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Artificial Intelligence Integration in UNCLOS Implementation for Resolving Maritime Disputes in South China Sea

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Abstract: This research investigates the integration of Artificial Intelligence (AI) into the implementation of the United Nations Convention on the Law of the Sea (UNCLOS) to enhance the effectiveness of maritime dispute resolution, particularly in the South China Sea—a region marked by overlapping territorial claims and geopolitical tensions. The objective of this study is to explore how AI technologies can support legal mechanisms under UNCLOS in resolving disputes more efficiently, transparently, and equitably. Using a normative legal research method with a conceptual and statutory approach, this study examines existing legal frameworks, analyzes the potential of AI-based tools such as machine learning, big data analytics, and automated decision-making systems, and evaluates their relevance in UNCLOS enforcement and dispute resolution mechanisms. The findings indicate that AI can play a transformative role in various aspects: real-time maritime monitoring, evidence verification, predictive modeling of potential conflicts, and assisting international tribunals in the interpretation and application of UNCLOS provisions. Furthermore, AI can facilitate trust-building among stakeholders by ensuring transparent data processing and minimizing human bias. The study concludes that while the integration of AI into UNCLOS implementation poses regulatory, ethical, and technical challenges, it also presents a timely and innovative opportunity to modernize international maritime governance. As an academic contribution, this research offers a forward-looking framework for the digital transformation of international legal instruments and encourages interdisciplinary dialogue between law, technology, and policy in addressing complex maritime disputes such as those in the South China Sea.

Keywords: AI, Maritime Disputes, UNCLOS, South China Sea

1. Introduction

The South China Sea is a strategic region that holds not only geographical significance but also immense economic, political, and military value.[1] More than one-third of global trade passes through this area each year, making it a vital artery of the global economy. However, this potential is accompanied by complex territorial disputes involving several countries such as China, Vietnam, the Philippines, Malaysia, Brunei, and Indonesia, all of which assert overlapping maritime claims based on their respective interpretations of history, sovereignty, and international law.[2] These conflicting claims have triggered long-standing tensions and have at times led to military incidents, violations of territorial boundaries, and a race to develop infrastructure on the contested islands. The United Nations Convention on the Law of the Sea (UNCLOS),[3] as a widely recognized international legal framework, is supposed to serve as the primary reference for resolving these conflicts.[4] Unfortunately, in practice, the implementation of UNCLOS still

[1] Rob McLaughlin, "The Law of the Sea and PRC Gray-Zone Operations in the South China Sea," *American Journal of International Law* 116, no. 4 (October 27, 2022): 821–35, https://doi.org/10.1017/ajil.2022.49.
[2] Yongping Yu et al., "Analysis of the Hydraulic Fracturing Mechanism and Fracture Propagation Law With a New Extended Finite Element Model for the Silty Hydrate Reservoir in the South China Sea," *Journal of Natural Gas Science and Engineering* 101 (May 2022): 104535, https://doi.org/10.1016/j.jngse.2022.104535.
[3] Sara McLaughlin Mitchell and Andrew P. Owsiak, "Judicialization of the Sea: Bargaining in the Shadow of UNCLOS," *American Journal of International Law* 115, no. 4 (October 18, 2021): 579–621, https://doi.org/10.1017/ajil.2021.26.
[4] Bingying Dong, Lowell Bautista, and Ling Zhu, "Navigating Uncharted Waters: Challenges and Regulatory Solutions for Flag State Jurisdiction of Maritime Autonomous Surface Ships Under UNCLOS," *Marine Policy* 161 (March 2024): 106039, https://doi.org/10.1016/j.marpol.2024.106039.

faces significant challenges. Some states, such as China, continue to reject unfavorable international arbitration rulings and prefer bilateral negotiations or military strength to assert their claims.[5]

Technological developments,[6] particularly in the field of Artificial Intelligence (AI), offer new hope for reforming the international legal system, especially in the context of maritime dispute resolution. AI technology has the capacity to manage and analyze large volumes of big data with high efficiency, process satellite imagery in real time, identify patterns of territorial violations,[7] and even predict potential conflicts based on geographical and political variables. Within the UNCLOS framework, AI can be utilized to strengthen maritime surveillance systems, detect illegal vessels, and monitor military activities in disputed areas with high accuracy and speed. Furthermore, AI can assist in drafting legal documents, analyzing precedents of similar cases, and supporting decision-making in international arbitration by drawing from vast and standardized databases. However, the application of AI in the law of the sea remains very limited due to concerns about algorithmic bias, a lack of data harmonization among states, and the absence of international regulations explicitly governing the integration of such technologies. Therefore, there is a pressing need for cross-national and interdisciplinary collaboration to formulate guidelines that regulate the ethical and legal use of AI in support of UNCLOS implementation.[8]

Maritime dispute resolution has long centered on traditional approaches that emphasize political dynamics, international legal frameworks, and the historical context of inter-state relations.[9] Most studies in this field tend to focus on interpretations of international conventions such as the United Nations Convention on the Law of the Sea (UNCLOS), the geopolitical positioning of disputing states, and the historical construction of territorial sovereignty claims. While these approaches provide an essential conceptual foundation, they often fall short of addressing the contemporary complexities of maritime conflict resolution, particularly in the highly dynamic South China Sea region. The disputes in this area are not solely about maritime boundary delimitation or sovereign entitlements, but have evolved into strategic issues involving regional security, natural resource exploitation, and the authority of international law. Ironically, despite rapid advances in digital technology—especially in the field of Artificial Intelligence (AI)—the integration of such innovations into maritime dispute resolution discourse and practice remains minimal. AI holds immense potential in enhancing maritime data analysis, enabling real-time monitoring of disputed waters, detecting violations of maritime law, and efficiently analyzing relevant international legal precedents. In this context, AI should not be viewed merely as a technical tool, but as a strategic element capable of overcoming human limitations and accelerating conflict resolution processes with higher standards of objectivity and transparency.

This study aims to contribute meaningfully to the discourse on international legal reform by exploring the integration of Artificial Intelligence into the implementation of UNCLOS, with a specific focus on the resolution of maritime disputes in the South China Sea. The research adopts an interdisciplinary approach that merges international legal analysis, regional geopolitical dynamics, and advancements in information technology to formulate an adaptive framework for digital-era governance. By examining the various potentials of AI in supporting international arbitration mechanisms—such as data-driven legal document generation, predictive modeling of maritime conflicts, and thematic analysis of maritime legal practices—this study not only presents new perspectives but also offers concrete models for problem-solving. Integrating AI into the law of the sea system can also enhance legal certainty and accountability by presenting verifiable evidence, reducing subjectivity in legal interpretation, and minimizing power

[5] Jiangyu Wang, "Legitimacy, Jurisdiction and Merits in the South China Sea Arbitration: Chinese Perspectives and International Law," *Journal of Chinese Political Science* 22, no. 2 (June 18, 2017): 185–210, https://doi.org/10.1007/s11366-017-9472-0.

[6] Douglas Guilfoyle, "The Rule of Law and Maritime Security: Understanding Lawfare in the South China Sea," *International Affairs* 95, no. 5 (September 1, 2019): 999–1017, https://doi.org/10.1093/ia/iiz141.

[7] Kevin Chan, "A New Era of Maritime Arbitration: Ex Machina Determinations," *Journal of International Arbitration* 40, no. Issue 5 (October 1, 2023): 521–50, https://doi.org/10.54648/JOIA2023022.

[8] Bing Bing Jia, "The Curious Case of Article 281: A 'Super' Provision within UNCLOS?," *Ocean Development & International Law* 46, no. 4 (October 2, 2015): 266–80, https://doi.org/10.1080/00908320.2015.1089736.

[9] Rowland J Harrison, "Article 82 of UNCLOS: The Day of Reckoning Approaches," *The Journal of World Energy Law & Business* 10, no. 6 (December 1, 2017): 488–504, https://doi.org/10.1093/jwelb/jwx022.

asymmetries between disputing states. In this regard, AI is positioned as an augmentative—rather than substitutive—legal assistant, tasked with expediting processes, broadening access to reliable data, and deepening the quality of international legal judgments. This research aspires to serve as a strategic reference for stakeholders—including legal scholars, policymakers, and international dispute resolution bodies—in developing a more responsive, innovative, and relevant approach to the law of the sea in addressing 21st-century challenges. In doing so, digital transformation through AI integration emerges not only as a symbol of legal modernization but also as a vital bridge toward more just, efficient, and sustainable enforcement of maritime law in global governance.

2. Method

This study employs a normative juridical approach supported by an empirical dimension in analyzing the settlement of maritime disputes in the South China Sea through the implementation of UNCLOS and the integration of Artificial Intelligence (AI) technologies. The normative analysis is conducted using primary legal sources such as UNCLOS, decisions from the Permanent Court of Arbitration (particularly the 2016 ruling between the Philippines and China), and national regulations of the disputing countries. A case approach is used to examine relevant legal precedents, while a comparative perspective highlights how AI is beginning to be adopted in the international legal systems of other nations. A limited sociological approach is also applied, given the geopolitical dynamics and resistance to technology adoption in dispute resolution mechanisms. The research population consists of states directly involved in South China Sea territorial disputes, with the sample focusing on key stakeholders such as international law scholars, legal tech experts, and representatives of international arbitration institutions. Research instruments include interview guides and document analysis sheets developed to systematically collect and classify data from various sources.

Data collection is carried out through in-depth interviews, document analysis, and limited observation of international forums discussing the South China Sea, legal digital transformation, and AI in dispute resolution. Field research was conducted in Jakarta and Kuala Lumpur over a two-month period, as both cities serve as regional hubs for legal academia, policy institutions, and international maritime law advocacy. Key informants include scholars from leading universities, international legal practitioners, and foreign policy analysts. Data triangulation is used to verify the reliability of findings, by comparing interview responses with official documents and scholarly literature. The analytical technique applied is qualitative thematic analysis, focusing on the interrelation between the effectiveness of maritime law, the potential integration of AI, and its implementation challenges in politically sensitive regions like the South China Sea. Through this approach, the study aims to produce findings that are both academically rigorous and practically relevant for the development of a technology-integrated international maritime legal system.

3. Result and Discussion

3.1. The Relevance of UNCLOS 1982 in the South China Sea Dispute

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) is a pivotal milestone in the development of international maritime law,[10] providing a comprehensive legal framework for states to define, manage, and safeguard their maritime spaces.[11] UNCLOS is not merely a collection of technical norms but a globally accepted consensus born out of the necessity to establish order, fairness, and sustainability in the use of marine resources.[12] In this regard, UNCLOS serves as the legal basis for regulating various aspects such as maritime boundary delimitation, jurisdiction over natural resources,

[10] Konrad Jan Marciniak, "New Implementing Agreement under UNCLOS: A Threat or an Opportunity for Fisheries Governance?," *Marine Policy* 84 (October 2017): 320–26, https://doi.org/10.1016/j.marpol.2017.06.035.

[11] Zenel Garcia and Christine Bianco, "The Impact of Chinese History on Perceptions of the Law of the Sea in the South China Sea," *Territory, Politics, Governance* 13, no. 4 (April 21, 2025): 523–43, https://doi.org/10.1080/21622671.2023.2218427.

[12] Lan Ngoc Nguyen, "Expanding the Environmental Regulatory Scope of UNCLOS Through the Rule of Reference: Potentials and Limits," *Ocean Development & International Law* 52, no. 4 (October 2, 2021): 419–44, https://doi.org/10.1080/00908320.2021.2011509.

international navigation, marine environmental protection, and dispute resolution. As a multilateral instrument ratified by more than 160 countries—including all claimant states in the South China Sea except the United States—UNCLOS contains legally binding provisions that define the rights and obligations of coastal states and users of the high seas.[13] In the highly contested and complex South China Sea, UNCLOS is particularly relevant as it provides a legal yardstick for assessing the legitimacy of territorial claims, as exemplified by the 2016 South China Sea Arbitration ruling.[14] However, the effectiveness of UNCLOS lies not only in its textual existence but also in the willingness of states to recognize and comply with the norms they have collectively agreed upon.

UNCLOS 1982 defines several fundamental concepts in the law of the sea, including baselines, exclusive economic zones (EEZs),[15] and continental shelves, each of which determines the extent of jurisdiction and sovereign rights a coastal state may exercise over its maritime domain. Baselines serve as the reference point from which the breadth of territorial seas, EEZs, and continental shelves is measured. In the South China Sea, the application of these principles has become highly contested, as many states interpret and establish baselines unilaterally based on geopolitical interests and historical narratives. The EEZ, extending 200 nautical miles from the baselines, grants a coastal state sovereign rights to explore and exploit marine resources in the water column and seabed, while ensuring the freedom of navigation for other states. Meanwhile, the continental shelf can extend beyond 200 nautical miles if geologically proven to be a natural prolongation of the landmass, subject to validation by the Commission on the Limits of the Continental Shelf (CLCS).[16] In the South China Sea, the implementation of these concepts is a key source of conflict, particularly due to China's nine-dash line claim, which has been deemed inconsistent with UNCLOS provisions.[17] The rejection of these legal principles has led to diplomatic and military tensions and increased legal uncertainty in the region.

One of the key principles upheld by UNCLOS is the freedom of navigation, which plays a critical role in supporting global economic stability by ensuring the uninterrupted and safe flow of maritime trade. The South China Sea is among the world's busiest sea lanes, with over one-third of global commerce transiting through it annually, including strategic commodities such as oil, gas, and manufactured goods. UNCLOS guarantees the right of innocent passage and transit passage for all states through territorial seas and international straits. However, in practice, the implementation of this principle faces numerous challenges in the South China Sea, especially due to actions by certain states seeking to control or restrict access to disputed waters based on unilateral sovereignty claims. The establishment of military outposts, aggressive maritime patrols, and artificial island construction in contested areas have often led to confrontations with other states exercising their navigational rights. In this context, UNCLOS not only provides legal legitimacy to freedom of navigation but also establishes mechanisms to address violations and balance coastal states' rights with the interests of the international community. The enforcement of this principle has become increasingly crucial in light of the potential for conflict arising from navigational incidents in disputed waters.

The United Nations Convention on the Law of the Sea (UNCLOS) establishes a comprehensive legal

[13] Michael Sheng-ti Gau, "The Interpretation of Article 121(3) of UNCLOS by the Tribunal for the South China Sea Arbitration: A Critique," *Ocean Development & International Law* 50, no. 1 (January 2, 2019): 49–69, https://doi.org/10.1080/00908320.2018.1511083.

[14] Fran Humphries et al., "A Tiered Approach to the Marine Genetic Resource Governance Framework Under the Proposed UNCLOS Agreement for Biodiversity Beyond National Jurisdiction (BBNJ)," *Marine Policy* 122 (December 2020): 103910, https://doi.org/10.1016/j.marpol.2020.103910.

[15] Keyuan Zou and Anastasia Telesetsky, "UNCLOS and Its Contributions to the Development of International Law: An Editorial Note," *Marine Policy* 155 (September 2023): 105703, https://doi.org/10.1016/j.marpol.2023.105703.

[16] Mark E. Rosen, "U.S. International Oceans Law and Policy Interests in the South China Sea Arbitration: Implications for the U.S. Administration in the South China Sea and Elsewhere," *Journal of Chinese Political Science* 22, no. 2 (June 6, 2017): 251–67, https://doi.org/10.1007/s11366-017-9468-9.

[17] Changping Zhao et al., "Economic Stability Analysis of Blue Carbon Cooperation in the South China Sea Region Using Evolutionary Game Model with Weber's Law," *Chinese Journal of Population, Resources and Environment* 18, no. 3 (September 2020): 172–78, https://doi.org/10.1016/j.cjpre.2021.04.007.

framework for the peaceful settlement of maritime disputes,[18] offering multiple mechanisms that include arbitration, adjudication, and mediation. These mechanisms are enshrined primarily in Part XV of the Convention and are designed to provide states with flexible, yet legally binding options to resolve disputes arising from the interpretation or application of the Convention. Arbitration, as provided under Annex VII of UNCLOS, is one of the most frequently used pathways, as it allows for the constitution of an ad hoc tribunal tailored to the specific dispute, ensuring both procedural flexibility and neutrality. A prominent example is the 2016 South China Sea Arbitration between the Philippines and China, which, although boycotted by China, still resulted in a landmark ruling that clarified important aspects of maritime entitlements and environmental obligations. Adjudication, primarily conducted through the International Tribunal for the Law of the Sea (ITLOS) or the International Court of Justice (ICJ), provides a more formal and institutionalized dispute resolution process. ITLOS, headquartered in Hamburg, has been instrumental in several high-profile cases, including those involving prompt release of vessels and provisional measures in environmental disputes. Meanwhile, mediation—although less commonly utilized—is promoted within UNCLOS as a non-binding but constructive method for initiating dialogue and reducing tensions before escalation. The availability of these mechanisms underscores UNCLOS's commitment to the rule of law in international maritime relations, providing states with multiple avenues to address grievances while upholding peace and stability on the seas.

UNCLOS plays a pivotal role in curbing unilateral maritime claims and reinforcing the primacy of international law in the governance of ocean spaces. By clearly defining maritime zones—such as territorial seas, exclusive economic zones (EEZs), and continental shelves—and establishing the rights and duties of coastal and non-coastal states within these zones, UNCLOS seeks to eliminate ambiguity and reduce the scope for excessive or arbitrary claims. This is particularly crucial in geopolitically sensitive regions such as the South China Sea, where overlapping territorial assertions and expansive historical claims have the potential to ignite regional instability. The Convention mandates that any claim must be rooted in legal entitlements as stipulated by the provisions of UNCLOS, rather than based on vague historical narratives or power-based assertions. Through its compulsory dispute settlement mechanisms, UNCLOS discourages the use of coercion or force to settle maritime disagreements, thus fostering a rules-based order that privileges diplomacy and adjudication over military posturing. Moreover, by requiring coastal states to submit information on the limits of their continental shelves to the Commission on the Limits of the Continental Shelf (CLCS), UNCLOS imposes procedural checks on unilateral extensions of sovereignty. In this context, the Convention not only provides a legal blueprint but also acts as a normative constraint on behavior, shaping state conduct and expectations in maritime affairs. It thereby serves as a cornerstone of global maritime governance, upholding predictability, equity, and peaceful coexistence among states.

Despite the comprehensive legal architecture provided by UNCLOS, significant challenges persist in harmonizing the interpretation and implementation of its provisions among claimant states in the South China Sea. These challenges arise due to a complex interplay of legal ambiguity, national interests, historical grievances, and geopolitical rivalries. While UNCLOS offers definitions and frameworks for maritime zones and entitlements, certain terms—such as "rocks," "islands," and "low-tide elevations"—remain open to interpretation, leading to divergent claims regarding the extent of maritime zones generated by various features. China's "nine-dash line" claim, for instance, lacks clear legal grounding under UNCLOS yet continues to be asserted based on historical usage, despite the 2016 arbitral ruling that deemed it incompatible with the Convention. Meanwhile, other claimant states such as the Philippines, Vietnam, Malaysia, and Brunei attempt to frame their claims within the UNCLOS regime, creating a fragmented legal landscape. Compounding the issue is the absence of a centralized enforcement mechanism under UNCLOS, which allows powerful states to disregard rulings without immediate consequences. Additionally, political sensitivities and fears of domestic backlash often inhibit

[18] Jan Jakub Solski, "The Genesis of Article 234 of the UNCLOS," *Ocean Development & International Law* 52, no. 1 (January 2, 2021): 1–19, https://doi.org/10.1080/00908320.2020.1835026.

states from engaging fully in binding legal processes, instead opting for bilateral negotiations or strategic ambiguity. These divergent approaches undermine the uniform application of UNCLOS and dilute its authority as a universal framework. Hence, the harmonization of interpretations requires not only legal clarity and adjudication but also sustained diplomatic engagement, mutual trust-building, and perhaps the evolution of regional mechanisms that can contextualize UNCLOS norms in the unique geopolitical environment of the South China Sea.

3.2. Weaknesses of UNCLOS Implementation in Disputed Maritime Areas

One of the most pressing challenges facing the international legal order, particularly in the context of maritime law under UNCLOS,[19] is the inconsistent behavior of states in accepting and enforcing the decisions rendered by international arbitration tribunals.[20] While the Convention mandates that parties to a dispute must comply with rulings issued through binding dispute resolution mechanisms such as arbitration under Annex VII, state practice often deviates from this legal obligation. A prime example of this is the People's Republic of China's outright rejection of the 2016 arbitral tribunal ruling in the case brought by the Philippines regarding the South China Sea. Despite the tribunal's detailed legal reasoning and its affirmation of the Philippines' rights under UNCLOS, China dismissed the verdict as "null and void," citing sovereignty concerns and historical claims not recognized by the Convention. This refusal to comply not only undermines the authority of the arbitration mechanism but also sets a dangerous precedent, encouraging other states to similarly disregard unfavorable rulings. Moreover, even states that publicly support the rule of law at sea sometimes adopt a selective approach to compliance, especially when national interests or domestic political pressures are at stake. The lack of a supranational enforcement body means that the legitimacy and effectiveness of international arbitral decisions rely heavily on voluntary state adherence and peer pressure from the international community.

Another significant weakness in the current maritime legal framework is the lack of robust and institutionalized mechanisms for verifying and monitoring violations of the law of the sea. While UNCLOS provides a detailed legal structure governing maritime entitlements, navigation rights, and environmental responsibilities, it does not establish a centralized body with the mandate to systematically oversee state compliance or investigate breaches. Unlike other international regimes such as the nuclear non-proliferation framework or the human rights system—both of which are supported by specialized agencies and monitoring committees—the enforcement of the law of the sea relies heavily on the self-reporting and goodwill of states. This structural gap enables maritime powers to undertake activities such as illegal fishing, unregulated construction on disputed islands, and excessive maritime claims with relative impunity. In contested regions like the South China Sea, unauthorized land reclamation and the militarization of artificial features have proceeded largely unchecked, despite clear violations of UNCLOS provisions. Efforts by regional organizations such as ASEAN to develop monitoring frameworks have been hindered by a lack of consensus and the principle of non-interference. Meanwhile, global initiatives like satellite surveillance and maritime domain awareness programs remain fragmented and often lack the authority or coordination needed to effectuate legal consequences. The absence of independent verification not only facilitates ongoing violations but also contributes to a lack of transparency and mutual trust among states. Strengthening verification mechanisms—perhaps through a dedicated international maritime oversight body—would be a necessary step toward enhancing accountability and ensuring the credibility of the legal regime governing the world's oceans.

A fundamental shortcoming in the current system for governing maritime behavior under UNCLOS lies in

[19] Ke Song, "Liberal or Constrained? Judicial Incorporations of Other Rules of International Law in the UNCLOS and the Application of the 'Genuine Link Test,'" *Journal of East Asia and International Law* 13, no. 1 (May 31, 2020): 161–78, https://doi.org/10.14330/jeail.2020.13.1.08.

[20] Minyou Yu and Weizhe Liu, "Improving China's Maritime Law Enforcement Operations Against Overfishing in the South China Sea—Based on a Comparison With the Indonesian Law Enforcement System Against IUU Fishing," ed. Tzen-Yuh Chiang, *PLOS ONE* 20, no. 4 (April 15, 2025): e0319525, https://doi.org/10.1371/journal.pone.0319525.

the lack of effective,[21] enforceable sanctions for states that violate its provisions.[22] Although the Convention lays out detailed legal standards and mandates binding dispute settlement,[23] it does not include coercive enforcement tools or punitive measures that can be automatically triggered in cases of non-compliance. This deficiency has allowed powerful states to flout their legal obligations without facing tangible repercussions, thereby weakening the normative power of international maritime law. For instance, repeated incidents of illegal fishing in exclusive economic zones, environmental degradation caused by negligent marine practices, and non-compliance with arbitral decisions have often gone unpunished, fostering a climate of impunity. While other international legal regimes—such as those governing trade (e.g., WTO) or nuclear non-proliferation—provide for economic or diplomatic sanctions as deterrents, UNCLOS relies on peer pressure, diplomatic protest, and the reputational costs of non-compliance, which are often insufficient to alter state behavior. Moreover, efforts by individual states or regional blocs to impose unilateral sanctions in response to maritime violations risk escalating geopolitical tensions and are rarely sustained in multilateral forums. The ineffectiveness of current sanctions mechanisms has led some legal scholars and policymakers to call for the development of complementary enforcement tools, such as linking UNCLOS compliance to access to international maritime resources or integrating it into broader international accountability frameworks.

One of the structural weaknesses of UNCLOS lies in the legal ambiguity present in several of its key provisions,[24] which has led to varied and sometimes contradictory interpretations by different states. Despite being hailed as a "constitution for the oceans," UNCLOS contains terminology that lacks precise definitions, such as what constitutes an "island" versus a "rock" under Article 121, or the criteria for "historic rights" and "due regard" in overlapping maritime zones. These ambiguities have allowed states to manipulate legal texts to serve their strategic interests, often at the expense of regional stability and legal predictability. In the South China Sea, for instance, China's expansive "nine-dash line" claim is partly justified by invoking vaguely defined "historic rights," which were explicitly rejected by the 2016 arbitral tribunal ruling but are still maintained in Chinese official discourse. Similarly, interpretations of what constitutes a legitimate basepoint for maritime entitlements vary widely among claimant states, further complicating delimitation efforts. These dual interpretations are exacerbated by the lack of a centralized interpretive authority in UNCLOS, as the Convention depends largely on state practice and jurisprudence from disparate tribunals to evolve its meaning. While flexibility in legal interpretation can be advantageous in adapting to new challenges, in this context, it has often led to inconsistent application of maritime law and has hampered dispute resolution efforts.

Another critical impediment to the effective implementation of UNCLOS lies in the insufficient regional collaboration among states to support the technical and institutional aspects of the Convention's application.[25] While UNCLOS sets out comprehensive legal frameworks for maritime delimitation, marine environmental protection, and resource management, it leaves much of the practical implementation—such as hydrographic surveys, environmental monitoring, and maritime boundary negotiations—to the capacity and willingness of individual states or regional mechanisms. Unfortunately, in many parts of the world, particularly in the Indo-Pacific region, multilateral cooperation remains weak, fragmented, or

[21] Kishore Vaangal, "Reexamining the UNCLOS: A Lack of Compliance and Enforceability," *Lex Portus* 8, no. 1 (February 9, 2022), https://doi.org/10.26886/2524-101X.8.1.2022.1.

[22] Xuexia Liao, "The Road Not Taken: Submission of Disputes Concerning Activities in Undelimited Maritime Areas to UNCLOS Compulsory Procedures," *Ocean Development & International Law* 52, no. 3 (July 3, 2021): 297–324, https://doi.org/10.1080/00908320.2021.1959772.

[23] Ngo Huu Phuoc, "Compulsory Dispute Settlement Entailing Binding Decisions under the UNCLOS: Its Applicability to the Case of Vietnam," *Journal of East Asia and International Law* 14, no. 1 (May 30, 2021): 35–54, https://doi.org/10.14330/jeail.2021.14.1.02.

[24] Hayley Roberts, "Identifying 'Exclusionary Agreements': Agreement Type as a Procedural Limitation in UNCLOS Dispute Settlement," *Ocean Development & International Law* 52, no. 2 (April 3, 2021): 113–42, https://doi.org/10.1080/00908320.2021.1886448.

[25] Marta Hermez, "Global Commons and the Law of the Sea: China's Lawfare Strategy in the South China Sea," *International Community Law Review* 22, no. 5 (December 9, 2020): 559–88, https://doi.org/10.1163/18719732-12341447.

hindered by mutual distrust.[26] For example, ASEAN has struggled to form a unified and enforceable maritime policy despite facing common threats like overfishing, pollution, and territorial encroachment. Technical mechanisms such as joint development zones, coordinated patrolling,[27] or shared marine data systems are often underutilized due to the lack of institutional trust, competing claims, or domestic political sensitivities. Additionally, the absence of a binding regional enforcement framework makes it difficult to monitor compliance with environmental standards or to effectively mediate disputes. As a result, the burden of implementation often falls on national institutions, many of which lack the financial, technical, or legal capacity to fulfill UNCLOS obligations comprehensively.

Despite the availability of legal pathways for resolving maritime disputes under UNCLOS,[28] geopolitical realities have often led to the dominance of military and political strategies over juridical mechanisms.[29] In many contentious maritime regions, particularly the South China Sea and parts of the East Mediterranean, states have increasingly relied on naval power projection,[30] defense alliances, and strategic coercion to assert territorial claims or deter rival claimants,[31] sidelining legal channels such as arbitration or adjudication.[32] This trend reflects a broader erosion of confidence in the capacity of legal institutions to deliver enforceable and timely resolutions, especially when powerful actors choose to ignore or delegitimize binding decisions.[33] For instance, despite the legal clarity provided by the Permanent Court of Arbitration in the 2016 ruling, China's continued militarization of artificial features and expanded maritime patrols in disputed areas exemplify how power politics can eclipse the authority of international law. Similarly, joint military exercises, the establishment of air defense identification zones (ADIZ), and unilateral exploration activities in contested waters reflect a growing reliance on "facts on the sea" rather than rules in the treaty. The preference for power-based over rule-based solutions not only exacerbates tensions but also delegitimizes UNCLOS as a conflict-resolution tool. In the absence of robust enforcement mechanisms or collective international will to defend legal norms, states may increasingly view military deterrence and political negotiation as more effective, albeit riskier, pathways to secure their maritime interests. This dynamic poses a significant threat to the stability of the rules-based maritime order and underscores the urgent need for renewed multilateral commitment to the primacy of international law.

3.3. Artificial Intelligence Integration in the Reform of International Maritime Law

Artificial Intelligence (AI) holds immense potential in enhancing real-time surveillance of maritime activities, particularly in monitoring vessel movements and detecting violations of maritime boundaries under the framework of UNCLOS. With the growing complexity of maritime disputes and the expansion of global shipping networks, traditional monitoring methods—often limited to patrols and manual data analysis—are increasingly insufficient to manage large-scale oceanic traffic and to enforce exclusive

[26] Yizhan Chen et al., "Observational Analysis of the Formation Reasons and Evolution Law of Winter Counter-Wind Current in Jiazi Sea Area of Northeastern South China Sea," *Journal of Marine Science and Engineering* 10, no. 7 (June 28, 2022): 893, https://doi.org/10.3390/jmse10070893.

[27] K.S. Nathan, "ASEAN and the Major Powers in the South China Sea: The Role of Law, Diplomacy, and Deterrence in Moderating Sovereignty Claims," *Philippine Political Science Journal* 44, no. 3 (December 28, 2023): 215–41, https://doi.org/10.1163/2165025x-bja10050.

[28] Naomi Clark-Shen et al., "A Comparative Study of Fishery and Environment Laws in the South China Sea: Utilizing Existing Laws to Promote Peace," *Marine Policy* 121 (November 2020): 103568, https://doi.org/10.1016/j.marpol.2019.103568.

[29] Humphries et al., "A Tiered Approach to the Marine Genetic Resource Governance Framework Under the Proposed UNCLOS Agreement for Biodiversity Beyond National Jurisdiction (BBNJ)."

[30] Martijn Hoogeland, "Case Note: The South China Sea Dispute and the Role of UNCLOS in the Settlement of the Dispute," *Revue Québécoise de Droit International*, April 20, 2020, 93–116, https://doi.org/10.7202/1068733ar.

[31] Phuoc, "Compulsory Dispute Settlement Entailing Binding Decisions under the UNCLOS: Its Applicability to the Case of Vietnam."

[32] Finn Mørk, "Classification of Seafloor Highs in Accordance With Article 76 of UNCLOS—Consequences of the Commission on the Limits of the Continental Shelf Recent Modifications of Its Interpretations," *Ocean Development & International Law* 49, no. 4 (October 2, 2018): 368–92, https://doi.org/10.1080/00908320.2018.1509509.

[33] Maximo Paulino T. Sison, "Universalizing the Law of the Sea in the South China Sea Dispute," *Ocean Development & International Law* 49, no. 2 (April 3, 2018): 157–75, https://doi.org/10.1080/00908320.2018.1442181.

economic zones (EEZs) effectively.[34] AI-powered systems can process massive streams of data from Automatic Identification Systems (AIS), radar, and satellite feeds to track the trajectories, speeds, and behavioral patterns of vessels with unprecedented accuracy and speed.[35] This capability allows authorities to detect anomalies such as illegal fishing, unauthorized intrusions into territorial waters, and suspicious vessel behavior indicative of smuggling or transshipment.[36] For example, AI algorithms can identify when ships turn off their AIS transponders, make irregular stops near disputed features, or engage in "dark" operations, which are common tactics in sensitive zones like the South China Sea.[37]

AI is revolutionizing the collection, integration, and analysis of maritime data, particularly through the interpretation of satellite imagery and remote sensing technologies. In the context of UNCLOS,[38] which relies heavily on accurate geographic, hydrographic, and environmental data to determine maritime entitlements and monitor marine resources, the infusion of AI into satellite-based analysis represents a major leap forward. Machine learning algorithms can rapidly process high-resolution satellite imagery to identify illegal constructions on reefs, unauthorized dredging, oil spills, and environmental degradation in real time. These tools can also assist in the mapping of continental shelves and the delineation of maritime boundaries—processes that require meticulous geospatial analysis and were traditionally time-consuming and vulnerable to political manipulation. Moreover, AI systems are increasingly capable of correlating environmental data with human activity, enabling policymakers to assess the ecological impacts of shipping routes, fishing intensity, or port development in sensitive marine ecosystems. By automating data fusion from multiple sources—including Synthetic Aperture Radar (SAR), optical satellites, and oceanographic sensors—AI enhances both the speed and reliability of maritime intelligence gathering.

Beyond its application in surveillance and data management, AI also offers significant promise in enhancing the legal dimension of maritime governance, particularly in supporting arbitration processes related to UNCLOS by analyzing legal precedents. Dispute resolution in international maritime law often hinges on interpreting complex legal principles, case law, and treaty provisions. AI, particularly natural language processing (NLP) and legal reasoning systems, can sift through thousands of past rulings, legal commentaries, and academic publications to identify patterns, contradictions, and relevant precedents. This capability can assist legal practitioners, arbitrators, and even states in preparing arguments, understanding jurisprudential trends, and assessing the likely outcomes of disputes based on prior cases. For example, AI can analyze how previous tribunals have interpreted terms like "rock," "island," or "historic rights," offering insights that contribute to more consistent and coherent decision-making. Additionally, AI tools can assist in drafting legal briefs, highlighting inconsistencies in party submissions, and simulating legal scenarios to forecast the implications of different rulings.

The integration of Artificial Intelligence into legal workflows has introduced new efficiencies and capabilities in the drafting of legal documents, particularly through the utilization of big data analytics. In the context of international maritime law under UNCLOS,[39] AI systems can now process enormous volumes of legal texts, state practice records, arbitral decisions, diplomatic correspondences, and academic writings to assist in producing highly detailed, data-driven legal reports and position papers.

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[34] Nuurrianti Jalli, Angel Martinez, "Artificial Intelligence Is Intensifying South China Sea Disputes in the Philippines," Fulcrum: Analysis on Southeast Asia, 2025, https://fulcrum.sg/artificial-intelligence-is-intensifying-south-china-sea-disputes-in-the-philippines/.

[35] Erik Franckx, "A Single Maritime Boundary: From UNCLOS III to Present-Day Developments," *Marine Policy* 148 (February 2023): 105425, https://doi.org/10.1016/j.marpol.2022.105425.

[36] Hui Wu, "International Law Challenges for Underwater Cultural Heritage Protection in the South China Sea," *Ocean Development & International Law* 55, no. 3 (July 2, 2024): 259–301, https://doi.org/10.1080/00908320.2024.2393083.

[37] Chen et al., "Observational Analysis of the Formation Reasons and Evolution Law of Winter Counter-Wind Current in Jiazi Sea Area of Northeastern South China Sea."

[38] Jianping Guo, "The Developments of Marine Environmental Protection Obligation in Article 192 of UNCLOS and the Operational Impact on China's Marine Policy – A South China Sea Fisheries Perspective," *Marine Policy* 120 (October 2020): 104140, https://doi.org/10.1016/j.marpol.2020.104140.

[39] Max Zhang and Shihui Yu, "A Review on the Preparedness of Chinese Maritime Law Education for Emerging Industry and Technology Trends: Sustainable Net-Zero Shipping, Maritime Digitalization, and Application of Artificial Intelligence Technologies," *Sustainable Futures* 9 (June 2025): 100752, https://doi.org/10.1016/j.sftr.2025.100752.

Unlike traditional methods that rely heavily on manual research and interpretation, AI-powered legal engines can identify relevant precedents, detect patterns in case outcomes, and cross-reference applicable treaty provisions in a matter of seconds. This is especially valuable when states or international bodies prepare submissions for boundary delimitation, environmental disputes, or issues of freedom of navigation, where vast and complex datasets are involved. Furthermore, AI can standardize legal documentation across jurisdictions, reduce human error, and enhance precision in legal argumentation by grounding conclusions in quantifiable patterns found in prior rulings and practices. Natural Language Generation (NLG) technologies are also being employed to produce initial drafts of legal documents, which human experts can then refine and validate, significantly expediting legal proceedings.

Despite its transformative potential, the use of AI in international law—particularly within the UNCLOS framework—raises serious ethical concerns and highlights the urgent need for robust regulatory oversight.[40] One of the most pressing issues is algorithmic bias, which can arise from imbalanced training data, flawed assumptions in code design, or the unintentional reinforcement of geopolitical narratives. For instance, if an AI system trained predominantly on Western legal cases or interpretations is used to support maritime legal analyses, it may inadvertently marginalize non-Western legal traditions or state practices, leading to skewed outcomes. Furthermore, opaque AI decision-making processes pose challenges for transparency and accountability in legal proceedings, which are fundamental principles of justice.[41] The automation of legal analysis must therefore be guided by clear ethical standards, including explainability, fairness, and the right to human oversight. Additionally, data privacy concerns must be addressed, especially when AI processes sensitive geopolitical data or uses surveillance tools to inform legal conclusions. Without internationally accepted guidelines and regulations, the deployment of AI in legal contexts could exacerbate existing power imbalances, infringe on state sovereignty, or delegitimize international legal institutions.

To fully harness the potential of AI in advancing maritime governance and upholding the principles of UNCLOS, cross-border collaboration is essential in constructing a unified digital legal framework. Given the transnational nature of maritime law, no single state or institution can independently develop and maintain a comprehensive AI-driven legal infrastructure that accounts for the diversity of legal traditions, linguistic systems, and geopolitical interests.[42] Collaborative efforts involving international organizations such as the United Nations, the International Tribunal for the Law of the Sea (ITLOS), and regional bodies like ASEAN or the African Union are critical to establishing interoperable AI systems, shared legal databases, and transparent decision-making protocols. These joint ventures can ensure that AI tools are trained on balanced datasets, inclusive of multiple legal cultures and historical precedents, thereby improving the credibility and legitimacy of their outputs. Additionally, global forums can serve as platforms for negotiating standards for ethical AI development, governance, and dispute resolution procedures. In practical terms, this collaboration could result in the creation of multilingual AI legal assistants, blockchain-secured archives of maritime claims and rulings, and coordinated surveillance systems to monitor unlawful maritime activities. Such a framework would not only facilitate more effective implementation of UNCLOS but also promote digital equity by ensuring that less technologically advanced states are not left behind.

4. Conclusion

This study concludes that the integration of Artificial Intelligence (AI) into the implementation of the United Nations Convention on the Law of the Sea (UNCLOS) offers a promising pathway toward addressing the long-standing maritime disputes in the South China Sea. The main findings highlight that AI technologies, such as real-time vessel monitoring, satellite-based data analysis, and precedent-based legal reasoning,

[40] Ana K. Spalding and Ricardo de Ycaza, "Navigating Shifting Regimes of Ocean Governance," *Environment and Society* 11, no. 1 (September 1, 2020): 5–26, https://doi.org/10.3167/ares.2020.110102.

[41] Jorge Isaac Torres Manrique, "New Technologies, Artificial Intelligence, International Maritime Law and Fundamental Rights," *Law & Digital Technologies* 3, no. 1 (2023): 12, https://doi.org/10.18254/S278229070025288-2.

[42] Wei Wang, "Innovative Strategies and Forward Thinking on China's Digital Maritime Law Enforcement," *Marine Policy* 169 (November 2024): 106369, https://doi.org/10.1016/j.marpol.2024.106369.

can enhance the effectiveness, transparency, and objectivity of maritime governance. These innovations provide timely and data-driven insights into complex maritime activities, thus enabling better enforcement of legal boundaries and increasing compliance with UNCLOS provisions. Furthermore, AI's capability to support the drafting and analysis of legal documents contributes to consistency in arbitration processes and helps reduce subjectivity in legal interpretation. However, the research also finds that the successful application of AI in this field depends heavily on the establishment of ethical safeguards, unbiased algorithms, and multilateral cooperation, given the risks of algorithmic bias and technological asymmetries among states. These findings address the core problems of legal ambiguity, enforcement weaknesses, and power-politics domination that have hindered the full realization of UNCLOS in the South China Sea context.

The implications of this research are significant for both the theoretical and practical development of international maritime law. Theoretically, it contributes to the emerging discourse on the intersection between law and technology, particularly how AI can support legal interpretation, compliance, and dispute resolution mechanisms under UNCLOS. Practically, the findings encourage international institutions, regional organizations, and coastal states to adopt AI-based solutions for maritime monitoring and legal documentation while simultaneously advocating for ethical and inclusive AI governance frameworks. Despite its contributions, this study acknowledges certain limitations, including the evolving nature of AI technologies, unequal technological capacities among states, and limited access to classified maritime data, which may constrain comprehensive analysis. Therefore, future research should explore the development of globally accepted AI regulatory frameworks in maritime law, investigate the role of AI in preventive diplomacy and conflict de-escalation, and assess how digital legal infrastructures can be made accessible and equitable for all maritime stakeholders. By advancing these directions, the international community can move toward a more just, secure, and technologically adaptive maritime order, guided by the spirit and objectives of UNCLOS.

Declarations

Author Contribution Statement

Si Yusuf Al Hafiz contributed to the conceptualization of the research topic, the design of the study, and the initial drafting of the manuscript. Nurul Izzah Al Badi'ah was responsible for coordinating the research process, conducting the literature review, performing the data analysis, and finalizing the manuscript for submission. M. Abdurrozaq contributed to the theoretical framework, provided critical revisions to the legal analysis section, and ensured the consistency and integrity of the argumentation throughout the paper. All authors reviewed and approved the final version of the manuscript.

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The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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