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Application of Legal Provisions and Liability for Maritime Autonomous Surface Ships (MASS) in International Law

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Abstract

Introduction: *Technological developments in the maritime sector have led to innovations such as unmanned surface vessels (Maritime Autonomous Surface Ships/MASS). The emergence of MASS brings efficiency, safety, and new innovations to the world of shipping, but it also poses legal challenges, particularly regarding the application of international regulations that have traditionally governed manned vessels.*

Purposes of the Research: *This study aims to analyze the application of legal provisions and identify liability mechanisms for MASS under international law, as well as compare practices across several countries.*

Methods of the Research: *The methodology employed is normative legal research using a legislative, comparative legal, and conceptual approach, utilizing primary legal sources such as international conventions (UNCLOS, SOLAS, and IMO regulations) and relevant literature.*

Results of the Research: *The results of the study indicate that most international legal instruments have not yet fully accommodated the characteristics and regulatory needs of autonomous ships, particularly in terms of the definition of legal subjects, the role of the captain, and accountability mechanisms in the event of an incident. This is because most of these international legal provisions are still based on the assumption that ships are controlled by humans. Some countries, such as the United Kingdom, Norway, and the United States, have begun to formulate specific regulations to govern MASS that can fill this gap. Therefore, accountability is needed, which indicates the need for updating and harmonizing international rules to address the challenges arising from technological developments in the maritime sector. Additionally, it is important to develop national implementation guidelines aligned with the principles of international maritime law to ensure maritime safety, marine environmental protection, and legal certainty.*

Keywords: Legal Protection; Traditional Knowledge; Sui Generis.

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INTRODUCTION

This increasingly rapid advancement of technology and science has led humans to technological discoveries that affect various aspects of each individual's life. This technological advancement encourages every industry to give birth to an artificial intelligence that can make it easier and help society. One of them is through *Artificial Intelligence* (AI) technology, where AI itself can apply knowledge, make its own decisions and study human life and record various responses that are then developed with its own capabilities.[1] As an archipelagic country, Indonesia needs a very effective and efficient sea

[1] Ahmad Rickianto Afandi and Heri Kurnia, "Revolusi Teknologi: Masa Depan Kecerdasan Buatan (AI) dan Dampaknya Terhadap Masyarakat," *Academy of Social Science and Global Citizenship Journal* 3, no. 1 (2023): 9–13, https://doi.org/10.47200/aossagcj.v3i1.1837. p. 10

connection.[2] Increasing productivity to safety and efficiency in the 118 level of shipping, one of the innovations found is a ship without the presence of a crew (*crewless*) to be able to operate.[3] The history of ship technology without the presence of a crew began with the level of clock-shaped navigation technology on ships that used wood-based materials, then the invention of radar to make it easier for navigators to steer iron-based ships.[4] This then developed again into a technology of ships that move without the presence of a crew. The technology is known as *Maritime Autonomous Surface Ships* (MASS). MASS was introduced as a concept in World War 2 that could bring many benefits to the military to save people.[5]

MASS began to be used for various purposes, ranging from the use of *oceanography*, transportation needs, scientific research, to environmental monitoring needs.[6] However, developments in MASS present great challenges, especially the uncertainty of legal aspects and accountability in implementing the provisions of international law. The current international legal system, namely the *United Nations Convention on the Law of the Sea* (UNCLOS) 1982, *the International Convention for Safety of the Life at Sea* (SOLAS) 1974, *the Convention on the International Regulations for the Prevention of Collisions at Sea* (COLREG) 1972) and other conventions issued by the *International Maritime Organisation* (IMO), are basically made for ships controlled by humans.[7]

Article 94 of UNCLOS requires flag states to ensure that such ships are manned by competent crews and meet safety standards by taking into account the applicable international provisions in the exercise of jurisdiction under their national legislation. Likewise, in Regulation 5 SOLAS Chapter V, ships are required to have a competent crew. So many articles in UNCLOS and SOLAS use many terms for "*master*" or "*crew*", which in the case of MASS can operate without a remote-controlled crew,[8] Therefore, these regulations give rise to debate, are irrelevant and adequate or whether it is necessary to make fundamental changes to international regulations that can be in line with the development of these technologies.

Another problem that can arise is legal liability in the event of accidents, pollution and violations of the law involving MASS. In the current legal system, legal liability is imposed on the crew, captain, or owner of the ship based on the principle of *fault-based liability* or *strict liability*.[9] However, in the context of MASS, with no humans on board and controlled by remote operators, the question arises "who is responsible?" in the event of an accident involving MASS. Is it a ship owner, remote operator, software developer, or hardware manufacturer? What about if there is an oil leak or drug smuggling caused by *autonomous shipping*. This is compounded by the possibility of "marching learning" that makes the behavior of unmanned ships completely unpredictable, making proving elements of error

[2] Wiwoho Soedjono, *Hukum Laut: Khusus Tentang Pengangkutan Barang di Indonesia*, Pertama (Yogyakarta: Liberty, 1986). p. 7

[3] A Indah Camelia and Athyra Elmilla, "Tantangan Hukum dalam Pemanfaatan Maritime Autonomous Surface Ship (MASS)," *Media Iuris* 5, no. 1SpecialIssue (2022): 1–20, https://doi.org/10.20473/mi.v5i1SpecialIssue.42296. p. 1

[4] Muhammad Aqil Kamaluddin, "Urgensi Pengaturan Terhadap Marine Autonomous Surface Ships (MASS) dalam Pertanggungjawaban Pengangkutan Bahan Berbahaya," *Media Iuris* 5, no. 1SpecialIssue (2022): 107–20, https://doi.org/10.20473/mi.v5i1SpecialIssue.38320. p. 108

[5] João Filipe, "Design of Autonomous Surface Vessels" (2015). p. 4

[6] Bela Awaliyah Agustina, "Hukum Pengoperasian Kapal Nirawak," *Perspektif* 26, no. 2 (2021): 120–28, https://doi.org/10.30742/perspektif.v26i2.798. p. 121

[7] Akbar Akbarov, "Analysis of the Impact of Mass on the International Regulatory Framework in the Example of UNCLOS Terminology: Issues, Legal Challenges, Possible Solutions," n.d. p. 4

[8] A. Karitzis and Associates L.L.C, "Autonomous Vessels and The Current International Legal Framework," *Mondaq* (blog), 2022, https://www.mondaq.com/cyprus/marine-shipping/1192450/autonomous-vessels-and-the-current-international-legal-framework.

[9] Maximo Q. Mejia Jr., 'Liability and MASS: Revisiting Maritime Law Principles' in Henrik Ringbom (ed), *Autonomous Ships and the Law* (Routledge 2020).

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and negligence more complicated in court.[10] There is a void and legal uncertainty, this issue is the main concern IMO. In 2021, the IMO conducted *a Regulatory Scoping Exercise* (RSE) to see how the tier could be applied to ships using different levels of automation.[11] This RSE is a systematic effort to identify the provisions of international agreements where it is impossible to apply to MASS.[12] The initial results show that many provisions still need to be revised, especially in the legal definition, the role of the captain, navigation safety, and the protection of the marine environment.[13]

At the international level, several countries have begun to develop specific regulations for MASS to fill the void in international law. For example, the UK designed the first statutory instrument to regulate MASS through *The Merchant Shipping (Small Workboats and Pilot Boats) Regulations* 2023 and *the Workboat Code* which provides legal recognition for autonomous vessels and sets safety standards and remote control.[14] This shows the need for clear international regulations and the most appropriate legal accountability mechanisms in international law for MASS to be able to accommodate the roles of long-distance operators, ship owners, and flag states in a clear and measurable manner. This is to ensure shipping safety, security, protection of the marine environment, and fill legal gaps to anticipate risks arising from the operation of *autonomous ships.*

This research is different from previous research, such as the research conducted by Muhammad Aqil (2022) entitled "The Urgency of Regulation of Marine Autonomous Surface Ships (MASS) in the Responsibility of Transporting Hazardous Materials" focuses more on regulating the transportation of hazardous materials using MASS, but has not comprehensively discussed legal regulations and accountability in the operation of MASS.[15] Another study was also conducted by A. Indah Camelia and Athyra Elmilla (2022) entitled "Legal Challenges in the Utilization of Maritime Autonomous Surface Ships (MASS)" focusing more on legal challenges in general in the use of MASS without discussing in detail the application of legal provisions in various countries and the most appropriate accountability mechanisms in international law. Meanwhile, the author's research aims to fill a gap in international regulations that examine the application of legal provisions to MASS in various countries and accountability mechanisms in the operation of MASS that are most in accordance with the principles of international law.

METHODS OF THE RESEARCH

This research is a normative legal research (doctrinal legal research)[16] which aims to analyze the application of legal provisions and accountability mechanisms to *Maritime Autonomous Surface Ships* (MASS) in international law as well as the practices of several countries. The approaches used are the statute approach, the comparative legal approach, and the conceptual approach. The sources of legal materials used include primary legal sources such as international conventions (e.g. UNCLOS, SOLAS, and IMO rules), as well

[10] Brett Cowell, Anna Young, and Alex Dorrington, "Autonomous Maritime Vessels - Who's Liable?," September 2024, https://www.cowellclarke.com.au/insights/autonomous-maritime-vessels-who-s-liable.

[11] IMO, "Autonomous Shipping," n.d., https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx.

[12] *Ibid*

[13] IMO, "Autonomous Ships: Regulatory Scoping Exercise Completed,", https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx.

[14] Ananta Gultom, "Autonomous Vessel: Perlunya Kerangka Regulasi Nasional Dan Internasional Untuk Aturan Kapal Tanpa Awak," April 2023, https://www.emaritim.com/2023/04/autonomous-vessel-perlunya-kerangka.html.

[15] Muhammad Aqil Kamaluddin, *Op. Cit*

[16] Soerjono Soekanto and Sri Mamudji, *Penelitian Hukum Normatif Suatu Tinjauan Singkat* (Jakarta: RajaGrafindo Persada, 2019).

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as secondary legal sources in the form of literature, journals, and policy documents related to MASS. Data sources are drawn from official documents, IMO reports, and relevant literature studies. The technique of collecting legal materials is carried out through library research by collecting, reviewing, and sorting legal documents and literature related to the topic. The method of analyzing legal materials and data uses descriptive qualitative analysis techniques, namely delineating, interpreting, and critically examining the content of legal regulations and literature to find suitability, gaps, and challenges in the application of legal provisions and MASS accountability mechanisms in international law.

RESULTS AND DISCUSSION

The development of MASS technology has prompted many countries to start adapting their national legal frameworks and show dynamic developments. These autonomous vessels use artificial intelligence technology, advanced sensors, and remote control systems to improve operational efficiency, reduce costs, and minimize human error, with the advent of autonomous vessels undergoing a massive transformation of the maritime industry.[17]

According to IMO, there are four levels of ship autonomy in the exercise to determine the scope of regulations, namely:[18] The first level is *a ship with automated processes and decision support,* the crew is on board to operate the ship's systems and functions although there are several operations that can be automated. The second level is *a remotely controlled ship with seafarers on board,* a ship that is controlled from another location but there is also a crew available on board to take control of the ship. The third level is *a remotely controlled ship without seafarers on board,* the ship is controlled and operated from another location and there is no crew on board. The fourth level of *fully autonomous ship,* the ship's operating system is able to make decisions and determine its own actions.

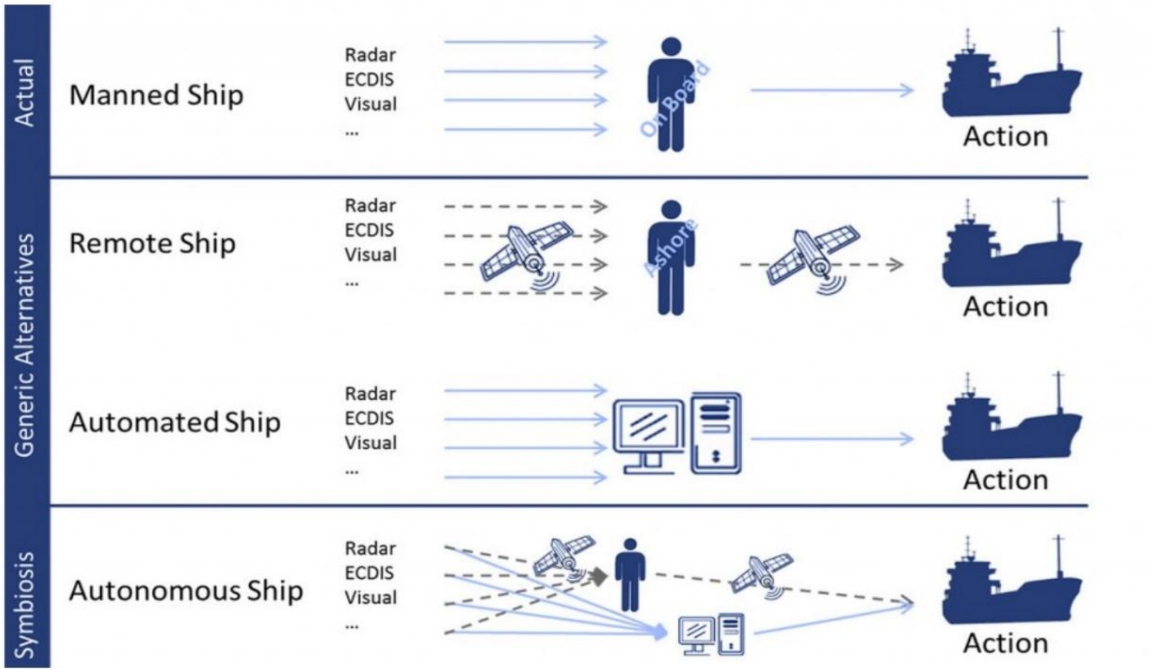

Figure 1. Four Levels of Autonomous Ships

[17] Rhaptyalyani Della and M. Adhari Rachmannullah, *Kapal Otonom: Konsep, Teknologi, Dan Prospek Transportasi Maritim* (Eureka Media Aksara, 2024).

[18] "Autonomous Shipping." *Ibid*

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A. Application of Autonomous Ship Legal Provisions in Various Countries

The implementation of legal provisions for MASS in various countries faces various challenges. Regulations such as UNCLOS and SOLAS, designed for human-operated ships, are confusing when applied to autonomous vessels.[19] There have been many changes as a result of advances in shipping, so it is necessary to adapt the provisions to the new circumstances.[20] While there is no single legal system that is fully integrated with this technology, a number of countries have taken steps that point to the direction of regulation going forward. At the national level, several countries are taking concrete steps to make regulations to accommodate their shipping. Some of the countries that have begun to develop national regulations for MASS are: a) United States: The United States does not yet have a national policy that explicitly regulates MASS. However, through the *Maritime Administration* (MARAD) and the United States Coat Guard (USCG), some regulations are designed for the testing and operation of autonomous vessels, including research and military projects. The USCG released *Policy Letter 02-21*, which provides guidelines for the operation of unmanned and semi-autonomous vessels, as well as reporting requirements, *line-of-sight operation*, and redundancy systems.[21] However, different federal and state legal systems often lead to overlap, particularly in port jurisdictions and local maritime authorities.[22] Under the *Ghost Fleet Overlord Program*, America also conducted several tests of autonomous military ships launched by the U.S. Navy in conjunction with *the Defense Advanced Research Project Agency* (DARPA). However, the test is more concerned with national security and is not regulated in maritime civil law;[23] b) Norway: Norway is the first country to conduct autonomous ship trials on commercial shipping lanes with the *Yara Birkeland project,*[24] a cargo ship that does not use crew and operates in the Brevik and Larvik regions. Through the maritime authority *Norwegian Maritime Authority* (NMA), the Norwegian Government publishes specific guidelines such as RSV-12-2020 Guidance which governs the construction and installation of automation functions for the operation of unmanned or partially unmanned vessels.[25] This regulation provides a legal basis for companies and autonomous ship operators to conduct trial *(exemption permits)* and ship operations in Norwegian waters in accordance with the IMO convention. In addition, Norway provides special test beds in Trondheim and Horten that are officially designated for the development and testing of autonomous vessels.[26] The area provides a safe and controlled space to test autonomous vessels before they are commercially operated. As there is no specific regulation on autonomous vessels in national law, the NMA uses a *case-by-case* approach to approve vessel operations based on *the precautionary principle* and risk evaluation. NMA is also actively working with IMO to promote standardization of safety

[19] Bingying Dong, Lowell Bautista, and Ling Zhu, "Navigating Uncharted Waters: Challenges and Regulatory Solutions for Flag State Jurisdiction of Maritime Autonomous Surface Ships under UNCLOS," *Marine Policy* 161 (2024): 106039, https://doi.org/10.1016/j.marpol.2024.106039. p. 1

[20] Mochtar Kusumaatmadja, *Bunga Rampai Hukum Laut* (Offset CV. Rosda, 1978). p. 213

[21] "USCG Policy Letter 02- 21, 2021," n.d.

[22] "MARAD Mariner Workforce Strategic Plan - Rev. March 2025_0," n.d.

[23] Kraska, "US Autonomous Naval Operations," Naval War College Review, 2021.

[24] Asle Skredderberget, "The First Ever Zero Emission, Autonomous Ship," n.d., https://www.yara.com/knowledge-grows/game-changer-for-the-environment/.

[25] "Autonomous and Remotely-Operated Ships," DNV, n.d., https://www.dnv.com/maritime/autonomous-remotely-operated-ships/regulatory/.

[26] "Norwegia Membuka Area Uji Baru Untuk Kapal Otonom," OUCO, https://id.oucomarine-facotry.com/info/norway-opens-new-test-area-for-autonomous-ship-23619886.html.

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supervision and certification for MASS;[27] c) UK: The UK Government through *the Department for Transport (DfT),* in collaboration with the *Maritime and Coastguard Agency (MCA),* is actively pushing for a progressive approach to legal regulation of MASS. This is done while still prioritizing the principles of shipping safety and compliance with international maritime laws such as SOLAS and *the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs).*[28] One of the important steps is the ratification *of The Merchant Shipping (Small Workboats and Pilot Boats) Regulations 2023* along with Workboat Code Edition 3. This regulation explicitly regulates small work vessels, including commercially used remotely operated unmanned vessels (ROUVs), with a length of less than 24 meters.[29] The rules apply to British-flagged vessels around the world and foreign vessels sailing in British waters. The *Workboats Code* regulates safety requirements, pollution prevention, incident reporting, and administrative and criminal sanctions for violations, including suspension or revocation of certificates and detention of non-compliant vessels.[30] The UK also established the *Maritime Autonomy Regulation Lab* (MARLab), a flexible policy experiment on MASS.[31] MARLab is also a forum for legal simulation trials without violating international law.

Referring to some of the countries above, it can be said that no one country has a completely complete legal system in regulating MASS. MASS, which is a new technology, is a challenge in the harmonization of national regulations and international maritime law.[32] One of the issues that must be considered is the issue of safety in MASS operations, both conventional manned vessels, remote-controlled vessels and unmanned vessels interacting in the same sea area,[33] For this reason, the need for comprehensive regulations and an adaptive legal liability system is increasingly urgent to ensure shipping safety, security, and protection of the marine environment. So that MASS becomes a strategic issue that must be addressed so that the technology can be implemented safely and effectively in the future.

B. The Most Appropriate Autonomous Ship Liability Mechanism in International Law

MASS as a new technology in international maritime law raises new legal questions regarding who is responsible if autonomous vessels cause losses and violations of the law of the sea. Unlike ships that have the captain and crew as legal subjects, MASS is carried out automatically by AI or remotely controlled, so there is no *master on board* who can be held directly accountable. Provisionally regulated explicitly according to the IMO report in determining accountability in MASS and international maritime law instruments such as UNCLOS, SOLAS, COREG. This creates a legal *lacunae* that must be filled by interpretation, adaptation, and creating new laws.[34] The current international Maritime Laws are UNCLOS,

[27] "Maritime Safety Committee, 102nd Session (MSC 102), 4-11 November 2020 (Virtual Session)," IMO, n.d., https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MSC-102nd-session.aspx.

[28] "Maritime 2050: Navigating the Future," *Department for Transport UK* (blog), 2019.

[29] "Consultation Document," Maritime & Coastguard Agency, GOV.UK, 2023, https://www.gov.uk/government/consultations/the-merchant-shipping-small-workboats-and-pilot-boats-regulations-2023/consultation-document.

[30] Martyn Wingrove, "Autonomous Vessels: Legislating for a New Generation of Ships," Riviera, 2023, https://www.rivieramm.com/news-content-hub/news-content-hub/autonomous-vessels-legislating-for-a-new-generation-of-ships-75634.

[31] "Maritime Autonomy Regulation Lab (MARLab) Report," Maritime & Coastguard Agency, GOV.UK, 2020, https://www.gov.uk/government/publications/maritime-autonomy-regulation-lab-marlab-report/maritime-autonomy-regulation-lab-marlab-report.

[32] Taufik Rachmat Nugraha et al., "Maritime Autonomous Surface Ship (MASS): Tantangan dan Peluang Kemaritiman Masa Depan," *Media Iuris* 5, no. 1 Special Issue (2022): 149–72, https://doi.org/10.20473/mi.v5i1SpecialIssue.38307. p. 158

[33] Tae-eun Kim et al., "Safety challenges related to autonomous ships in mixed navigational environments," *WMU Journal of Maritime Affairs* 21, no. 2 (2022): 141–59, https://doi.org/10.1007/s13437-022-00277-z. p. 157

[34] "USCG Policy Letter 02- 21, 2021."

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SOLAS, COREG, which are basically drafted assuming ships are directly controlled by humans. Article 91 of the UNCLOS regulates the registration of ships and requires the existence of a *genuine link* between the ship and its flag country as the basis for the jurisdictional authority and responsibility of the country. However, in the context of MASS, the concept *of genuine links* becomes difficult to implement because the ship can be controlled remotely and does not have a crew on board.[35] UNCLOS 1982 does not specifically mention autonomous ships, but establishes the basic principles of state responsibility for their *flag state responsibility* and the principle of international responsibility in the event of violations of international law Article 94 and Article 304 of UNCLOS.

According to James Crawford (2002), state *responsibility* only applies if the infringing act is committed by or can be attributed to the state.[36] But in the case of MASS operated by a private company, AI system, or server outside the jurisdiction of the ship's home country, attribution and responsibility become blurred. Article V SOLAS; COLREG Rules 5, 7, and 8 also require the physical presence of a competent crew, so that in their application to MASS, reinterpretation or amendment is needed to accommodate the remote control system or AI.

Many academics and policymakers discuss several models of accountability: 1) Operator-Based Liability: This model establishes that the MASS controller is considered a substitute for the skipper and is responsible for all actions of the autonomous system. This model is aligned with *strict liability* in international marine environmental law (such as the 1996 London Convention on Marine Pollution).[37] 2) Product Liability: If the MASS damage stems from a defect in the software system, sensors, or automated navigation system, then the responsibility may be transferred to the technology developer (manufacturer or programmer). It is close to the principle of responsibility in consumer protection law and high-tech law. Through the AI Liability and Product Liability Directive 2022 approach in the European Union which provides responsibility for losses due to artificial intelligence, including maritime autonomous systems.[38] However, this approach poses other challenges in the context of *causation* and error determination in complex systems that often use *machine learning* whose results are not always predictable.[39] 3) Flag State Responsibility: In accordance with Article 94 of UNCLOS, flag states retain responsibility for ships flying their flags, including MASS. However, this implementation is problematic when flag states do not have full control or oversight over autonomous technologies operated from other jurisdictions. This approach entails reform of flag state administration and adjustment of the ship registration system that now does not recognize non-human entities as operators.[40]

The accountability mechanism for MASS in international law is still in the process of being formed, but the most appropriate one at the moment is the multi-level liability model. This model offers flexibility and fairness, while covering a legal vacuum in the current international regime. However, the success of this model depends on international harmonization that must be led by the IMO through the drafting of new legal instruments, for which any action of a state that violates international obligations based on the theory of international legal liability can be legally attributed to that country giving rise to

[35] Camelia and Elmilla, *Op. Cit*. p. 11

[36] James Crawford, *The International Law Commission's Articles on State Responsibility* (United Kingdomd: Cambridge University Press, 2002).

[37] "UK Maritime and Coastguard Agency, Autonomous Vessels Code of Practice," 2019.

[38] "Proposal for a Directive on Liability for Defective Products; AI Act and AI Liability Directive.," European Commission, 2022.

[39] Ugo Pagallo, "AI and Maritime Responsibility," *AI & Law* 31(1) (n.d.). p.67-85

[40] R. Barners, "Flag State Duties and MASS: A Legal Gap?," *Ocean Development and International Law* 51(2) (2022).

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international liability, so the theory is used to examine the possible liability of the state, operator, or software manufacturer.[41]

CONCLUSION

The development of MASS technology has not been fully able to accommodate the readiness of existing international law. The provisions in instruments such as UNCLOS, SOLAS, and COLREG are still oriented towards human-operated ships, so there are many doubts in their application to autonomous ships. The lack of clarity as to who was responsible for the incidents involving MASS indicates a significant legal lacunae. Some countries such as the United Kingdom, Norway, and the United States have taken progressive steps by formulating national regulations that accommodate MASS operations, which have not been able to fill the void on a global scale. Legal accountability is a crucial issue that needs to be regulated immediately clearly, considering the potential impact caused by accidents or violations of maritime law. Responding to these challenges, an accountability approach that involves multiple parties simultaneously, such as operators, ship owners, technology manufacturers, and flag states, is considered the most relevant approach. It is hoped that the IMO can take a more active role in encouraging the drafting of an international legal framework that is able to regulate MASS comprehensively, in order to ensure the safety, security, and protection of the marine environment in a sustainable manner.

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[41] Crawford, *The International Law Commission's Articles on State Responsibility*. *Ibid*

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