# Artificial intelligence and human rights at sea: Legal challenges and opportunities in maritime governance

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## Abstract

The interconnection between the law of the sea and human rights law is increasingly shaping the legal order envisioned by the UN Convention on the Law of the Sea. With the rise of Artificial Intelligence (AI) and rapid technological advances in the shipping industry, the urgency of protecting human rights at sea has intensified. Nevertheless, significant challenges remain in monitoring, preventing, and prosecuting rights violations in maritime spaces. This article explores whether emerging technologies in maritime navigation bolster or undermine human rights protection at sea. It assesses how innovation may enhance safeguards, while also identifying its persistent shortcomings. The analysis begins by examining the relationship between the law of the sea and human rights law and reviewing relevant regulatory developments related to AI in navigation, including reference to practical examples such as varying

levels of automation in shipping. The discussion then turns to AI's dual role at sea – its regulatory potential in preventing and detecting violations, and its risks, including algorithmic bias, opaque decision-making ("black box" effects), and vulnerabilities in the maritime supply chain. The article concludes that vilifying AI is misguided; like any tool, its impact will depend on how and where it is deployed.

**Keywords**: Law of the sea, human rights law, artificial intelligence, European Union, IMO, shipping.

# 1. Introduction

The interrelation between the law of the sea and human rights law has become increasingly crucial in shaping the legal order of the seas and the oceans, as envisioned by the UN Convention on the Law of the Sea (UNCLOS).[1] In this context, the advent of Artificial Intelligence (AI) and the broader technological revolution transforming the shipping industry are creating unprecedented opportunities, while simultaneously heightening the urgency of safeguarding human rights at sea. Despite the considerable promise of emerging technologies in enhancing maritime navigation and surveillance, significant challenges persist in the detection, prevention, and prosecution of fundamental rights violations in maritime contexts.

Such violations have historically thrived on a combination of factors. Chief among them is the vastness and remoteness of maritime spaces, which has rendered abuses more difficult to detect than their terrestrial

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**1.** United Nations Convention on the Law of the Sea (Montego Bay, 10 December 1982, in force, 16 November 1994) 1833 UNTS 397. Preamble (4).

counterparts, thereby contributing to their neglect by States.[2] The persistence of such violations – and their widespread impunity – has been further facilitated by the prioritisation of border control measures, as well as by the vested interests of commercial shipping entities, the fishing industry, and transnational criminal networks.[3] As a result, individuals at sea remain vulnerable to a range of human rights abuses, including slavery, forced labour, sexual harassment, discrimination, human trafficking, and migrant smuggling, often without access to effective mechanisms of protection or redress.[4]

These factors have all contributed to what scholars refer to as the 'sea blindness' of human rights.[5] Given that more than thirty million people are estimated to be on the world's oceans every day, the urgency of addressing this issue cannot be overstated.[6]

Concurrently, the use of AI in the maritime industry is expanding at a rapid pace, exerting a transformative influence on global shipping. Notably, the maritime AI technology market nearly tripled between 2023 and 2024.[7] Further, research conducted in 2024 estimates the value of the global AI market at USD 4.13 billion, with a projected compound annu-

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**2.** Natalie Klein, 'Geneva Declaration on Human Rights at Sea: An Endeavour to Connect Law of the Sea and International Human Rights Law' (2022) 53(2)-(3) Ocean Development and International Law, 1.

**3.** Ibid., 3-4.

**4.** Ibid.

**5.** E.g., Elizabeth Mavropoulou, 'UK UNCLOS Inquiry: Is UNCLOS Fit for Protecting Human Rights at Sea? A Comment' (*EJIL: Talk! Blog of the European Journal of International Law*, 27 December 2021), available at <<https://www.ejiltalk.org/uk-unclos-inquiry-is-unclos-fit-for-protecting-human-rights-at-sea-a-comment/>>; Anna Petrig, 'Human Rights and Law Enforcement at Sea' in Ruxandra-Laura Bosilca, Susana Ferreira, Barry J. Ryan (eds.), *Routledge Handbook of Maritime Security* (Routledge 2022) 153-164, 155.

**6.** Steven Haines, 'Developing Human Rights at Sea' (2021) 35 Ocean Yearbook, 21.

**7.** Fiona Macdonald and Dave Martin, 'Beyond the Horizon: Opportunities and Obstacles in the Maritime AI Boom' (Thetius 2024) 8, available at <<https://thetius.com/free-report-beyond-the-horizon-opportunities-and-obstacles-in-the-maritime-ai-boom/>>.

al growth rate (CAGR) of 23% over the next five years.[8] This technological revolution serves as a catalyst for both opportunities and challenges in the realm of human rights – issues that industry stakeholders and the international community are increasingly called to confront. While certain AI applications have the potential to strengthen the protection of human rights at sea, others may give rise to significant risks and unintended consequences.

Against this backdrop, researchers and practitioners are increasingly prompted to assess the extent to which AI ultimately supports or undermines the protection of human rights at sea. To begin exploring this issue, the present article provides a preliminary overview of the current relationship between the law of the sea and human rights law. This includes reference to the Geneva Declaration on Human Rights at Sea (GDHRS) – a soft-law instrument launched in 2022 by the non-governmental organization *Human Rights at Sea*, with academic backing, aimed at addressing the legal and practical gap between international human rights law and the law of the sea.[9]

The analysis then turns to two recent initiatives aimed at regulating AI: Regulation (EU) 2024/1689 (the AI Act),[10] adopted by the European Union on 13 June 2024, and the ongoing regulatory efforts of the International Maritime Organization (IMO) concerning autonomous vessels. Finally, the article examines several ways in which AI is currently being employed in maritime navigation, comparing their respective benefits and drawbacks in relation to the protection of fundamental rights at sea.

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**8.** Ibid.

**9.** Geneva Declaration on Human Rights at Sea (launched 1 March 2022).

**10.** OJ L, 2024/1689, 12.7.2024.

## 2. The relationship between the Law of the Sea and Human Rights Law

From a legal perspective, the shortcomings in the protection of human rights in maritime spaces highlight the need for a stronger interconnection between the law of the sea and human rights law.[11] Historically, however, these fields have not automatically or reciprocally permeated one another. By its nature, the law of the sea tends to be particularly 'state-centric' and has traditionally been drafted to address the 'human' elements of maritime activities only marginally.[12] In contrast, human rights law has primarily focused on land-based contexts, where territorial boundaries are clearer, thereby making it easier to establish jurisdiction over the protection of rights.[13] The GDHRS marks a significant step toward bridging this gap, as will be discussed below. Moreover, implicit intersections between the use of maritime spaces and human rights law can be identified in both international legal instruments and judicial decisions. The following sections offer illustrative examples of such convergence.

### 2.1 References to Human Rights Law in the Law of the Sea

Such references are particularly evident in several provisions of UNCLOS. While the Convention does not directly address human rights,

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**11.** Felipe Gonzalez Morales, UN Special Rapporteur on the Human Rights of Migrants, Means to address the human rights impact of pushbacks of migrants on land and at sea, UN Doc A/HRC/47/30 (12 May 2021), para 107; and Irini Papanicolopulu, *International Law and the Protection of People at Sea* (OUP 2018) 73;

**12.** Seline Trevisanut, 'The Future of the Oceans: The Role of Human Rights Law and International Environmental Law in Shaping the Law of the Sea' in Nico Krisch and Ezgi Yildiz (ed.) *The Many Paths of Change of International Law* (OUP 2024) 201-226, 201.

**13.** Klein (n 2) 1.

certain provisions nonetheless pertain to the treatment of individuals and reflect underlying human rights considerations.[14] For example, Article 18 provides an exception to the prohibition on stopping or anchoring during innocent passage,[15] allowing such actions "for the purpose of rendering assistance to persons, ships, or aircraft in danger or distress".[16] This provision is further reinforced by Article 98, which imposes a general duty to assist vessels and individuals in distress on the high seas.[17] Under Article 58(2) of the Convention, this obligation is also applicable within the Exclusive Economic Zone (EEZ).[18] In addition, Article 73(3) explicitly prohibits coastal States from imposing penalties of "imprisonment" or "any form of corporal punishment" on individuals violating fisheries laws within their EEZs without the consent of the States concerned.[19]

Furthermore, the International Tribunal for the Law of the Sea (ITLOS) has made significant contributions toward bridging the gap between the law of the sea and human rights law. Over the years, ITLOS has explicitly affirmed that principles derived from human rights law are applicable in the interpretation and application of UNCLOS, even when they are not expressly stated in its provisions.[20] This approach was most clearly articulated in the *M/V Saiga (No. 2)* case, where the Tribunal held:

> Although the Convention does not contain express provisions on the use of force in the arrest of ships, international law, which is applicable by virtue of Article 293 of the Convention, requires that the use of force

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**14.** Tullio Treves, 'Human Rights and the Law of the Sea' (2010) 28 Berkeley Journal of International Law, 3.

**15.** UNCLOS (n 1), Article 17: "Subject to this Convention, ships of all States, whether coastal or land-locked, enjoy the right of innocent passage through the territorial sea".

**16.** Ibid., Article 18(2).

**17.** Ibid., Article 98(1).

**18.** Ibid., Article 58(2).

**19.** Ibid., Article 73(3).

**20.** Treves (n 14) 5.

must be avoided as far as possible and, where force is unavoidable, it must not go beyond what is reasonable and necessary in the circumstances. Considerations of humanity must apply to the Law of the Sea as they do in other areas of international law.[21]

The reference to 'considerations of humanity' echoes the International Court of Justice (ICJ)'s reasoning in the *Corfu Channel* case, in which the ICJ acknowledged *elementary* considerations of humanity as "general and well-recognized principles" of international law.[22] Besides the already mentioned *M/V Saiga (No. 2)* case, ITLOS reprised the reference to 'considerations of humanity' in subsequent cases, notably *M/V Virginia G* and *Enrica Lexie*.[23] While this formula was not specifically defined in any of these judgements, some authors have praised its flexibility as the "starting point of a greater process of humanisation of the law of the sea", deeming it a decisive reference to human rights law and a symbolic bridge between the latter and UNCLOS.[24]

ITLOS further developed this human rights-oriented approach in cases such as *Juno Trader* and *Hoshinmaru*.[25] Although the respective applications concerned the prompt release of vessels, ITLOS took the opportunity to also address the treatment of the individuals involved, demanding that the masters and crews be allowed to leave the territories of

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**21.** *M/V Saiga (No. 2)* (St. Vincent and the Grenadines v. Guinea), ITLOS Reports 1999, 10, 120, I.L.R. 143 (International Tribunal for the Law of the Sea, 1999) ¶ 155.

**22.** *Corfu Channel* (United Kingdom of Great Britain and Northern Ireland v. Albania), 1949 ICJ Rep 4 (International Court of Justice, 1949) (Merits); Yoshifumi Tanaka, *The International Law of the Sea* (CUP 2015) 15-16.

**23.** *M/V Virginia G* (Panama v. Guinea-Bissau) (Judgement), ITLOS Reports 2014, 5, 53 ILM 1187 (International Tribunal for the Law of the Sea, 2014) ¶ 359; *Enrica Lexie* (Italy v. India), Provisional Measures, ITLOS Reports 2015, 24, ¶ 133.

**24.** Anna Petrig and Marta Bo, 'The International Tribunal for the Law of the Sea and Human Rights' in Martin Scheinin (ed.) *Human Rights Norms in 'Other' International Courts* (CUP 2019) 353-411, 404-405; and Treves (n 14) 5-6.

**25.** Treves (n 14) 4-5.

the detaining States "without any condition".[26] In the *Juno Trader* judgement, ITLOS particularly emphasised that "the obligation to grant the prompt release of vessels and crews includes elementary considerations of humanity and due process of law."[27] These examples highlight the Tribunal's awareness of humanitarian concerns, while also demonstrating that human rights principles may significantly influence the application and interpretation of the law of the sea.

## 2.2 References to the Law of Sea in ECtHR judgements

The law of the sea may, in turn, inspire human rights practice, as demonstrated by several relevant judgements of the European Court of Human Rights (ECtHR).[28] For instance, the ECtHR considered maritime legal principles in the *Women on Waves* case, stemming from a complaint by three NGOs against the Portuguese government.[29] The complaint concerned the Portuguese government's prevention of the entry of their chartered vessel, *Borndiep* – which hosted activities advocating the legalization of abortion, a practice illegal in Portugal at the time – into Portuguese waters.[30] While the Court confirmed that the vessel's inno-

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**26.** *Juno Trader* (Saint Vincent and the Grenadines v. Guinea Bissau), ITLOS Reports 2004, 17, 128 I.L.R. 267 ¶ 77, Order of 19 November 2004; *Hoshimaru* (Japan v. Russian Federation), ITLOS Reports 2005-2007, 18, ¶ 12, Order of 9 July 2007.

**27.** *Juno Trader* (n 26) ¶ 77.

**28.** The ECtHR adjudicates on alleged violations of the rights set out in the European Convention on Human Rights on behalf of the member States of the Council of Europe, on the grounds of applications filed by those States or by individuals: see Convention for the Protection of Human Rights and Fundamental Freedoms (ECtHR) (Rome, 4 November 1950, in force, 3 September 1953) ETS No. 5, Articles 33 and 34.

**29.** Namely *Women on Waves*, *Clube Safo* and *Não Te Prives*: see *Women on Waves and Others v. Portugal*, Application n. 31276/05, European Court of Human Rights (Judgement of 3 February 2009).

**30.** Ibid.

cent passage had been obstructed in accordance with UNCLOS, thereby recognising the relevance of the Convention in the application of human rights law, it also ruled that the plaintiffs' rights to freedom of expression, peaceful assembly, and association had been violated. Indeed, the Court found that Portugal could have adopted more proportionate measures in this case.[31]

The ECtHR's willingness to balance maritime legal principles with human rights considerations is further evidenced by its judgements in *Medvedyev et al. v. France* and *Rigopoulos v. Spain*.[32] Both cases stemmed from the seizure of vessels – flying the Cambodian and Panamanian flags, respectively – on suspicion of drug trafficking.[33] In each instance, the crew members were detained aboard naval ships and subjected to legal proceedings in the arresting States (France and Spain, respectively), where they argued that their rights under Article 5(3) of the European Convention on Human Rights were violated. This provision stipulates that persons arrested or detained "shall be brought promptly before a judge or other officer authorized by law to exercise judicial power".[34] While the Court acknowledged that the respective time between arrest and hearing (sixteen days in *Rigopoulos* and thirteen days in *Medvedyev*) should normally constitute a breach of the 'promptness' required by Article 5(3), it nevertheless found that the exceptional circumstances in both cases warranted derogations from the norm.[35] The ECtHR justified its

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**31.** Treves (n 14) 11.

**32.** Douglas Guilfoyle, 'Human Rights Issues and Non-Flag State Boarding of Suspect Ships in International Waters' in Clive Ralph Symmons (ed.) *Selected Contemporary Issues in the Law of the Sea* (Martinus Nijhoff Publishers 2011) 83-104, 87; and Treves (n 14) 12.

**33.** *Medvedyev and Others v. France*, Application n. 3394/03, European Court of Human Rights (Judgement of 29 March 2010); *Rigopoulos v. Spain*, Application n. 37388/97, European Court of Human Rights (Judgement of 12 January 1999).

**34.** ECtHR (n 28), Article 5(3).

**35.** *Medvedyev and Others v. France* (n 32); and *Rigopoulos v. Spain* (n 32)

reasoning by emphasising the great distance from the mainland at which the arrests were effected, as well as the urgency of combating drug trafficking at sea.[36] This case law underscores the importance of considering the unique characteristics of maritime contexts when evaluating potential human rights violations.[37]

## 2.3 The GDHRS

While the aforementioned examples demonstrate that the law of the sea and human rights law can influence one another to a meaningful degree, persistent reports of rights violations indicate that their current integration remains insufficient to guarantee effective protection.[38] The absence of a specific, universal legal framework governing the intersection of these two domains arguably undermines legal clarity and exacerbates the jurisdictional ambiguities that have historically hindered the enforcement of human rights at sea.[39] This legal vacuum inspired the GDHRS, which was drafted with the support of renowned publicists under the auspices of *Human Rights at Sea*.[40] The essence of this document is best captured in its four 'fundamental principles':

1. Human rights are universal; they apply at sea, as they do on land.
2. All persons at sea, without any distinction, are entitled to their human rights.
3. There are no maritime specific reasons for denying human rights at sea.

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**36.** Treves (n 14) 8.

**37.** Ibid.

**38.** Klein (n 2) 1-2.

**39.** Ibid.

**40.** Including Dr. Sofia Galani, Dr. Elizabeth Mavropoulou, Prof. Steven Haines, Mr. David Hammond, Prof. Irini Papanicolopulu, Prof. Anna Petrig: see Human Rights at Sea, 'The Geneva Declaration on Human Rights at Sea' (*Human Rights at Sea*) available at <<https://www.humanrightsatsea.org/GDHRAS>>.

4. All human rights established under both treaty and customary international law must be respected at sea.[41]

The GDHRS does not seek to create new categories of human rights or impose novel obligations on States; rather, it aims to consolidate and re-affirm rights and duties already established under existing international law.[42] For example, Annex B lists the principal multilateral and regional human rights instruments that inform the Declaration – such as the International Covenant on Civil and Political Rights[43] – alongside specific rights that are particularly relevant in maritime contexts, including the right to life, the principle of non-refoulement, and the right to freedom of expression.[44] The remainder of the GDHRS consists of non-binding 'Guidelines' intended to assist States in upholding human rights obligations in maritime spaces.[45] As a document drafted and adopted by a private group of experts – without formal endorsement by States or intergovernmental organizations – the GDHRS currently holds the status of a soft-law instrument and lacks direct legal effect on State conduct.[46]

Nonetheless, the GDHRS may still exert normative influence on the evolution of human rights protections at sea. As Papanicolopulu observes, "the practice of non-state actors may be quite relevant in the shaping of international custom, and in its recognition, since it may drive unwilling States to act, or to voice their beliefs, in connection with the existence or non-existence of an international customary rule."[47]

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**41.** GDHRS (n 9) Fundamental Principles.

**42.** Klein (n 2) 23.

**43.** International Covenant on Civil and Political Rights (New York City, 16 December 1966, in force 23 March 1976) 999 UNTS 171.

**44.** GDHRS (n 9) Annex B.

**45.** Ibid., Annex C.

**46.** Klein (n 2) 18.

**47.** Irini Papanicolopulu, "Informal Lawmaking in Maritime Migration" in Natalie Klein (ed.), *Unconventional Lawmaking in the Law of the Sea* (OUP 2022) 62-75, 73.

Given that customary international law constitutes a recognised source of law under Article 38(1)(b) of the ICJ Statute, the GDHRS may contribute to the gradual emergence and consolidation of new customary norms, particularly in relation to the protection of human rights in maritime contexts.[48]

The presence of the GDHRS within the international legal landscape may also influence the future interpretation of treaties in a manner conducive to the advancement of human rights at sea. While it may be contended that, in the absence of formal public endorsement, the GDHRS does not constitute one of the conventional interpretive tools under the Vienna Convention on the Law of Treaties (VCLT),[49] its normative orientation nonetheless holds interpretive value. Specifically, it may inform the application of Article 31(3)(c) VCLT, which refers to "relevant rules of international law applicable in the relations between the parties", thereby allowing the GDHRS to serve as a supplementary reference in the interpretation of treaty obligations in light of evolving human rights norms.[50]

Consequently, the GDHRS may further contribute to encouraging States to acknowledge the need for an official international legal framework that substantively integrates the law of the sea with human rights law. Historical precedents demonstrate that non-State actors have, at times, played a pivotal role in influencing State positions and promoting the development of international treaties. A notable example is the 1997 Ottawa Convention on the Prohibition of Anti-Personnel Mines, the adoption of which was largely driven by civil society initiatives and supported by a coalition of more than 1,200 non-governmental organi-

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**48.** Statute of the International Court of Justice (adopted 26 June 1945, entered into force 24 October 1945) 33 UNTS 933, Article 38(1).

**49.** Vienna Convention on the Law of Treaties (adopted 23 May 1969, entered into force 27 January 1980), 1155 UNTS 331.

**50.** Ibid., Article 31(3)(c).

zations across numerous countries.[51]

Owing to its flexible legal format, the GDHRS may also provide a valuable foundation for the development of emerging customary practices concerning the application of AI in the protection of human rights at sea. Notably, it may serve as a normative reference for States and international organisations in crafting future regulatory frameworks for emerging technologies that align with established human rights standards. In any event, its normative influence will ultimately hinge on the degree to which States engage with its principles and translate them into concrete legal and operational practice.

# 3. AI and its impact on the safeguard of human rights at sea

The extent to which AI may contribute to the protection of human rights at sea similarly depends on the willingness of States and other relevant actors to engage with and regulate its use. In fact, while the deployment of AI technologies in maritime contexts is expanding globally, a comprehensive international legal framework specifically governing this development is yet to be created. As a result, many technological innovations currently operate within a legal grey zone, affording both States and private entities considerable discretion. Nonetheless, significant regulatory efforts are emerging. Notably, in 2024 the European Union adopted the AI Act, representing a pioneering supranational attempt to comprehen-

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**51.** Convention on the Prohibition of the Use, Stockpiling, Production, and Transfer of Anti-Personnel Mines and on their Destruction (adopted 3 December 1977, entered into force 1 March 1999) 2056 UNTSS 211; and Kenneth Anderson, 'The Ottawa Convention Banning Landmines, the Role of International Non-governmental Organizations and the Idea of International Civil Society' (2000) 11 (1) European Journal of International Law, 105.

sively address AI regulation. Simultaneously, the IMO is undertaking work on a regulatory code for autonomous maritime navigation. In the interim, as the shipping industry increasingly benefits from AI technologies, their impact on human rights at sea may be either beneficial or detrimental, depending on how these technologies are implemented and governed in practice.

## 3.1 The European Union's AI Act

The European Union's AI Act marks a legal milestone as the world's first comprehensive regulatory framework on AI. Its expansive scope is also expected to influence the role of AI in the maritime sector, including its implications for human rights at sea. While the AI Act warrants a more detailed analysis than can be offered here, several of its provisions are particularly relevant to the present discussion. Article 3 of the AI Act defines an AI system as

> [A] machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations or decisions that can influence physical or virtual environments.[52]

Based on this definition, the AI Act seeks to ensure a safe and ethical deployment of AI technologies by categorising systems according to their potential risk: namely, systems of unacceptable, high, limited, and minimal risk.[53]

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**52.** OJ L 2024/1689 (n 10), Article 3.

**53.** European Commission, 'Shaping Europe's Digital Future: AI Act', (*European Commission*) available at <<https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai>>.

AI systems classified as posing an *unacceptable risk* are prohibited within the European Union, as they employ manipulative techniques such as "social scoring", defined as the evaluation or classification of individuals or groups based on social behaviour or personal characteristics.[54] *Limited-risk* systems, by contrast, are permitted provided they comply with specific transparency obligations. *Minimal-risk* systems – such as AI-enabled video games or spam filters – may be used without restriction.[55]

The primary focus of the AI Act's regulatory obligations, however, is on *high-risk* systems.[56] These are AI systems intended for use in sensitive contexts, including critical infrastructures, safety components of products, or applications capable of automated profiling and analysis of individuals' personal data to assess sensitive dimensions of their lives.[57] In general, high-risk AI encompasses systems whose improper use could seriously endanger the life, health, or fundamental rights of individuals.

The provisions of the Act are primarily directed at the *providers* and *deployers* of AI systems. For the purposes of the AI Act, a *provider* is defined as any natural or legal person, public authority, agency, or other entity that develops an AI system or places it on the market under its own name or trademark.[58] A *deployer*, by contrast, refers to an entity that uses an AI system under its authority, excluding uses for personal or non-professional purposes.[59] Notably, the AI Act is drafted with a reach extending beyond the borders of the Union, as it applies to *providers* and *deployers* irrespective of their geographic location, insofar as their AI

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**54.** Future of Life Institute, 'High Level Summary of the AI Act' (30 May 2024 Update) (*EU Artificial Intelligence Act,* 27 February 2024, Updated on 30 May 2024), available at <<https://artificialintelligenceact.eu/high-level-summary/>>.

**55.** European Commission (n 53).

**56.** Future of Life Institute (n 54).

**57.** OJ L, 2024/1689 (n 10), Article 6; and European Commission (n 53).

**58.** OJ L, 2024/1689 (n 10), Article 3.

**59.** Ibid.

systems – or the outcomes thereof – are used within the Union, as such including Union waters.[60]

In particular, *providers* and *deployers* of *high-risk* AI systems are subject to a range of obligations, including the establishment of robust risk management frameworks, the implementation of sound data governance measures (ensuring that datasets are relevant, representative, and, where possible, error-free), and the maintenance of adequate cybersecurity standards. These safeguards must also be complemented by mechanisms allowing effective human oversight.[61]

While the AI Act does not explicitly refer to the protection of human rights at sea, it nonetheless holds significant potential to shape the role of AI in this context. Indeed, the Act demonstrates a significant awareness of both fundamental rights and the legal implications of AI deployment in maritime domains. A contextual and systematic reading of several key provisions suggests that the European Union seeks to regulate AI applications – including those at sea – in a manner that complements and reinforces the protection of individuals' rights.

First, it is worth noting that the AI Act explicitly references human rights, including the "right to dignity and non-discrimination", to assert that any AI system violating such values should be classified as unacceptable, and therefore prohibited.[62] Moreover, Article 5(1)(d) of the Act prohibits the use of systems designed to assess the likelihood that certain individuals might commit a crime "based solely on their profiling or the evaluation of their personality traits and characteristics";[63] such practices would violate privacy rights and the principle of non-discrimination. However, this prohibition does not extend to AI systems used

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**60.** Ibid., Article 2.

**61.** Ibid., Articles 8-15.

**62.** Ibid., para (31).

**63.** Ibid., Article 5(1)(d).

to "support human assessment of an individual's involvement in criminal activity", provided that the assessment is based on "objective and verifiable facts".[64] In a similar vein, Article 5(1)(h) prohibits the use of real-time remote biometric identification systems in publicly accessible spaces for law enforcement purposes, except when necessary for criminal investigations or for the identification, location, or prosecution of criminal suspects in relation to offenses listed in Annex II.[65] Several of these offenses – such as "trafficking in human beings", "sexual exploitation of children and child pornography", "murder, grievous bodily injury", and "rape" – are crimes intrinsically linked to human rights, highlighting the EU's commitment to protecting individuals through an ethical use of AI.[66] Article 77 further reinforces this interpretation by granting authorities tasked with safeguarding fundamental rights the power to access all documentation created or maintained under the AI Act.[67]

On a separate note, the transport sector has been explicitly identified by the European Commission as a critical infrastructure for the purpose of determining the operational contexts of high-risk AI systems.[68] Consequently, it is reasonable to infer that the *providers* and *deployers* of AI systems intended for the shipping industry will be required to comply with the AI Act when their activities affect the European Union territory, ensuring that their practices align with human rights standards. The AI Act's influence on maritime law is further evidenced by the explicit inclusion of the "unlawful seizure of aircraft or ships" among the criminal offenses that justify the use of AI for law enforcement purposes.[69] Addi-

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**64.** Ibid.

**65.** Ibid., Article 5(1)(h).

**66.** Ibid, Annex II.

**67.** Ibid., Article 77 (1).

**68.** European Commission (n 53).

**69.** OJ L, 2024/1689 (n 10), Annex II.

tionally, the Act refers to Directive 2014/90/EU on marine equipment as a relevant source of European Union law when assessing high-risk AI systems that serve as safety components of products or systems.[70] On these grounds, it may be inferred that several provisions of the AI Act are inspired by human rights considerations, while also targeting key actors and activities within the maritime industry.

The AI Act will become fully effective in August 2026.[71] However, the EU's concern regarding the "unacceptable risks associated with the use of AI in certain ways" has led to the anticipation of the Act's prohibitions and general provisions, which – as specified by the Regulation – apply as of February 2025.[72] Meanwhile, the shipping industry is already employing AI across various activities. Most notably, AI is driving the growth of autonomous navigation, which has, in turn, prompted regulatory efforts by the IMO.

## 3.2 Autonomous navigation and the ongoing development of a "MASS" Code

Most existing maritime legislation rests on the assumption that every vessel must be operated by a human crew. However, the emergence of AI is disrupting this paradigm by enabling the development of autonomous ships, which are poised to reshape the global shipping and shipbuilding industries by delegating tasks traditionally performed by humans to technological systems.[73] The maritime sector's increasing shift toward autonomous navigation is reflected in the growth of the associated mar-

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**70.** Ibid., Annex II, para (49).

**71.** Ibid., para (179) and Article 113.

**72.** Ibid.

**73.** Mohammad Riyadh, 'Transforming the Shipping Inustry with Autonomous Ships and Artificial Intelligence' (2024) 3(2) Maritime Park: Journal of Maritime Technology and Society, 81-82.

ket, which recorded a revenue share exceeding USD 89 million in 2021 and is projected to grow at a compound annual growth rate (CAGR) of 6.81% through 2031.[74]

In light of this, the IMO has acknowledged the pressing need to develop a regulatory framework for the application of AI in the decision-making processes underpinning autonomous navigation.[75] With the aim of enforcing a mandatory Maritime Autonomous Surface Ships (MASS) Code by 2032 (preceded by a non-mandatory code currently scheduled to come into effect in 2026), the IMO established a MASS Joint Working Group (JWG) and is conducting legal studies with the support of its member States.[76] In particular, in 2021 the IMO completed a regulatory scoping exercise to assess the applicability of existing IMO legal instruments to autonomous navigation. This exercise resulted in the identification of vessels corresponding to four possible degrees of autonomy, which may be outlined as follows:

1. Ships with automated processes and decision-support systems, but with crew on board capable of taking control if necessary;
2. Remotely controlled ships operated from another location, with seafarers on board who can assume control if required;
3. Remotely controlled ships without crew on board, operated entirely from a remote location; and

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**74.** Thor Maalouf and Julia Norsetter, "Big waves: global autonomous ship market on the rise" (*ReedSmith Ship Law Log,* 8 March 2024), available at <<https://www.shiplawlog.com/2024/03/08/big-waves-global-autonomous-ships-market-on-the-rise/>>.

**75.** IMO, 'Autonomous ships: regulatory scoping exercise completed' (25 May 2021), available at <<https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx#:~:text=The%20Maritime%20Safety%20Committee%20(MSC,(MASS)%20could%20be%20regulated>>.

**76.** IMO, 'Autonomous shipping', available at <<https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx >>; and Barbara Stepien, 'Navigating New Waters: IMO'S Efforts to Regulate Autonomous Shipping' (2024) 23(3) Chinese Journal of International Law, 610-612.

4. Fully autonomous ships, equipped with operating systems capable of making decisions and selecting courses of action independently, without any crew on board.[77]

While this classification is likely to serve as a foundational element of the forthcoming MASS Code, its practical implications raise complex legal considerations. The interplay between AI and the existing regulatory frameworks and maritime safety standards – which were developed for traditional, crew-operated vessels – is a delicate one, as the current laws will have to undergo changes in order to accommodate autonomous ships.[78]

Moreover, while autonomous shipping has significantly advanced, technologies such as sensors and decision-making algorithms are not infallible, making it difficult for stakeholders to place a total and unwavering trust in these tools, especially with regards to maritime safety.[79] In this regard, the implementation of higher degrees of autonomy also prompts concerns over the attribution of legal liability in cases of malfunction or accidents. The current international legal framework lacks specific norms addressing the distribution of responsibility among the actors involved, such as AI system manufacturers, ship operators and shipowners when decision-making functions are delegated to AI tools.[80] In such scenarios, the traditional rules governing liability become increasingly difficult to apply, especially where human involvement is limited or entirely absent.[81]

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**77.** IMO, MSC 1/ Circ. 1638, Outcome of the Regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS) (Adopted 3 June 2021).

**78.** Riyadh (n 73) 83-84.

**79.** Ibid.

**80.** Linlin Chen, 'Maritime rights, obligations, and liabilities of intelligent ships from the perspective of risk distribution' (2023) 7(4) Taylor & Francis Group, Journal of International Maritime Safety, Environmental Affairs and Shipping, 9-10.

**81.** Ibid.

AI's impact on maritime labour should also not be underestimated, as the evolving role of seafarers underscores the necessity for adapted training and preparedness to engage with and operate alongside new technologies. Some scholars have begun to advocate the formal integration of AI modules in maritime education programmes as an essential step to project maritime professions into the future and equip seafarers with the necessary skills to face an increasingly automated maritime domain.[82]

Against this backdrop, the JWG observed that there should always be a "human master" responsible for all modes of navigation.[83] Accordingly, the master of an autonomous vessel – whether located on board or operating remotely – should always retain the ability to intervene directly when necessary, regardless of the vessel's level of autonomy.[84] In practice, this is likely to result in the implementation of flexible and dynamic degrees of autonomy, calibrated in response to contextual factors such as geographic location, maritime traffic density, navigational hazards, and the requirements of coastal or port States.[85] In other words, at least in the foreseeable future, the degree of navigational autonomy will likely vary based on operational parameters and applicable legal standards. Furthermore, Secretary-General Kitack Lim has emphasised that technological innovations must be matched by evolving IMO standards to "ensure the

**82.** Sergey Karianskyi, "Artificial Intelligence in Maritime Transport" (Institute of Marine Engineering, Science and Technology, 30 April 2025), available at <<https://www.imarest. org/resource/mp-artificial-intelligence-in-maritime-transport.html>>; Elham Karimi, Jennifer Smith, Randy Billard and Brian Veitch, 'AI-based adaptive instructional systems for maritime safety training: a systematic literature review' (2024) 4 Discover Artificial Intelligence 51, available at <<https://doi.org/10.1007/s44163-024-00153-0>>.

**83.** IMO Repository, Joint MSC-LEG-FAL Working Group on MASS, 2nd session, Report of the Joint Working Group, MASS-JWG 2/WP.1, 21 April 2023, Point 13, 4.

**84.** Ibid.

**85.** Murat Sumer, 'Applicability of the right of innocent passage to maritime autonomous surface ships: Exploring the potential role of advisory opinions', in Pierandrea Leucci and Ilaria Vianello (eds.) *ASCOMARE Yearbook on the Law of the Sea. Volume 3 – Maritime Security, New Technology and Ethics* (Luglio Editore 2023) 158-159.

safe, secure and environmentally sound operation of remotely operated and autonomous vessels".[86] Therefore, the forthcoming MASS Code faces the complex task of balancing diverse operational, legal, and safety-related considerations.

Meanwhile, the deployment of AI in the shipping sector is progressing at a significantly faster pace than the corresponding regulatory developments. In March 2023, the M/V *Yara Birkeland* – the world's first fully electric, autonomous, and zero-emission container vessel – completed its inaugural voyage within Norwegian waters.[87] Other automated vessels are following suit, undergoing operational trials across various jurisdictions, facilitated in part by the IMO's issuance of Interim Guidelines for MASS trials.[88] Concurrently, the maritime industry is increasingly integrating AI-based technologies into conventional vessels, generating substantial improvements in navigational efficiency – developments that are also likely to affect the protection and promotion of human rights at sea.

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**86.** IMO, "Symposium on Making headway on the IMO MASS Code" (*International Maritime Organization)*, available at <<https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/Symposium-on-"Making-headway-on-the-IMO-MASS-Code"-.aspx>>.

**87.** Yara International ASA, 'Yara Birkeland, two years on' (*Yara International Asa*, 28 April 2024), available at <<https://www.google.com/search?client=safari&rls=en&q=yara+birklenad+two+years+on&ie=UTF-8&oe=UTF-8&sei=c0CaZ-rRIp6fi-gPocauwQk>>.

**88.** IMO, MSC 1/Circ. 1604, Interim Guidelines for MASS Trials (adopted 14 June 2019); by way of illustration: Austal, "Austal Australia Completes Sea Trials for Royal Australian's Navy's Patrol Boat Autonomy Trial" (*Austal,* 23 April 2024), available at: https://www.austal.com/news/austal-australia-completes-sea-trials-royal-australian-navys-patrol-boat-autonomy-trial; Manuela Perrone, 'Navi senza equipaggio, al porto di Livorno si sperimentano le manovre digitali', *Il Sole 24 Ore* (22 March 2024) available at <<https://www.ilsole24ore.com/art/navi-senza-equipaggio-porto-livorno-si-sperimentano-manovre-digitali-AF-A5PX9C>>; The Nippon Foundation, 'The Nippon Foundation MEGURI2040 Fully Autonomous Ship Program Introduced at Meeting of IMO's Maritime Safety Committee' (*The Nippon Foundation*, 12 December 2024), available at <<https://en.nippon-foundation.or.jp/news/articles/2024/20241215-107557.html>>.

## 3.3 Opportunities for the safeguard
   of human rights at sea through AI

The increasing employment of AI technologies into the maritime sector responds to a range of long-standing challenges, including the need for improved operational efficiency, enhanced safety, and greater environmental sustainability.[89] In addressing these concerns, AI has already demonstrated its potential to produce significant positive outcomes, as evidenced by several of its current applications. These developments, in turn, present promising opportunities for the protection and promotion of fundamental human rights at sea.

One of the primary drivers behind the growing demand for automation in maritime transport is AI's capacity to optimise voyages. For instance, AI-powered sensors facilitate real-time access to performance data, while decision-support platforms that integrate proprietary information from shipping companies with publicly available data can generate rapid, legally accurate responses to queries from crew members or shore-based teams; this enables more efficient and informed decision-making.[90] In addition, AI can forecast the logistical and financial consequences of various scenarios – such as route deviations, adverse weather conditions, or unscheduled port calls – thus promoting safer and more efficient navigation.[91]

Given that the principal causes of maritime accidents continue to include human error, equipment failure, adverse weather, and outdated or incomplete navigational information (such as uncharted obstacles), the enhanced accuracy offered by AI-based systems holds considerable

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**89.** MacDonald and Martin (n 7) 3.
**90.** Ibid., 12 and 15.
**91.** Ibid., 17.

promise for improving maritime safety.[92] This, in turn, strengthens the protection of the health and lives of seafarers, passengers, and others involved. In this regard, the maritime technology company OrcaAI reported a 33% reduction in close-quarters incidents across 267 vessels, based on data collected over 15 million nautical miles through its AI-powered situational awareness platform.[93]

AI-driven voyage optimisation can further significantly enhance energy efficiency in maritime operations.[94] Advanced algorithms are capable of monitoring a vessel's energy consumption in real time and recommending strategies for its reduction, such as route recalibration or operational adjustments.[95] This application is particularly salient in light of recent legislative developments at the European Union level – most notably, Regulation (EU) 2023/1805 (the "FuelEU Maritime" Regulation)[96] – which place increasing obligations on States and industry actors to reduce greenhouse gas emissions.[97] In this context, AI has the potential to contribute meaningfully to the reduction of marine pollution and the advancement of the right to a clean, healthy, and sustainable environment, formally acknowledged as a human right by the United Nations

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**92.** Yong Bai and Jeom Kee Paik, *Risk Assessment and Management for Ships and Offshore Structures* (Elsevier 2024) 285.

**93.** The Digital Ship, 'ORCA'S navigation situation awareness platform leads to 33% reduction in close encounters' (*The Digital Ship*, 22 February 2024), available at <<https://thedigitalship.com/news/electronics-navigation/orca-s-navigation-situation-awareness-platform-leads-to-33-reduction-in-close-encounters/>>.

**94.** Macdonald and Martin (n 7) 15.

**95.** Ibid.

**96.** OJ L 234, 22.9.2023, p. 48–100.

**97.** Lloyd's Register, The Monohakobi Technology Insitute, NYK Line, "The benefits and opportunities of data-driven condition-based maintenance" (*Lloyd's Register*, 2024), 13, available at <<https://www.lr.org/en/knowledge/research-reports/2024/data-driven-condition-based-maintenance/>>.

General Assembly in 2022.[98]

Another key area in which the shipping industry is benefiting from AI is data-driven, condition-based maintenance and remote diagnostics.[99] AI algorithms can analyse data from on-board sensors to predict equipment failures before they occur, thereby enabling pre-emptive maintenance operations.[100] This proactive approach not only extends the lifespan of equipment but also enhances safety standards – particularly in instances where preventing mechanical breakdowns mitigates the risk of accidents and casualties.

In addition, AI has the potential to become a critical asset in search and rescue (SAR) operations. AI-powered sensors and data analysis tools can detect distress signals and accurately determine the location of vessels or individuals at sea with greater speed and precision than traditional methods.[101]Furthermore, by processing large volumes of environmental data, AI can help predict and mitigate potential risks associated with SAR missions, thereby improving their overall effectiveness.[102] This application is particularly relevant in light of the ongoing phenomenon of mass migration across maritime routes. A notable example is the Emergency Integrated Lifesaving Lanyard (EMILY), an AI-enabled, remotely operated rescue device resembling a buoy, which was successfully deployed by the Greek Coast Guard to assist migrants in the Aegean Sea.[103] More recently, in Valencia, Spain, an AI-based drone played a pivotal

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**98.** UNGA Res A/76/L/75 (26 July 2022).

**99.** Lloyd's Register, The Monohakobi Technology Insitute, NYK Line (n 97) 13.

**100.** Ibid.

**101.** Young-Gyu Lee, Chang-Hee Lee, Young-Hun Jeon and Jae-Hwan Bae, 'Transformative Impact of the EU AI Act on Maritime Autonomous Surface Ships' (2024), 13(5) Laws, 68.

**102.** Ibid.

**103.** Warren Duffie, 'From Whales to Silver Foxes to Refugees: Emily Robot is a Lifesaver' (*Office of Naval Research*, 5 May 2016), available at <<https://www.onr.navy.mil/media-center/news-releases/whales-silver-foxes-refugees-emily-robot-lifesaver>>.

role in rescuing a boy at risk of drowning, detecting and reaching him faster than lifeguards and delivering an inflatable life vest that kept him afloat until help arrived.[104]

Similar considerations apply to law enforcement at sea. AI-based tools such as sensors, drones, and automated watchkeepers can facilitate the detection and monitoring of vessels suspected of involvement in activities such as forced labour, illegal fishing, piracy, and human trafficking.[105] Crucially, AI's capacity to accurately track vessel positions may help address longstanding challenges related to the identification of jurisdictional boundaries at sea, which have often constituted an obstacle to the prosecution of offenders. Crime prevention efforts may also be bolstered through the use of AI-powered onboard surveillance technologies, which can deter unlawful conduct and support the collection of reliable evidentiary material. As previously discussed, the AI Act expressly permits the use of real-time remote biometric identification in combating crimes linked to human rights violations, potentially including those occurring at sea, thereby setting a precedent that could influence future legislation on maritime AI applications.

In this context, a practical illustration can be found in Regulation (EU) 2023/2842, which amends the existing legal framework governing the Common Fisheries Policy of the European Union.[106] This regulation introduces new rules targeting fishing practices involving forced labour and explicitly recognises the role of technology in addressing such viola-

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**104.** Charlie Devereux, 'Drone rescues boy caught in riptide off beach in Spain' (*The Times*, 25 July 2022), available at <<https://www.thetimes.com/world/europe/article/drone-rescues-boy-caught-in-riptide-off-beach-in-spain-lfbsbh3nb>>.

**105.** Mark Floyd, 'Researchers to use Artificial Intelligence "big data", to locate and predict crime at sea' (*Oregon State University Newsroom*, 19 December 2018), available at <<https://news.oregonstate.edu/news/researchers-use-artificial-intelligence-"big-data"-locate-and-predict-crime-sea>>.

**106.** OJ L, 2023/2842, 20.12.2023.

tions.[107] Fishing vessels are now required to install systems such as vessel monitoring systems, automatic identification systems, and remote electronic monitoring with closed-circuit television, and to regularly transmit data regarding their operations to flag States.[108] While these technologies are not new, many are now available in AI-enhanced versions that operate through machine learning or can be augmented with AI to improve their accuracy and operational effectiveness.

Meanwhile, in the announcement letter for a new study presented by the FAO during the fifth session of the Joint FAO/ILO/IMO Working Group on Illegal, Unreported, and Unregulated Fishing and Related Matters (held in Geneva in 2024), the Secretariat noted that "advancements in data technology, particularly through the analysis of fishing vessels" patterns using various sources of information, may significantly enhance the detection of labour exploitation.[109] This statement further corroborates AI's potential to support the safeguarding of human rights at sea.

## 3.4 Current and future challenges related to the use of AI

At the same time, increasing concerns have emerged regarding the human, ethical, and economic costs associated with the advantages offered by AI. While this technology presents significant opportunities, it also introduces substantial challenges. Among the most pressing issues are

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**107.** Pierandrea Leucci, 'Fishing activities conducted with the use of forced labour under the revised EU fisheries control system: Improving maritime security through control, inspection and technology', in Pierandrea Leucci and Ilaria Vianello (eds.) *ASCOMARE Yearbook on the Law of the Sea. Volume 3–Maritime Security, New Technology and Ethics* (Luglio Editore 2023) 278.

**108.** Ibid., 294.

**109.** FAO Secretariat, 'Safety and Working Conditions on the Fishery Sector', FAO/ILO/IMO Joint Working Group on IUU Fishing and related matters, 5th session, 8-12 January 2024, Geneva.

those related to the nature and governance of data, a lack of transparency in algorithmic decision-making, the potential for social and economic discrimination, and the absence of a harmonised international legal framework.

Data serves as the foundational element of most AI-based systems, including algorithms.[110] However, ensuring access to high-quality, reliable data remains a central obstacle to the effective deployment of AI. When AI systems are fed with suboptimal or obsolete data, their performance may be compromised, potentially resulting in serious errors or user-related difficulties.[111] This is especially evident in the case of autonomous navigation: inadequate data collection or irregular updates of the onboard AI systems may cause equipment malfunctions or even lead to maritime accidents.

The issue is further compounded by the "black box" effect, a concept frequently discussed in AI literature.[112] This term refers to the inherent unpredictability of machine learning, which is AI's capacity to observe its environment and process the information it receives.[113] The outcomes of these processes are not predetermined, making them difficult to foresee. Consequently, the functioning of AI systems remains largely opaque, even to their creators and programmers. Indeed, current AI systems often fail to articulate the reasoning behind their conclusions in a manner that is fully understandable to humans. As a result, placing absolute trust in AI can be problematic, particularly when sensitive data or the protection of fundamental rights is involved.

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**110.** Macdonald and Martin (n 7) 18.

**111.** Ibid.

**112.** Vasiliki Papadouli, 'Artificial Intelligence's Black Box: Posing New Ethical and Legal Challenges on Modern Societies' in Angelos Kornilakis, Georgios Nouskalis, Themistoklis Tzimas, Vassilis Pergantis (eds.), *Artificial Intelligence and Normative Challenges International and Comparative Legal Perspectives* (Springer International Publishing 2023) 39-64, 41.

**113.** Ibid.

Against this backdrop, the inherent characteristics of the maritime domain – where data availability is generally more limited than in terrestrial environments – underscore the risks posed by AI in terms of opacity and its potential detachment from human rights realities on multiple levels.[114] To date, the development of AI technologies has been predominantly led by experts and institutions based in the Global North, whereas much of the empirical focus of human rights research remains centred on the Global South.[115] This geographic and epistemic divide is particularly significant in data-driven investigations, which are frequently conducted remotely, often relying on data gathered through technological systems or provided by third parties closer to the events in question.[116] Such detachment increases the risk of analytical bias and misinterpretation. For instance, scholars have criticised remote sensing and observation technologies for failing to correctly identify or distinguish between different onboard activities such as fishing, maintenance, or medical operations, demonstrating the necessity of local cooperation and context-specific insight to ensure an accurate interpretation of events.[117]

Furthermore, the high cost and technological complexity associated with the most advanced AI tools underscore their uneven accessibility. These tools are largely concentrated in the hands of economically

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**114.** Jamie Hancock, Ruoyun Hui, Jatinder Singh, Anjali Mazumder, 'Trouble at sea: Data technology and challenges for maritime human rights concerns' (2024) The 2024 ACM Conference on Fairness, Accountability Transparency - FAccT '24, June 3-6, Rio de Janeiro, Brazil, ACM Digital Library, 992, available at <<https://dl.acm.org/doi/pdf/10.1145/3630106.3658950>>.

**115.** Eman El-Sherbiny, 'Symposium on Fairness, Equality and Diversity in Open Source Investigations: Why Tapping Into Open Source Intelligence Still Comes at a Cost for Researchers in the Global South' (*Opinio Juris*, 6 February 2023), available at <<http://opiniojuris.org/2023/02/06/symposium-on-fairness-equality-and-diversity-in-open-source-investigations-an-introduction/>>.

**116.** Hancock et al. (n 114) 992.

**117.** Ibid., 995.

powerful actors, thereby exacerbating existing global disparities.[118] This inequality is particularly concerning in view of the fact that marginalised or underdeveloped communities – often the most vulnerable to human rights abuses – stand to benefit most from AI's protective potential. The unequal distribution of AI-related capabilities creates an asymmetry in both protection and agency, reinforcing structural imbalances. A further issue in this respect is the fact that much of the training data used in contemporary AI systems originates from developed countries, and may embed culturally specific assumptions or biases.[119] When such data is employed without sufficient contextual calibration, it can lead to discriminatory or inappropriate outcomes in diverse maritime settings.

These issues are particularly pertinent to SAR missions and the management of migration at sea. Several actors involved in these domains – including the European Border and Coast Guard Agency (Frontex) – have begun to integrate advanced technologies such as Extended Reality (XR) systems, often supported by AI.[120] While such tools may enhance operational efficiency, they also raise substantial human rights concerns that must not be underestimated. Given the complex nature and provenance of data processed by AI systems, the risk of algorithmic bias – and its potential to perpetuate or amplify discriminatory outcomes – has been extensively acknowledged in academic literature.[121] Scholars have documented how algorithmic decision-making may entrench existing

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**118.** Philip Schellekens and David Skilling, 'Three Reasons Why AI May Widen Global Inequality' (*Center For Global Development*, 17 October 2024), available at <<https://www.cgdev.org/blog/three-reasons-why-ai-may-widen-global-inequality>>.

**119.** Hancock et al. (n 114) 994-995.

**120.** Francesca Romana Partipilo, 'Getting rescued by RoboCop? Legal and ethical challenges of the use of extended reality in Frontex's search and rescue operations at sea', in Pierandrea Leucci and Ilaria Vianello (eds.) *ASCOMARE Yearbook on the Law of the Sea. Volume 3–Maritime Security, New Technology and Ethics* (Luglio Editore 2023) 213, 214.

**121.** Ibid., 234.

patterns of exclusion based on race, ethnicity, language, nationality, or religion.[122] In this regard, the outputs of AI systems could shape the conduct and responses of SAR personnel, giving rise to significant ethical dilemmas. Moreover, technological fallibility presents further risks: for instance, testing conducted by the NGO Space-Eye using satellite-based AI tools revealed a troubling number of "false negatives", wherein small migrant vessels went undetected.[123] Clearly, such oversights could have life-threatening consequences.

The lack of a universal, comprehensive legal framework for the governance of AI intensifies these challenges. While many governments and international organisations remain in the early stages of regulatory development, the rapid pace of AI innovation continues to outstrip existing oversight mechanisms. As a result, the dual-use nature of AI – its capacity to be harnessed for both protective and harmful purposes – has become increasingly evident. Improper deployment of AI surveillance tools, for example, could lead to violations of privacy and exacerbate risks for vulnerable individuals.[124] In this regard, allegations of AI-enabled facial recognition technologies being used by Chinese authorities to monitor, track, and prosecute Uyghurs – a predominantly Muslim minority in Xinjiang – illustrate the profound dangers of such practices.[125] In the maritime domain, NGOs have expressed concern about Frontex's use of drones in the Mediterranean, alleging that surveillance

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**122.** Matthias Leese (et al.), 'Data matters: The politics and practices of digital border and migration management (2022) 27 Geopolitics 5.

**123.** Elli Wittmann, 'Creating a dataset to spot refugee boats in the Mediterranean' (*Medium,* 22 June 2021), available at <<https://medium.com/data-science/creating-a-dataset-to-spot-refugee-boats-in-the-mediteranean-449e86e2d4b2>>.

**124.** Hancock et al. (n 114) 991.

**125.** Paul Mozur, 'One Month, 500,000 face scans: How China is using AI to Profile a Minority', *The New York Times*, 14 April 2019, available at <<https://www.nytimes.com/2019/04/14/technology/china-surveillance-artificial-intelligence-racial-profiling.html>>.

data has facilitated interceptions by Libyan authorities, resulting in the forced return of migrants in contravention of the principle of non-refoulement.[126]

Similar apprehensions apply to the growing threat of AI-facilitated supply chain attacks in the cybersecurity realm.[127] Machine learning algorithms have been shown to bypass traditional security measures, deploying sophisticated malware or exploiting vulnerabilities to extract sensitive personal data.[128] Such breaches could expose victims to multiple risks, including identity theft, surveillance, or coercion. Furthermore, the opacity of AI systems may enable the concealment of ongoing abuses within global supply chains – such as forced labour, human trafficking, or systemic discrimination – by obscuring patterns that would otherwise be detectable through human oversight.

# 4. Conclusion

This article offered a preliminary overview of the relationship between human rights law and the law of the sea, suggesting that – despite their reciprocal, implicit references in treaty and case law – the international legal framework would benefit from their clearer statutory connection. While the GDHRS represents a remarkable effort in this regard, it would be desirable for it to receive a formal endorsement, or for States to fol-

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**126.** Human Rights Watch, 'EU: Frontex Complicit in Abuse in Libya: Aerial Surveillance is Enabling Interceptions, Return of Migrants to Harm' (*Human Rights Watch*, 12 December 2022), avaialble at <<https://www.hrw.org/news/2022/12/12/eu-frontex-complicit-abuse-libya>>.

**127.** Oladoyin Akinsuli, 'AI-Powered Supply Chain Attacks: A Growing Cybersecurity Threat' (2024) 8 Issue 3 IRE Journals, 696.

**128.** Ibid.

low its example and integrate the law of the sea with human rights law through global legal efforts.

This is particularly true in view of the staggering growth of AI, even in maritime contexts. Certainly, the AI Act constitutes a legal milestone as the first comprehensive regulatory framework on AI, and includes references to human rights and to the maritime legal domain that are bound to shape the employment of new technologies at sea. Moreover, while any AI regulation depends on a careful balance of multiple interests, the IMO's ongoing work on a Code specifically addressing autonomous ships is as promising as it is necessary, given the growth of the respective market.

Nonetheless, the issues surrounding AI's impact on the safeguard of human rights at sea are of increasing urgency. Indeed, the use of AI at sea appears to present a maritime landscape both illuminated by opportunities and shadowed by potential risks. Each positive impact that AI might have on the protection of human rights at sea seems to be counterbalanced by a corresponding danger, depending on how the relevant technologies are applied. The contribution highlighted this tension through practical examples of advantages (such as those related to voyage optimisation and enhanced accuracy in SAR operations) and shortcomings (including a general lack of transparency and the possible hazards for the cybersecurity of individuals) stemming from AI applications at sea. In any case, AI has firmly established its place in a world increasingly required to adapt to its rapid growth. Furthermore, the benefits that could arise from its appropriate use are too significant to justify its blanket demonization.

While the evidence indicates that the protection of fundamental rights at sea would benefit from a binding international legal framework that regulates the intersection of the law of the sea and human rights law, it is difficult to envision such an effort without addressing AI's role. Overall, an instrument as powerful as AI urgently requires more global

regulatory initiatives that both harness its potential and mitigate its risks, even with regards to the safeguard of human rights. Until such frameworks are developed, the impact of AI at sea rests in the hands of States and stakeholders with access to the relevant innovations, who must, it is hoped, navigate these technological waters with human rights as their guiding compass.