include technologies such as autonomous navigation and automated control, leading to significant questions about how legal liability should be applied in cases of maritime accidents that may arise due to errors in smart systems or technological malfunctions[50].

1- The Concept of an Autonomous Ship Legal Entity: In the traditional context, ships are registered in the name of their owner or operator, and legal liability in maritime accidents is attributed to these parties. However, autonomous ships operate based on artificial intelligence systems that make decisions independently of humans, raising the question: Can the ship itself be legally responsible? The idea here is that an autonomous ship could be considered an independent legal entity, meaning that the ship could bear legal responsibility for accidents that may occur, as if it were an independent legal person.

2- Legal Challenges Associated with Granting the Ship Legal Personality: One of the greatest challenges posed by this change is determining legal liability. If the ship possesses smart systems that manage most of its operations, such as navigation and communication with other parties at sea, who is responsible in the event of an accident? Is it the designer of these smart systems, the maritime operator, or the ship itself? Also, liability for accidents: In the traditional system, in the event of an accident, liability is attributed to the owner or operator. However, with autonomous ships, artificial intelligence may be considered partially or fully responsible for accidents. Determining the legal cause of these accidents has become complex, as well as technological liability: In the case of an error caused by a malfunction in the software or the smart systems operating the ship, who would be responsible? Is it the manufacturer of these systems, or the owner or operator? This issue raises legal challenges, especially with the development of artificial intelligence.

3- The Required Legislative Framework: If autonomous ships are to be considered independent legal entities, this would require fundamental changes in existing maritime legislation. International laws such as the SOLAS Convention (International Convention for the Safety of Life at Sea) and the COLREGs Convention (International Regulations for Preventing Collisions at Sea) must take into account the modern technologies used by autonomous ships, such as autonomous navigation and artificial intelligence. By granting autonomous ships independent legal personality, it will become easier to determine liabilities among the involved parties, especially in the event of accidents.

The creation of an independent legal entity for autonomous ships represents a paradigm shift in legal thinking within maritime law. This change requires broad legislative amendments, as well as international cooperation to regulate this new field of maritime transport. It will be necessary to find sustainable legal solutions that allow the development of maritime technology in a way that aligns with the newly introduced legal responsibilities.

Third: Establishing a "Digital Maritime Tribunal" (Digital Maritime Tribunal): The idea of establishing a digital maritime tribunal arises from the urgent need to address the challenges of modern maritime law in light of the technological advancements witnessed in the maritime transport industry. With the emergence of autonomous ships and smart systems, it has become essential to have a comprehensive judicial system capable of addressing evolving maritime issues, including liability for accidents caused by modern technologies. The digital maritime tribunal represents a judicial innovation that relies on the use of advanced technology to expedite legal proceedings and ensure more effective justice. The digital maritime tribunal is a judicial entity dedicated to resolving maritime disputes that arise in a world increasingly dependent on digital technology. This type of tribunal is distinguished by its ability to complete legal procedures online using digital platforms, making access to justice easier and faster[51]. This judicial system relies on tools such as artificial intelligence, blockchain, and data analytics to keep pace with the technological evolution in the maritime transport industry[52].

The digital tribunal works to ensure the application of maritime law in a way that aligns with contemporary challenges, such as the advanced technologies used in smart ships and sustainable maritime transport. Previous experiences in the digital judicial system in other areas of law, such as commercial law or civil law, have demonstrated the ability of these tribunals to expedite procedures and reduce legal costs. This applies perfectly to maritime cases that require fast and effective solutions[53].

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[49]) Dimitrios Ziakkas, Anastasios Plioutsias, ibid, barograph 4,2.1 .

[50]) Dr. Mahmoud Ibrahim Fayad, Ahmed Abdullah Al-Mudafir, Dr. Mohamed Morsi Abdo, "The Basis of Liability for Damages Caused by Autonomous Ships in Light of Recent Legislation in the United Arab Emirates," published research in Al-Ustadh Researcher Journal for Legal and Political Studies, Volume 9, Issue 2, 2024, pp. 129-153.

[51]) Simon Baughen, shipping law, 4ed, routledge Cavendish, New York, 2009, P. 172.

[52]) The electronic chart, 2ed, geomares, 2009, P. 243.

[53]) Liang Zhao, Lianjun li, maritime law and practice in china, 1st, informa law from routledge, New York, 2017, Paragraph 4.4, 4.5.

The increase in maritime disputes resulting from the use of smart ships has led to the need for a specialized court to handle these cases, especially with the growing reliance on autonomous systems. Modern technologies such as autonomous navigation, automation, and artificial intelligence have become a challenge for traditional judicial systems, which may find it difficult to keep up with this rapid change. The digital maritime tribunal relies on advanced digital tools to ensure the effectiveness of its operations(54).

The Second Requirement

Ethical and Philosophical Dimensions - Can Artificial Intelligence Be Held Morally Responsible?

The statement of the ethical and philosophical dimensions, which revolve around answering the question of whether artificial intelligence can be held morally responsible, requires dividing this requirement into two sections, as follows:

Section One

The Problem of "Legal Intent" (Legal Intent) in Artificial Intelligence

The problem of legal intent in artificial intelligence, particularly in the case of autonomous ships, raises fundamental challenges related to how legal responsibility is applied in a world increasingly dependent on autonomous intelligent systems. These challenges arise from the lack of legal intent in non-human entities such as AI-powered ships, complicating the determination of who bears responsibility in the event of errors or accidents. In traditional legal doctrine, mental awareness and intent are core elements of legal responsibility. For example, under civil liability law, a person must have committed an unlawful act with premeditation or at least through negligence. However, when it comes to autonomous ships, the human element that can be directly linked to the decision causing the accident is absent. Ships operating with artificial intelligence or autonomous systems do not possess the awareness or intent that distinguish human actions, creating a legal dilemma as the "intent" typically attributed to individuals or legally independent entities cannot be traced. If the intelligent system made a decision that led to an accident, is it reasonable to hold the system itself accountable, or should the responsibility fall on the one who designed the system or decided to use it? Here, responsibility must be redefined in light of autonomous ships, and several legal theories are proposed to address this dilemma(55).

1. Objective Liability Theories: This theory is based on the idea that liability rests on the party who bears the result, rather than looking at intent or deliberate action. In the case of autonomous ships, liability would be objective, meaning that manufacturers or developers may be responsible for faulty design or programming of the system, regardless of their intentions. For example, if the ship caused an accident due to a programming error, liability would fall on the one who developed the software or designed the system, even if they did not intend to commit a mistake.
2. Negligence-Based Liability: Parties involved can be held responsible based on negligence if the system designers or operators fail to verify the accuracy and effectiveness of the smart system. They may be considered liable for the resulting damages. This approach is based on the idea that the operator or designer neglected their legal responsibilities regarding the safety of the system or ensuring its effectiveness(56).
3. Escalation of Liability: Liability in the case of autonomous ships is distributed among several parties, starting from the owner and operator to the manufacturers and developers. In the traditional system, the owner may avoid liability if they have done everything necessary to maintain and repair the ship. However, in the case of smart ships, the manufacturer or developer may be the primary party responsible due to a design flaw or malfunction in the smart system, leading to a shift in the boundaries of responsibility. It is important to note that current legal systems, which regulate ships and maritime technology, may not be designed to accommodate the new challenges arising from the use of smart ships. Legislative bodies continue to attempt to create new legal frameworks to define the responsibility of parties in cases of environmental damage or maritime violations related to artificial intelligence technologies. The problem of legal intent in autonomous ships is not just a traditional legal issue, but a modern challenge that requires a radical rethink of how to determine liability in the context of innovative technology. This requires the development of new legal and technological frameworks that deal with smart systems in line with the rapid changes in this sector, taking into account objective liability and negligence in software design and system maintenance(57).

Section Two

Can an Autonomous Ship Be "Liable" Without Consciousness?

Philosopher John Searle presents the problem of the "Chinese Room" (Chinese Room Argument), which suggests that artificial intelligence can make complex decisions without "understanding" what it is doing(58). So, can the decisions made by the ship be considered "legally enlightened," or are they simply cold calculations?

It is clear that John Searle's Chinese Room theory plays a pivotal role in the philosophical questions surrounding autonomous ships. According to this theory, artificial intelligence (AI) can simulate human intelligence through

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54) Liang Zhao, Lianjun li, ibid, p. 4.5.

55) Tshilidzi Marwala, Letlhokwa George Mpedi, artificial intelligence and the law, 1st, springer nature, UK., 2024, P. 7.

56) BARIS SOYER, DAMAGES RECOVERIES AND REMEDIES IN SHIPPING LAW, 1ST, INFORMA LAW ROUTLEDGE, NEW YORK, 2023, P. 122.

57) Robert Force, A.N. Yiann opoulos, martin Davies, admirality and maritime law, abridged edition, beard book,2006, P. 298.

58) Jack Copeland, artificial intelligence, 1st, Blackwell publishers, Uk, 2015, P. 146.

programming (Programming) and algorithms (Algorithms), but lacks the consciousness (Consciousness) or understanding (Understanding) that allows humans to make decisions based on emotions (Emotions) or intent (Intent). What is central in this context is that autonomous ships, despite their ability to make complex decisions (Complex Decisions) based on the data they receive from their surrounding systems, remain, in the traditional legal sense, devoid of the essential human components such as mens rea (Mens Rea) or conscious understanding. In this context, the legal responsibility for autonomous operations (Autonomous Operations) falls to the parties responsible for these ships, such as manufacturers (Manufacturers), developers (Developers), and operators (Operators). Since these systems operate based on programmed instructions (Programmed Instructions) and algorithms (Algorithms), they lack the intent required by the law in most legal cases related to liability. For example, in the case of an accident or damage caused by a malfunction in the autonomous ship, the legal responsibility may be assigned to the manufacturers or operators under civil liability. When it comes to legal responsibility in this context, it cannot be directly assigned to the ship itself or the artificial intelligence (AI) that manages it. This aligns with John Searle's Chinese Room theory, which assumes that machines can be capable of simulating human understanding but, at their core, lack the true understanding or self-awareness required by the law in determining responsibility[59].

One of the main legal issues lies in the criminal responsibility (Criminal Responsibility) of autonomous ships. It is essential to determine whether artificial intelligence (AI) can be held accountable for actions that may be considered criminal in certain contexts. Even with directed programming (Directed Programming), the ships remain unable to perceive actions the way humans do.

To address this issue, some propose a hybrid model that combines criminal responsibility and civil liability. For example, developers (Developers) and operators (Operators) could be held responsible if it is found that the accident was caused by a design flaw or negligence (Negligence) in the operation of the system. In this model, the ship is viewed as a tool (Tool) rather than a legal entity capable of making legal decisions (Legal Decisions). Based on the above, we can say that the Chinese Room Theory (Chinese Room Theory) highlights the gap between technology (Technology) and human understanding (Human Understanding). Autonomous ships, despite their ability to make advanced decisions, still lack the self-awareness (Self-awareness) or deep knowledge (Deep Knowledge) necessary to understand their legal responsibility in a manner similar to humans.

CONCLUSION

The research concludes that Maritime Autonomous Surface Ships (MASS) represent a revolution in the field of maritime transport. However, the current legal framework is still unable to accommodate the technological advancements associated with them. The most prominent findings are as follows:

First: Results, which can be summarized as follows:

1. Existing maritime laws, such as the United Nations Convention on the Law of the Sea (UNCLOS) and International Maritime Organization (IMO) conventions, are based on the assumption of a human crew responsible for operating the ship. With the emergence of autonomous ships, it has become essential to reconsider these legislations to keep pace with technological developments.
2. The study showed that the absence of human elements in operating autonomous ships raises questions about legal liability, especially in cases of maritime accidents or environmental damage. The key question remains: Who is responsible? The shipowner, the maritime operator, or the developers of AI-based navigation systems?
3. The research discussed the possibility of considering autonomous ships as an independent legal entity (legal personhood), similar to commercial corporations, so that they bear their legal responsibilities independently. This might serve as a middle ground between holding humans or AI systems accountable.
4. Although some countries, such as the United Kingdom, Norway, and Japan, have started developing legal frameworks to regulate autonomous ships, the absence of a unified international legislation hinders the practical application of these technologies on a wide scale.

Second: Recommendations: Based on the above, the research recommends the following:

1. Amending international maritime conventions, particularly the SOLAS Convention and the COLREGs Convention, to include a clear definition of autonomous ships, classify levels of autonomous operation, and define the responsibilities of different parties.
2. The research proposes adopting a hybrid model combining tort liability and strict liability, where AI system manufacturers are held accountable for technical defects, while maritime operators are responsible for overseeing the operation of the ships.
3. It is recommended to establish a Digital Maritime Court based on smart arbitration, utilizing smart contracts to resolve maritime disputes arising from errors in autonomous systems.
4. There is a recommendation to develop unified international standards to regulate maritime cybersecurity and AI-based maritime navigation systems, ensuring the safe operation of these ships and reducing legal risks.
5. A legal system could be introduced that grants autonomous ships limited legal personhood, treating them as independent maritime corporations that bear specific liability for damages they cause, without undermining the responsibility of the shipowner or the operator.

[59]) Geert Brone, Kurt Feyaerts, Tony Veale, cognitive linguistics and humor research, de gruyter mouton, Germany, 2015, P. 73.

Autonomous and Smart Ships Act

Chapter One: Definitions and General Provisions

Article (1): Definitions: For the purposes of this law, the following terms shall have the meanings set forth opposite them:

1. **Maritime Autonomous Surface Ship (MASS)**: A vessel equipped with artificial intelligence systems and independent operational capabilities, operating without direct human intervention or with limited intervention according to internationally recognized automation levels.
2. **Maritime Operator**: The person or entity responsible for operating the ship, including remote monitoring and operation management.
3. **AI-Based Navigation System**: A set of software and hardware that enables the ship to make navigational decisions without direct human intervention.
4. **Maritime Cybersecurity**: Preventive measures to protect autonomous ships' systems from cyber-attacks or technological breaches.
5. **Hybrid Legal Liability**: A legal framework that combines civil and tort liability with strict liability to regulate the risks arising from operating autonomous ships.

Chapter Two: Registration and Licensing of Autonomous Ships

Article (2): Registration Requirements:

1. A center for registering autonomous ships shall be established, responsible for issuing navigation certificates in accordance with international standards.
2. To be included in the national registry, a ship must demonstrate compliance with maritime safety and autonomous operation requirements.
3. This center is administratively affiliated with the Iraqi Supreme Maritime Authority under Law No. 18 of 2019.

Article (3): Operating License:

1. No autonomous ship shall be operated without a license issued by the competent authority, which specifies the level of automation and safety requirements.
2. Licenses shall be granted according to the approved operating categories, ranging from partial autonomous operation to fully independent operation.

Chapter Three: Legal Liability

Article (4): Determining Legal Liability:

1. The maritime operator shall be responsible for damages resulting from the operation of the ship in case of proven negligence or technical malfunction that does not comply with safety standards.
2. In the event of an accident caused by an AI error, the software manufacturer shall bear partial responsibility according to the "shared liability" principle.
3. If an investigation proves that the error was caused by independent decisions of the intelligent system, the ship may be held legally responsible under the limited legal personhood system.

Article (5): Insurance and Compensation

1. All maritime autonomous ships must be covered by special marine insurance that covers the risks arising from autonomous operation.
2. A digital maritime tribunal shall be established to consider disputes arising from the operation of smart ships, using smart arbitration technologies and smart contracts to resolve disputes efficiently.

Chapter 4: Cybersecurity and Safety

Article (6): Cybersecurity Standards

1. All maritime autonomous ships must comply with international cybersecurity standards to protect their systems from cyberattacks.
2. The maritime operator is required to implement emergency plans to handle potential cybersecurity threats, including regaining human control in emergency situations.

Chapter 5: Final Provisions

Article (7): Penalties

1. Any person operating a maritime autonomous ship without a license shall be penalized with a fine or administrative detention of the ship until compliance with legal standards is achieved.
2. In the event of a maritime accident caused by an undisclosed technical fault by the manufacturer, the producing company shall be liable for mandatory compensation for environmental and material damages.

Article (8): Effectiveness of the Law

This law shall be enforced six months after its publication in the official gazette, and the executive regulations will be issued during this period.

Justifications

This law aims to bridge the legislative gap in regulating maritime autonomous ships by establishing a comprehensive legal framework that balances technological innovation and legal security. This law was enacted for this purpose.

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