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Legal Implications of Autonomous Warships under UNCLOS: Navigating Definitional Gaps in International Maritime Law

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Abstract. Rapid technological advancements have outpaced legal frameworks in regulating autonomous warships, as United Nations Convention on the Law of the Sea (UNCLOS) human-centered definition fails to accommodate crewless or semi-autonomous vessels in modern naval operations. This study examines the legal implications of this definitional gap and explores how international law might evolve to address the governance of autonomous warships. Key issues include sovereignty, accountability, and compliance with existing maritime and wartime legal norms, such as whether a fully autonomous vessel can qualify as a warship under UNCLOS and what responsibilities states bear for their actions in conflict scenarios. Using a normative legal research design with doctrinal and conceptual approaches, the study analyzes UNCLOS, COLREGs, and SOLAS, employing deductive and analogical reasoning to compare autonomous vessels with technologies like remotely piloted UAVs. Autonomous warships do not fully qualify as warships under UNCLOS due to the absence of human command and crew, leading to ambiguities in liability, navigation compliance, cybersecurity risks, and humanitarian duties. However, remote operation and flag state discretion may allow classification, highlighting gaps in existing frameworks.

Keywords: Accountability, Autonomous warships, Legal implications, Maritime norms, Sovereignty, UNCLOS.

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Abstrak. *Kemajuan teknologi yang pesat telah melampaui kerangka hukum dalam mengatur kapal perang otonom, karena definisi yang berpusat pada manusia dalam Konvensi Perserikatan Bangsa-Bangsa tentang Hukum Laut (UNCLOS) gagal mengakomodasi kapal tanpa awak atau semi-otonom dalam operasi angkatan laut modern. Studi ini meneliti implikasi hukum dari kesenjangan definisi ini dan mengeksplorasi bagaimana hukum internasional dapat berkembang untuk mengatasi tata kelola kapal perang otonom. Isu-isu utama meliputi kedaulatan, akuntabilitas, dan kepatuhan terhadap norma hukum maritim dan perang yang ada, seperti apakah kapal yang sepenuhnya otonom dapat memenuhi syarat sebagai kapal perang berdasarkan UNCLOS dan tanggung jawab apa yang ditanggung negara atas tindakan mereka dalam skenario konflik. Dengan menggunakan desain penelitian hukum normatif dengan pendekatan doktrinal dan konseptual, studi ini menganalisis UNCLOS, COLREGs, dan SOLAS, menggunakan penalaran deduktif dan analogis untuk membandingkan kapal otonom dengan teknologi seperti UAV yang dikendalikan dari jarak jauh. Kapal perang otonom tidak sepenuhnya memenuhi syarat sebagai kapal perang berdasarkan UNCLOS karena tidak adanya komando dan awak manusia, yang menyebabkan ambiguitas dalam tanggung jawab, kepatuhan navigasi, risiko keamanan siber, dan kewajiban kemanusiaan. Namun, pengoperasian jarak jauh dan kebijakan negara bendera dapat memungkinkan klasifikasi, yang menyoroti celah dalam kerangka kerja yang ada.*

Kata kunci: *Akuntabilitas, Kapal perang otonom, Implikasi hukum, Norma maritim, Kedaulatan, UNCLOS.*

1. Introduction

Ships have long been essential for ocean navigation, evolving from rafts to steamships and modern diesel vessels.[1] Each advancement improved cost-efficiency, safety, and operations. Now, AI-powered autonomous vessels are transforming maritime industries, including military applications, by making independent decisions.[2] Their rise raises critical legal questions, particularly concerning UNCLOS, sovereignty, and accountability.

The main regulation examined in this study is the United Nations Convention on the Law of the Sea (UNCLOS), particularly Article 29, which describes a warship as a vessel commanded by an officer whose crew is governed by military discipline. This human-centered norm assumes the physical presence of humans (das sollen), creating a gap with the reality of AI-powered autonomous warships operating without a crew (das sein). This discrepancy raises issues of legal classification, accountability for actions, and compliance with navigational and humanitarian obligations, as autonomous vessels challenge the application of UNCLOS, requiring updates to align the legal framework with technological advances.

Autonomous warships represent a significant military shift, often advancing faster than civilian technology.[3] Equipped with sophisticated navigation and security systems, these vessels perform complex tasks but also pose risks, such as surveillance and conflict escalation.[4] Legal ambiguities arise when determining state responsibility for wrongful acts committed by autonomous ships.[5] Scholars highlight the need to refine legal frameworks to ensure accountability and compliance with international norms.

While previous research has addressed the differences between UNCLOS definitions of human-centric warships and autonomous unmanned operations,

[1] Lasse Johansson et al., "The evolution of shipping emissions and the costs of regulation changes in the northern EU area," *Atmospheric Chemistry and Physics* 13, no. 22 (2013): 11381.

[2] Andrzej Felski, and Karolina Zwolak, "The ocean-going autonomous ship Challenges and threats," *Journal of marine science and engineering* 8, no. 1 (2020): 41. See also, Carlos Barrera et al., "Trends and challenges in unmanned surface vehicles (Usv): From survey to shipping," *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation* 15 (2021): 435.

[3] Hitoshi Nasu, and David Letts, "The legal characterization of lethal autonomous maritime systems: warship, torpedo, or naval mine?" *International Law Studies* 96, no. 1 (2020): 4.

[4] Michael N. Schmitt, "Grey zones in the international law of cyberspace," *Yale J. Int'l L. Online* 42 (2017): 1.

[5] Rebecca Crootof, "The killer robots are here: Legal and policy implications," *Cardozo L. Rev.* 36 (2014): 1837. See also, J. Pietrzykowski et al., "Operations of maritime autonomous surface ships," *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation* 13, no. 4 (2019): 728.

these studies often overlook how this gap manifests in gray-zone tactics, where ambiguous conflicts can exploit unclear legal status to escalate without accountability. There is also limited exploration of the unique cybersecurity vulnerabilities of military AI vessels, such as hacking that obscures state responsibility, or the ethical dilemmas of AI-based force decision-making during armed conflict, leaving humanitarian law compliance underexplored.

Recent scholarship further underscores that the definitional and regulatory gap identified above is not merely theoretical but increasingly operational in contemporary maritime practice. For instance, Sabrina Hasan[6] critically examines the ambiguity in defining "ship" under the law of the sea, arguing that existing interpretations under UNCLOS remain overly dependent on traditional, human-centric assumptions, thereby complicating the legal recognition of Maritime Autonomous Surface Ships (MASS). Persistent uncertainties remain regarding flag State jurisdiction, particularly in relation to the attribution of responsibility and enforcement powers over unmanned vessels. Although UNCLOS provides a general legal framework, it does not contain explicit provisions addressing autonomous operations, leading to interpretative inconsistencies across different jurisdictions.[7] Furthermore, the operation of vessels without onboard crews weakens the application of the "genuine link" requirement, raising concerns about the effectiveness of flag State control in autonomous maritime contexts.[8]

In addition, existing literature has begun to explore specific operational rights and obligations, yet important gaps remain. Murat Sümer[9] questions the applicability of the right of innocent passage to autonomous vessels, suggesting that the absence of onboard human judgment complicates compliance with navigational norms. Autonomous shipping challenges traditional concepts of manning and seaworthiness under existing IMO frameworks, as well as creates tensions with established safety conventions such as SOLAS, particularly in ensuring compliance and operational safety in the absence of human crews.[10]

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[6] Sabrina Hasan, "Analysing the definition of "ship" to facilitate Marine Autonomous Surface Ships as ship under the law of the sea," *Australian Journal of Maritime & Ocean Affairs* 15, no. 3 (2023): 273.

[7] Bingying Dong et al., "Navigating uncharted waters: Challenges and regulatory solutions for flag state jurisdiction of Maritime Autonomous Surface Ships under UNCLOS," *Marine Policy* 161 (2024): 1639. See also, Ruth García-Llave et al., "Autonomous ships and flag state: challenges and opportunities in international maritime law," *Journal of Transportation Security* 18, no. 1 (2025): 15.

[8] Iva Parlov, "Remotely Controlled Maritime Autonomous Surface Ships (MASS), the "Genuine Link" Requirement, and the "Effectiveness" of Flag State Jurisdiction: Key Problems and Prospects," *Ocean Development & International Law* 56, no. 2 (2025): 219.

[9] Murat Sümer, "Applicability of the right of innocent passage to maritime autonomous surface ships: Exploring the potential role of advisory opinions," *Ascomare Yearbook* (2023): 149.

[10] Robert Veal, "Maritime Autonomous Surface Ships: autonomy, manning and the IMO," *Shipping & Trade Law* 18, no. 5 (2018): 3. See also, David Guevara, and Dimitrios Dalaklis,

Despite these contributions, current research still tends to focus on commercial or civilian applications, leaving military uses particularly autonomous warships in gray-zone operations underexplored. Furthermore, limited attention has been paid to how cybersecurity risks and AI-driven decision-making processes may obscure attribution of wrongful acts under international law. Therefore, this study contributes by bridging these gaps, integrating UNCLOS analysis with emerging security, accountability, and humanitarian concerns specific to autonomous naval warfare.

Recent research on the legal status of autonomous underwater vehicles emphasizes the integration of UNCLOS with domestic law to clarify ambiguities in international conventions. Other studies have also examined flag state challenges under maritime law, highlighting jurisdictional opportunities over AI vessels while emphasizing updates to pollution prevention and seafarer standards. Emerging theories focus on evolving norms to align global rules with advances in AI, including redefining risk in marine insurance and clarifying unmanned systems in naval operations.

This study examines UNCLOS and its application to autonomous vessels, analyzing their rights, obligations, and legal challenges. It also assesses whether existing international maritime law sufficiently addresses these vessels' unique characteristics and identifies gaps requiring urgent attention.

This study examines the definitional gap in international law regarding autonomous warships and its broader legal implications. The rapid development of autonomous weapon systems raises new legal questions about the status of unmanned vessels operating in maritime military operations. The discussion focuses on issues of state sovereignty, legal accountability, and compliance with existing maritime and the law of armed conflict norms. Furthermore, this study evaluates whether fully autonomous vessels can be classified as warships under the United Nations Convention on the Law of the Sea (UNCLOS), and how international legal frameworks may adapt to technological developments in autonomous naval warfare.

Based on this background, the research questions addressed in this study are as follows:

1. What is the legal status of autonomous warships within the framework of international maritime law?
2. Can Maritime Autonomous Surface Ships (MASS) be classified as warships under international law?

"Understanding the interrelation between the Safety of Life at Sea Convention and Certain IMO's Code," *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation* 15 (2021): 34.

3. What are the legal implications of the use of autonomous warships in the perspective of international law?

2. Research Methods

This research adopts a normative legal research design. This approach focuses on doctrinal and conceptual analysis of the existing legal framework, particularly in the context of international law, to highlight how current regulations can be applied to new phenomena such as autonomous warships. Rather than collecting empirical data, this research analyzes relevant legal documents, conventions, and literature to identify inconsistencies and discrepancies. The goal is to understand the legal issues arising from the human-centric definition of "warship" in the United Nations Convention on the Law of the Sea (UNCLOS) and how this definition clashes with the emerging reality of autonomous ships.

The legal approach used is a combination of a contextual (conceptual) and doctrinal (doctrinal) approach. The contextual approach is applied to examine core concepts such as "warship" and "genuine link" in the context of new technologies. This research explores how these concepts can be reframed or softened to accommodate unmanned ships. Additionally, a doctrinal method is employed to conduct a thorough review and analysis of several international legal instruments, including UNCLOS, the International Regulations for Preventing Collisions at Sea (COLREGs), and the International Convention for the Safety of Life at Sea (SOLAS).

The reasoning methods used are deductive and analogical. Deductive reasoning is used to draw conclusions from general legal principles contained in UNCLOS. For example, this study questions whether autonomous vessels can meet UNCLOS requirements, such as being under the command of an officer and manned by a crew. The study concludes that under existing rules, autonomous vessels cannot be considered warships, leading to the need for legal reform. Meanwhile, analogical reasoning is used to compare autonomous vessels with existing instruments, such as remotely piloted Unmanned Aerial Vehicles (UAVs), to argue that the master or crew does not need to be physically present. The analogical reasoning is applied by comparing the operational and command structures of autonomous vessels with remotely piloted UAVs, particularly in terms of remote control, decision-making authority, and the absence of onboard personnel. This analogy is used to argue that the requirement of 'commanded by an officer' under UNCLOS may be interpreted functionally rather than physically. The laws described include UNCLOS, specifically Articles 29, 94, and 95, as well as other regulations such as COLREGs, SOLAS, and the International Safety Management (ISM) Code. This research

argues that these legal conditions are crucial to ensuring their relevance and effectiveness in the era of artificial intelligence.

3. Results and Discussion

3.1. The Legal Status of Autonomous Warships under International Maritime Law

The legal classification of autonomous warships raises significant challenges within international law, particularly due to their unique and novel characteristics. Autonomous warships, as they evolve, present ambiguities regarding their status as warships or as alternative weapon systems, such as torpedoes or naval mines. The lack of consensus among states further complicates the enforcement of existing maritime laws and creates gaps in legal frameworks that are critical for maintaining navigational rights during peacetime and ensuring operational strategies during armed conflict. Policymakers must urgently address these uncertainties to preempt potential disputes.

Under UNCLOS, a warship is defined as a ship belonging to the armed forces of a State, bearing external marks distinguishing its nationality, under the command of an officer duly commissioned by the government of the State, and manned by a crew under regular armed forces discipline (Article 29). Therefore, based on UNCLOS, a warship must satisfy three primary elements: it must bear an external mark indicating its nationality, it must be under the command of a duly commissioned officer, and it must have a crew under regular armed forces discipline. Notably, Article 29 does not require a ship to be armed to be classified as a warship.[11]

Interestingly enough, article 29 does not require a ship to be armed to be considered as a warship, nor does it require the ship to belong to the naval forces of a State (rather, it refers more generally to 'armed forces').[12] This provision allows for ownership by different branches of armed forces, not solely naval forces. This broad definition highlights the distinct status of warships, subjecting them to specific international rules and granting them unique rights and obligations under UNCLOS. These include immunities, responsibilities for damages caused, and privileges such as the right of hot pursuit and the seizure of pirate vessels.

The differentiation between warships and ordinary vessels is significant because warships are governed by specific rules, including: adherence to the laws and regulations of coastal States, accountability of the flag State for damages caused

[11] United Nations, *United Nations Convention on the Law of the Sea (UNCLOS)*, Dec. 10, 1982, 1833 U.N.T.S. 397., art. 29.

[12] Bernard H. Oxman, "The regime of warships under the United Nations Convention on the Law of the Sea," *Va. J. Int'l L.* 24 (1983): 809.

by warships, general immunities, immunity on the high seas, authority to seize pirate ships, the right of visit on the high seas, hot pursuit, and exemptions from regulations related to the protection and preservation of the marine environment.[13]

Warships are entitled to several rights under international law that underscore their critical role in maritime security and sovereignty. For instance, the immunity granted during innocent passage, as outlined in Article 32, protects warships from the jurisdiction of coastal states as long as their passage remains innocent. This right is vital for ensuring the uninterrupted movement of naval forces, as demonstrated by incidents like the 1988 USS Yorktown passage through Soviet waters, which tested the boundaries of innocent passage under international law.[14] On the high seas, warships enjoy complete immunity from the jurisdiction of any state other than the flag state, as stated in Article 95. This immunity is crucial for maintaining operational security and avoiding interference during missions.

Warships also hold specific rights concerning piracy. Articles 107 and 110 authorize warships to seize pirate ships and exercise the right of visit on reasonable grounds of suspicion, such as piracy, unauthorized broadcasting, or lack of a valid state flag. Hijacking such as the Maersk Alabama Hijacking case in 2009 is a real-world example where warships exercised these rights to combat piracy.[15] Article 111 outlines the right of hot pursuit, permitting warships to chase and apprehend foreign vessels that have breached the laws of the pursuing state's jurisdiction. This provision has been instrumental in cases like the 2019 interception of drug-smuggling vessels in the Pacific Ocean by U.S. Coast Guard warships. Furthermore, Article 236 exempts warships from provisions concerning the protection and preservation of the marine environment, emphasizing their operational privileges. This exemption enables warships to prioritize their missions over environmental regulations when necessary, though it remains subject to scrutiny in environmentally sensitive areas.

Warships have both rights and obligations under international law, including compliance with coastal state regulations, as outlined in Article 30. For instance, warships entering Indonesian waters must follow specific navigation rules to avoid disputes. Additionally, Article 31 holds the flag state liable for damages caused by its warships or government-operated vessels used for non-commercial purposes. Warships are also expected to assist vessels in distress and uphold safety standards,

[13] S. P. Jagota, "The United Nations Convention on the Law of the Sea, 1982," *Ocean Yearbook Online* 5, no. 1 (1985): 13.

[14] James Kraska, and Raul Pedrozo, *International Maritime Security Law*, (Massachusetts: Brill Nijhoff, 2018), 84.

[15] Daiana Seabra Venancio, "Challenges in Defining the Legal Status of Autonomous Underwater Vehicles (AUVs)," *Ocean Development & International Law* 56, no. 3 (2025): 345.

as seen during the 2015 Mediterranean migrant crisis, where they played a critical role at sea in rescue efforts.[16]

Autonomous warships raise concerns about maintaining these obligations without human oversight. Their ability to comply with navigation laws or render assistance is limited compared to traditional warships, despite advanced sensors and communication tools. For example, while vessels like the Sea Hunter can detect distress signals, their capacity to assess and respond effectively remains uncertain. These challenges highlight the need to reassess legal frameworks as autonomous technologies evolve.

In addition to the doctrinal challenges outlined above, the emergence of autonomous warships also exposes structural limitations within existing international maritime regimes, particularly regarding enforcement and attribution of responsibility. Current legal frameworks, including UNCLOS, were designed with human-operated vessels in mind, thereby presuming the presence of crew, command hierarchy, and onboard decision-making. As noted by Aldo Chircop[17], "the advent of automated vessels tests the adequacy of existing international legal regimes", particularly where legal responsibility is traditionally linked to human actors. This challenge is further intensified by jurisdictional ambiguity, where enforcement mechanisms struggle to determine which State holds authority over autonomous operations across multiple jurisdictions.[18] As a result, the absence of clear attribution frameworks risks undermining accountability and effective law enforcement at sea.

Moreover, the operational deployment of autonomous warships introduces new risks in maritime security and armed conflict. Autonomous systems may lack the contextual judgment required to comply with complex rules of engagement or respond proportionally to threats in contested environments. As emphasized by Yurika Ishii[19], "autonomous vessels are particularly vulnerable to attacks at sea, including cyber interference and unlawful access", which may compromise both civilian and military operations. In response, scholars highlight the need for updated regulatory approaches, including clearer command structures, cybersecurity safeguards, and adaptive governance models to ensure safe

[16] Judith Sunderland, "The Mediterranean Migration Crisis: Why People Flee, What the EU Should Do," *Human Rights Watch*, 2015. Retrieved in November 27, 2025 from. https://www.hrw.org/report/2015/06/19/mediterranean-migration-crisis/why-people-flee-what-eu-should-do.

[17] Aldo Chircop, "Testing international legal regimes: The advent of automated commercial vessels," *German Yearbook of International Law* 60, no. 1 (2018): 112.

[18] Barbara Stępień, and Mauro Arturo Rivera León, "Law enforcement in autonomous shipping: rethinking jurisdictional challenges under UNCLOS, *International & Comparative Law Quarterly* 74, no. 1 (2025): 53.

[19] Ishii Yurika, "Attacks on commercial maritime autonomous surface ships at sea," *Asia-Pacific Journal of Ocean Law and Policy* 8, no. 2 (2023): 275.

operation.[20] Additionally, the absence of crew raises concerns about compliance with traditional maritime obligations, such as seaworthiness and lawful navigation, which have historically relied on human oversight.[21] These developments demonstrate the urgency of evolving international law to address the legal and operational realities of autonomous warships.

3.2. Classification of Maritime Autonomous Surface Ships (MASS) as warships

First formally recognized during the 98th session of its Maritime Safety Committee (MSC**)** in 2017, MASS refers to vessels operated with minimal or no human interaction.[22] They are designed to enhance marine efficiency, reduce transportation costs, improve onboard working conditions, lower emissions, and bolster shipping safety. These advancements are particularly pertinent given the tightening global labor market and shortages of qualified ship officers.[23]

The term "MASS" encompasses various levels of automation, from "ships with automated processes and decision support" to "fully autonomous ships" capable of independent decision-making and action.[24] Despite the variation, the underlying principle remains consistent: MASS are vessels capable of autonomous operation without the need for onboard human presence.

MASS has gained significant traction in recent years, particularly through initiatives like the Maritime Unmanned Navigation through Intelligence in Networks (MUNIN**)**.[25] The MUNIN project served as Europe's foundational exploration into the feasibility of unmanned shipping technology.[26] This endeavor laid the groundwork for a series of subsequent projects aimed at developing autonomous, zero-emission vessels capable of navigating global waterways. In the last ten years, these initiatives have progressed, leading to the development of advanced autonomous cargo vessels like the MV Yara Birkeland.[27] Commissioned

[20] Yaseen Adnan Ahmed et all., "Regulatory and legal frameworks recommendations for short sea shipping maritime autonomous surface ships," *Marine policy* 166 (2024): 10626.

[21] Thanasis Karlis, "Maritime law issues related to the operation of unmanned autonomous cargo ships," *WMU Journal of Maritime Affairs* 17, no. 1 (2018): 121.

[22] Mohamad Issa et al., "Maritime autonomous surface ships: Problems and challenges facing the regulatory process," *Sustainability* 14, no. 23 (2022): 15630.

[23] Kraska and Pedrozo, *International Maritime Security Law*, 84.

[24] International Maritime Organization (IMO). *Report on MASS Trials of 'VN REBEL' Conducted in Accordance with the Interim Guidelines for MASS Trials*. MSC 104/INF.19, 2018.

[25] Vladimir Karetnikov et al., "Technology level and development trends of autonomous shipping means," In *Energy Management of Municipal Transportation Facilities and Transport* (Cham: Springer International Publishing, 2019), 426.

[26] Sauli Ahvenjärvi, "The human element and autonomous ships," *TransNav: International Journal on Marine Navigation and Safety of Sea Transportation* 10, no. 3 (2016): 521.

[27] Hieronymus Bosch, "Column: Semi-Autonomous Navigation: Yara Birkeland, Suzaku, Njord Forseti and Orca Ai [Offshore Accounts]," *Baird Maritime, Work Boat World*, August 29, 2022.

in 2021, the Yara Birkeland functions as an autonomous container vessel traveling between the ports of Herøya and Brevik in Norway. Designed to reduce road truck traffic and demonstrate the viability of a fully autonomous vessel for global operations, this project exemplifies the industry's ambitions toward sustainable and efficient maritime transport.

Other international projects further illustrate the global interest in autonomous shipping. In Russia, the Autonomous and Remote Navigation Trial Project, backed by federal authorities, successfully tested essential technologies and launched a nationwide trial permitting any shipping company to operate autonomous vessels under the Russian flag.[28] Similarly, Japan's Nippon Yusen Kabushiki Kaisha introduced the Iris Leader, an autonomous cargo ship that completed voyages between Xinsha, Nagoya, and Yokohama.[29] Meanwhile, France trialed the VN Rebel, a merchant ship remotely controlled from Paris.[30] These advancements highlight the worldwide shift toward integrating autonomy into maritime logistics.

Despite these advancements, a universally recognized definition of MASS is still lacking. The International Maritime Organization (IMO), via the Maritime Safety Committee (MSC), has suggested a tentative definition and classified MASS operations into four levels of autonomy.[31] Degree One refers to vessels where onboard seafarers oversee systems that operate automatically. Degree Two covers ships that are remotely controlled but still have seafarers onboard to supervise operations. Degree Three describes remotely controlled vessels without any crew onboard, whereas Degree Four represents fully autonomous ships that can make decisions and carry out actions independently.[32]

Retrieved in November 27, 2025 from. www.bairdmaritime.com/work-boat-world/offshore-world/column-semi-autonomous-navigation-yara-birkeland-suzaku-njord-forseti-and-orca-ai-offshore-accounts/.

[28] Marinet, "Autonomous Navigation Pilot Project on Commercial Fleet Vessels," *Marinet*, August 19, 2022. Retrieved in November 27, 2025 from. https://marinet.org/autonomous-and-remote-navigation-trial-project-arntp/.

[29] Marinet, "Autonomous Navigation Pilot Project on Commercial Fleet Vessels," *Marinet*, 19 Aug. 2022. Retrieved in November 27, 2025 from. https://marinet.org/autonomous-and-remote-navigation-trial-project-arntp/.

[30] International Maritime Organization (IMO). *Report on MASS Trials of 'VN REBEL' Conducted in Accordance with the Interim Guidelines for MASS Trials*. MSC 104/INF.19, 2018.

[31] International Maritime Organization (IMO). *International Convention for the Safety of Life at Sea (SOLAS)*. 1184 UNTS 3, 1974.

[32] Tae-eun Kim, and Jens-Uwe Schröder-Hinrichs., "Research developments and debates regarding maritime autonomous surface ship: status, challenges and perspectives," *New Maritime Business: uncertainty, sustainability, technology and big data* (2021): 179. See too, Andrzej and Zwolak, "The ocean-going autonomous," 41.

Table 1. Maritime Autonomous Surface Ships (MASS)

No.	Personnel Onboard	Navigation Process	Military Capabilities	Applicable International Ruling
1	Seafarers onboard	Systems assist crew in decision-making and operations.	Comparable to traditional ships; direct human control.	UNCLOS, SOLAS, COLREGs, MARPOL
2	Remotely controlled; onboard crew	Remote monitoring with onboard crew handling operations.	Primarily human-operated, remote oversight possible.	UNCLOS, SOLAS, COLREGs, MARPOL
3	No personnel onboard	Remote monitoring and control from a shore-based facility.	Potentially equipped for surveillance; limited offensive capabilities.	UNCLOS (adaptation needed), COLREGs, MARPOL
4	Fully autonomous	Decisions and actions determined entirely by onboard systems.	Advanced capabilities possible; challenges in legal classification.	UNCLOS (adaptation needed), COLREGs

Table 1 outlines four degrees of Maritime Autonomous Surface Ships (MASS). Degrees 1 and 2 involve onboard crew with automation supporting human decision-making under existing regulations. Degree 3 operates without crew but is remotely controlled, requiring legal adjustments. Degree 4 represents fully autonomous ships, where all decisions are system-driven, posing significant challenges for legal classification and the application of current international maritime law.

One of the most critical legal challenges is the principle of a "genuine link" under UNCLOS.[33] Traditionally, this ensures that a flag State exercises effective jurisdiction over its vessels. For autonomous ships, this concept becomes unclear due to the involvement of multiple actors: the flag State, owner State, software developer State, and remote operator State. If an incident occurs such as collision or environmental damage determining responsibility becomes complex and fragmented.[34]

This issue reflects concerns raised in the *Nottebohm Case*, which emphasized the necessity of a meaningful connection between an entity and the State asserting jurisdiction.[35] In the context of MASS, the weakening of this connection risks undermining accountability and enabling regulatory avoidance. To address this, scholars and policymakers suggest stronger international cooperation or even centralized registries to ensure clear jurisdictional responsibility.

[33] International Maritime Organization (IMO). *Report on MASS Trials of 'VN REBEL' Conducted in Accordance with the Interim Guidelines for MASS Trials*. MSC 104/INF.19, 2018.

[34] *The Muscat Dhows Case (France v. Great Britain)*. Permanent Court of Arbitration, 1916.

[35] Nottebohm Case (Liechtenstein v. Guatemala), International Court of Justice (ICJ), 6 April 1955, *International Court of Justice.* Retrieved in September*, https://www.icj-cij.org/case/18*.

Another major issue is the absence of onboard crew. Existing frameworks such as UNCLOS, SOLAS, and STCW assume human presence, particularly requiring a qualified master responsible for navigation and safety. While some propose the concept of a "remote master," this raises questions about whether a remote operator possibly a corporate entity can fulfill the same legal and ethical responsibilities as a traditional shipmaster.[36]

The lack of crew also complicates compliance with duties such as rendering assistance to persons in distress at sea, as required under UNCLOS Article 98 and SOLAS Chapter V. Although autonomous ships may deploy technological solutions (e.g., drones, distress alerts, life-saving equipment), these methods may not fully replace human judgment in unpredictable rescue scenarios.[37] Liability in cases of failure to assist remains unclear.

A key challenge presented by MASS, especially autonomous warships, is the lack of an onboard crew. Conventional international maritime regulations, including UNCLOS, SOLAS, and the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), presuppose that vessels are managed by human personnel. Article 94(4)(b) of UNCLOS specifically mandates that every ship be "under the command of a master and officers who hold the necessary qualifications," raising concerns about whether remotely operated or fully autonomous vessels can meet this criterion.

Given the challenges posed by the absence of a crew, regulatory bodies must adapt existing frameworks to account for the operational realities of autonomous warships. The IMO has already initiated discussions on revising existing regulations to accommodate MASS, such as the has already initiated discussions on revising existing regulations to accommodate MASS such as the IMO MSC 100/20/Add.1, 2018 document. Some proposed solutions include defining clear legal responsibilities for remote operators and ensuring they hold the same qualifications as traditional shipmasters, implementing hybrid models where autonomous vessels maintain minimal human presence to oversee compliance with legal obligations, and developing international treaties specific to autonomous warships to clarify issues related to command, liability, and operational oversight. COLREGs is what

[36] ICC-IMB. *Piracy and Armed Robbery Against Ships Report January-December 2023*. 2023.

[37] Junghwan Choi, and Sangil Lee, "Legal status of the remote operator in Maritime Autonomous Surface Ships (MASS) under maritime law," *Ocean Development & International Law* 52, no. 4 (2022): 449. See also, Henrik Ringbom, "Regulating autonomous ships concepts, challenges and precedents," *Ocean Development & International Law* 50, no. 2-3 (2019): 146; Karetnikov et al., "Technology level and development," 427.

seamen call the "Rules of the Road" an international regulation for avoiding collisions at sea, which all ships are expected to be capable of following.[38]

Navigation rules under COLREGs further highlight limitations of autonomous systems. Rules such as Rule 5 (Lookout), Rule 6 (Safe Speed), and Rule 7 (Risk of Collision) rely heavily on human perception and judgment. Autonomous systems depend on sensors and algorithms, which may fail in complex or unusual situations. Rule 2, which allows deviation based on "ordinary practice of seamen," is particularly difficult for AI to interpret, raising concerns about compliance in real-world conditions.

The importance of human intervention is illustrated by incidents like the Ever-Given blockage of the Suez Canal, where rapid decision-making was critical.[39] Fully autonomous vessels may lack the adaptability required in such emergencies, increasing risks to navigation safety.[40]

Seaworthiness is another area requiring reconsideration. Traditionally, a seaworthy vessel must be properly manned, structurally sound, and capable of safe navigation. Under SOLAS and the ISM Code, shipowners must ensure proper maintenance and operation.[41] For MASS, this implies reliance on advanced predictive maintenance systems rather than human oversight. Failure of such systems could increase risks of breakdown and complicate liability.

Cybersecurity represents a major emerging threat. Autonomous vessels rely entirely on digital systems, making them vulnerable to hacking, GPS spoofing, and malware. The 2017 NotPetya attack on Maersk demonstrated how cyber incidents can disrupt global shipping. For autonomous warships, such vulnerabilities could have severe security implications, including loss of control or manipulation of navigation systems. Existing frameworks like the ISPS Code provide general guidance but are insufficient for fully autonomous systems. Enhanced

[38] International Maritime Organization (IMO). *Convention on the International Regulations for Preventing Collisions at Sea (COLREGs)*. 1050 UNTS 16, UKTS 77, 1977. See also, Choi and Lee, "Legal status of the remote," 451.

[39] Comité Maritime International (CMI), *CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework*, (2018).

[40] Zbigniew Pietrzykowski et al., "The autonomous navigation system of a sea-going vessel," *Ocean Engineering* 261 (2022): 1121. See also, Igor Bačkalov, "Safety of autonomous inland vessels: An analysis of regulatory barriers in the present technical standards in Europe," *Safety science* 128 (2020): 1047. Issa et al., "Maritime autonomous surface ships," 15630.

[41] *Convention of 25 August 1924 for the Unification of Certain Rules of Law relating to Bills of Lading* (Treaty Series 1953, 109) including the provision appearing in Section 1 of the accompanying Protocol of signature, as that Convention was amended by the Protocol signed at Brussels on 23 February 1968 (Treaty Series 1979, 26) and as furthermore amended by the Protocol signed at Brussels on 21 December 1979 (Treaty Series 1985, 122). See also, Karetnikov et al., "Technology level and development," 428.

cybersecurity standards, including encryption and system redundancy, are necessary.[42]

Finally, autonomous warships face unique challenges in contested maritime environments, particularly in "gray zone" conflicts such as those in the South China Sea.[43] These scenarios involve ambiguous, non-military actions like harassment, blocking, or swarming by civilian or paramilitary vessels. Human operators can interpret intent and respond proportionally, but autonomous systems may misjudge these situations either escalating conflict or failing to respond adequately.[44]

Electronic warfare, such as GPS jamming and cyber interference, can disrupt autonomous ship systems, while the absence of human judgment complicates compliance with international law. Although MASS improves efficiency and safety, it raises major legal and security challenges. Existing frameworks like UNCLOS and SOLAS must evolve to address autonomy, ensuring clear rules on accountability, jurisdiction, and cybersecurity.

3.3. Legal Implications of Autonomous Warships

As discussed in the previous sub-section, UNCLOS currently stipulates that a warship must include human components, specifically an officer and a crew subject to regular armed forces discipline. Consequently, fully autonomous vessels cannot be classified as warships in the traditional sense. However, as the saying goes, "Het recht hink achter de feiten aan" the law inevitably lags behind reality. In line with this notion, maritime law must adapt to global developments, particularly the rise of autonomous warships.[45]

The fact is, legal or not by UNCLOS' rulings, States have developed their versions of autonomous warships. Whether it's in the form of drones, or large

[42] Andy Jones, and Omera Khan, "Surviving NotPetya: Global supply chains in the era of the cyber weapo.," In *Cyber security and supply chain management: risks, challenges, and solutions* (Singapura: Word Scientifict, 2021), 143.

[43] Lyle J. Morris et al., *Gaining competitive advantage in the gray zone: Response options for coercive aggression below the threshold of major war* (Santa Monica: RAND Corporation, 2019), 34. See also, Tahir Mahmood Azad et al., "Understanding gray zone warfare from multiple perspectives," *World Affairs* 186, no. 1 (2023): 87. See also, Armin Krishnan, "Fifth generation warfare, hybrid warfare, and gray zone conflict," *Journal of Strategic Security* 15, no. 4 (2022): 18.; Van Jackson, "Tactics of strategic competition: Gray zones, redlines, and conflicts before war," *Naval War College Review* 70, no. 3 (2017): 41; Hideshi Tokuchi, "The Gray Zone in the Definition of Gray-Zone Warfare: Challenges for Japan-US Cooperation," *Murky Waters in the East China Sea: Chinese Gray-Zone Operations and US-Japan Alliance Cooperation* (2021): 9.

[44] J. van den Broek et al., "Meaningful human control in autonomous shipping: An overview," In *IOP Conference Series: Materials Science and Engineering*, vol. 929, no. 1 (2020): 1208. See also, Nasu and Letts, "The legal characterization," 7.

[45] Jennifer Parker, "The challenges posed by the advent of maritime autonomous surface ships for international maritime law," *Australian and New Zealand Maritime Law Journal* 35, no. 1 (2021): 38.

unmanned vessels, through varying degrees of automation, warships are getting advanced, and it is the task of the international community to regulate them. For example, the US of course has the Ranger previously mentioned in the article to have travelled across the US and performed military exercises with the US Navy. Another example, also originating from the US, is the Sea Hunter, an autonomous unmanned surface vessel launched in 2016 under the DARPA Anti-Submarine Warfare Continuous Trail Unmanned Vessel program.[46]

These autonomous warships are controlled by computers, with a human overseeing the system and taking control when needed. This is called "Sparse Supervisory Control" - the human is in charge, but not directly steering the ship.[47] They can also patrol independently, using cameras and radar to avoid collisions. Since it has no crew, it has a specially designed interior that allows for maintenance but isn't meant for people to live on.

While these autonomous vessels are becoming more common, not all of them qualify as ships or warships. For example, autonomous underwater gliders used for data collection are not considered ships, even though they may be government-owned and thus protected by sovereign immunity. However, the legal status of larger autonomous vessels, like the Sea Hunter and the Ranger, is more complex. As countries increasingly rely on them for both commercial and military purposes, the question of whether these larger systems can be classified as ships or warships under domestic and international law is becoming a pressing concern.

The Comité Maritime International (CMI), in assessing whether autonomous warships can be classified as a ship or vessel, observed that:

"Existing international conventions that define the term 'ship' do not include references to crewing and at national level…[and] the definition of a ship is usually disconnected from the question of whether or not the ship is manned. It would…seem unjustified that two ships, one manned and the other unmanned, doing similar tasks involving similar dangers would not be subject to the same rules that have been designed to address those dangers."[48]

Therefore, a vessel's level of autonomy is not a determining factor in its classification as a "ship" or "vessel," and in the absence of a clear opposing provision, most autonomous vessels can be considered ships under international law. Article 94 of UNCLOS mandates that ships be operated by a qualified crew

[46] James Vincent, "The US Navy's New Autonomous Warship Is Called the Sea Hunter," *The Verge*, April 8 2016. Retrieved in November 27, 2025 from. www.theverge.com/2016/4/8/11391840/us-navy-autonomous-ship-sea-hunter-christened.

[47] Christopher P. Cavas, "Unmanned Sub-Hunter to Begin Test Program," *Defense News*, August 19, 2022. Retrieved in November 27, 2025 from. www.defensenews.com/story/defense-news/2016/04/07/darpa-actuv-sea-hunter-test-antisubmarine-warfare-asw-drone-unmanned-vigor-portland-onr-naval-research/82744862/.

[48] Comité Maritime International (CMI), *CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework*, (2018).

under the authority of a master to ensure safety and compliance with international regulations. However, it does not explicitly require the crew to be physically onboard, supporting the CMI's position that remotely operated vessels can fulfill these obligations.[49] It can therefore be contended, similar to the use of remotely piloted UAVs over recent decades, that autonomous vessels could likewise be operated remotely, provided that the master, officers, and crew fully comply with the requirements set forth in Article 94 and other relevant instruments, including SOLAS, the International Convention for the Prevention of Pollution from Ships (MARPOL), and COLREGs.[50]

Circling back to article 29, can a State then designate its autonomous vessels as a "warship" under UNCLOS, and enjoy the belligerent rights that it carries?

A "warship" is defined as a vessel that belongs to a State's armed forces, displays the external signs identifying its nationality, and is commanded by an officer officially commissioned by the government of that State.[51] An armed forces of a State can own or operate a vessel. However, can said vessel be considered under the command of an officer, if it were fully autonomous?

The operational capabilities of autonomous warships and traditional warships present a complex landscape shaped by technological advancements and strategic demands. While traditional naval vessels benefit from human decision-making that allows for nuanced tactical responses, autonomous warships leverage artificial intelligence and advanced algorithms to ensure rapid execution of missions. However, the integration of these technologies raises concerns about their effectiveness in multinational operations, as small navies, in particular, often struggle to manage and adapt these innovations within existing frameworks.[52] As such, the disparity in adoption rates of military technologies further complicates this comparison; some innovations, including those relating to naval capabilities, diffuse slowly due to financial and organizational limitations.[53]Therefore, while autonomous warships may offer innovative solutions, their ability to fulfill international obligations is contingent upon overcoming significant operational challenges and achieving interoperability within diverse maritime forces.

The rise of autonomous warships brings complex challenges in decision-making, legal compliance, and operational effectiveness. Unlike human-crewed

[49] Comité Maritime International (CMI), *CMI International Working Group Position Paper on Unmanned Ships and the International Regulatory Framework*, (2018).

[50] Nathan Leys, "Autonomous Weapon Systems, International Crises, and Anticipatory Self-Defense," *Yale J. Int'l L.* 45 (2020): 375. See also, Sara Cabanas Area, "Liability for Defective Products in Autonomous Ships: Implications of Directive (EU) 2024/2853," *Cuadernos Derecho Transnacional* 17 (2025): 80.

[51] Jackson, "Tactics of strategic competition," 44.

[52] Andrzej Makowski, "Dilemmas faced in developing small navies," *Naval War College Review* 76, no. 1 (2023): 98. See also, Barrera et al., "Trends and challenges in unmanned," 438.

[53] Broek et al., "Meaningful human control," 1209.

warships, they rely on algorithms that may struggle in unpredictable scenarios, raising concerns about adherence to international laws, particularly in anticipatory self-defense. Military adoption of these technologies also varies, affecting their integration into global fleets. The lack of a specific legal framework for autonomous warships creates compliance uncertainties, necessitating a reassessment of existing maritime laws to address their unique operational and ethical implications.[54]

The key difference between traditional and autonomous warships in fulfilling international rights and obligations is that while traditional warships rely on their commanders and crews for direct accountability and compliance, autonomous warships present a more complex responsibility landscape, as responsibility is shared between the flag state, AI developers, programmers, and remote operators. Human crews are able to navigate ethical dilemmas and legal nuances, while AI-driven systems rely on pre-programmed rules that may not be adequate to handle complex situations such as the use of proportional force or humanitarian assessments. Similarly, traditional crews can communicate with coastal authorities and resolve legal ambiguities, a task that becomes more challenging for autonomous warships that rely on AI interpretation, which can increase the risk of miscommunication or violations.

When it comes to providing assistance and fulfilling humanitarian obligations, traditional warships offer direct rescue and medical assistance. In contrast, autonomous warships lack these human-driven capabilities and instead rely on drones or relaying distress signals to other vessels. For visitation rights, human officers can conduct inspections and reviews, allowing for more nuanced assessments. However, AI-led inspections using drones may not meet the required procedural and legal standards. Finally, in the event of operational errors and unintentional violations, human crews can quickly correct these errors. On the other hand, autonomous warships rely on AI, which may misinterpret data or fail to adapt, potentially leading to unintentional violations.

While autonomous warships can theoretically fulfill the same legal rights and obligations as traditional warships, technological, legal, and ethical challenges limit their effectiveness. They struggle with navigating complex legal frameworks, making nuanced decisions, and upholding humanitarian principles. Given that international treaties like UNCLOS, MARPOL, and SOLAS were drafted without anticipating fully autonomous ships, these vessels remain distinct from traditional warships until legal and technological advancements address these gaps.

[54] Justyna Nawrot, and Zuzanna Peplowska-Dąbrowska, "Revolution or evolution? Challenges posed by autonomous vessels for national and international legal framework," *Comparative Law Review* 25 (2019): 243. See also, Felix Collin, "Maritime Product Liability at the Dawn of Unmanned Ships–the Finnish Perspective," *SIMPLY: Scandinavian Institute of Maritime Law Yearbook 2018* (2018): 14.

Similar to the IMO instruments that apply to civilian vessels, neither UNCLOS nor any other international agreement mandates the physical presence of the commanding officer and crew aboard a warship. In the same way that remotely piloted UAVs are operated, the flag state has the authority to determine that a UMS can be remotely manned by a crew and commanded by a commissioned officer who is not physically present on the vessel. As a result, autonomous vessels can be classified as a "warship" in accordance with both domestic and international laws. The flag state has the discretion to determine the conditions under which an autonomous vessel can be designated as a "warship" according to its own domestic laws and regulations, just as it does with civilian ships.[55]

In the U.S., the Chief of Naval Operations (CNO) has the authority to classify naval vessels as "warships" under Navy Regulations and U.S. Code. [56]Any ship built or equipped for combat that is listed in the Naval Vessel Register can be designated as a warship, regardless of whether it is manned or unmanned.[57] The CNO can legally classify an autonomous vessel as a warship if it meets operational and international regulatory standards. While not all autonomous vessels qualify, those not designated as warships can be classified as naval auxiliaries, which may defend themselves but cannot conduct offensive operations. As autonomous vessels become more integrated, states must reassess their policies to ensure compliance with international law.

Of course, this implies that once more, while it is the duty of States to follow international rules, it is also the duty of international regulations to follow up with recent developments happening around the world.

4. Conclussion

The emergence of autonomous warships disrupts established international maritime legal frameworks, particularly the United Nations Convention on the Law of the Sea (UNCLOS), which defines warships as human-commanded vessels under military discipline. Autonomous systems, lacking direct human oversight, fail to meet these criteria, creating ambiguity around their legal status, operational privileges (e.g., sovereign immunity, innocent passage), and accountability. Key challenges include determining liability for violations such as navigational errors or unlawful military actions as responsibility could fall ambiguously on flag states, AI

[55] Choi and Lee, "Legal status of the remote," 453.

[56] James Kraska et al., *The Newport Manual on the Law of Naval Warfare* (Naval War College: Stockton Center for the Study of International Law, 2023), 43. See also, Ringbom, "Regulating autonomous ships concepts," 149.

[57] U.S. Department of the Navy. *Secretary of the Navy Instruction 5030.8C: General Guidance for the Classification of Naval Vessels and Battle Force Ship Counting Procedures*. 2016.

developers, or remote operators. This legal gray area risks undermining principles of state sovereignty, maritime security, and compliance with norms like collision avoidance or distress response protocols. Without updated definitions and liability mechanisms, coastal states may challenge autonomous warships' legitimacy in territorial waters, escalating diplomatic tensions.

To address these gaps, international law must evolve to integrate autonomous warships. Potential solutions include revising UNCLOS to explicitly define their rights and responsibilities, negotiating new treaties to govern their use, or empowering the International Maritime Organization (IMO) to set operational standards. Multilateral cooperation is critical to resolve issues of accountability, ensure ethical AI decision-making, and preserve maritime stability. Proactive legal adaptation is urgent: unresolved ambiguities could fuel disputes over sovereignty, escalate conflicts, and erode trust in maritime governance. By aligning legal frameworks with technological advancements, the global community can uphold the rule of law while harnessing the strategic benefits of autonomous naval systems.

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