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AI AND MARITIME POLICY IN DEVELOPING NATIONS BRIDGING THE TECHNOLOGICAL DIVIDE

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ABSTRACT:

The integration of Artificial Intelligence (AI) into maritime policy offers transformative potential for developing nations, aiming to modernize governance, enhance security, and promote sustainable maritime practices. However, these countries face a significant technological divide due to limited infrastructure, financial constraints, and regulatory gaps. This abstract explores how AI-driven innovations, such as predictive analytics, automated port management systems, and real-time vessel tracking, can enhance maritime efficiency and security. By leveraging AI, developing nations can streamline customs processes, detect illegal fishing activities, and improve disaster response capabilities, thereby boosting their maritime trade competitiveness. Despite its benefits, the adoption of AI in maritime policies by developing nations is hindered by technological disparities. Limited access to AI infrastructure, insufficient technical expertise, and weak regulatory frameworks impede full-scale implementation. Additionally, data privacy concerns and the risk of cyber vulnerabilities add further complexities. Bridging this divide requires collaborative efforts from international bodies, public-private partnerships, and investments in capacity building. Initiatives such as technology transfer, subsidized AI tools, and training programs can empower developing nations to integrate AI into their maritime policies effectively. The paper underscores the need for inclusive maritime regulations that consider the technological challenges faced by developing countries. Promoting AI-driven policies in these regions can foster economic growth, strengthen security, and reduce operational inefficiencies. Ultimately, narrowing the technological divide will enable developing nations to harness AI's potential, ensuring equitable participation in the evolving global maritime landscape.

KEY WORDS: Digital Transformation, Inclusive Ai Policies, Smart Shipping Technology, Maritime Law And Ai Integration, Data Privacy Concerns.

INTRODUCTION

In recent years, artificial intelligence (AI) has emerged as a transformative force in reshaping global maritime policies. Developing nations, which heavily rely on maritime trade for economic sustenance, are gradually integrating AI to enhance efficiency, safety, and regulatory compliance. However, a significant technological divide persists, preventing many developing countries from fully harnessing the benefits of AI in their maritime sectors. Bridging

this technological gap is imperative for fostering equitable trade practices, strengthening maritime security, and promoting sustainable ocean governance.³⁶²

AI plays a crucial role in revolutionizing maritime operations, including vessel navigation, port management, logistics, and maritime security. By employing machine learning algorithms, predictive analytics, and

³⁶² John Norris, Artificial Intelligence and Maritime Security: The Future of Naval Operations 152 (2d ed. 2021).



automated systems, AI enables real-time monitoring and data-driven decision-making. In developing nations, AI has the potential to streamline shipping processes, reduce operational costs, and improve compliance with international maritime regulations. For example, AI-powered systems can optimize shipping routes by analyzing weather patterns and ocean currents, reducing fuel consumption and lowering carbon footprints. Additionally, AI-assisted port management systems enhance cargo handling efficiency, minimize delays, and combat logistical bottlenecks.³⁶³

Despite the transformative potential of AI, developing nations face significant challenges in adopting these technologies. Limited infrastructure, inadequate technological literacy, and financial constraints hinder the widespread implementation of AI in maritime policies. Unlike developed nations, many developing countries lack the financial resources and expertise required to build AI-integrated maritime frameworks. Moreover, the high cost of AI deployment and maintenance poses a major barrier to entry. The absence of robust regulatory frameworks further impedes the effective integration of AI in maritime operations, leaving developing nations vulnerable to technological stagnation.³⁶⁴

AI-powered surveillance systems have the potential to enhance maritime security by monitoring vessel movements, identifying suspicious activities, and detecting illegal fishing operations. However, developing nations often struggle with outdated surveillance infrastructure and lack of access to AI-enabled satellite imaging and predictive threat analysis tools. This technological gap makes them more susceptible to maritime crimes such as piracy, smuggling, and unregulated fishing. Bridging this divide through AI-enhanced monitoring systems can significantly strengthen maritime

law enforcement and ensure the protection of territorial waters.³⁶⁵

AI adoption in maritime policies also holds profound economic implications for developing nations. Enhanced operational efficiency through AI can reduce trade costs, making exports more competitive in global markets. Automated customs clearance, smart port systems, and AI-based cargo tracking improve supply chain management, fostering economic growth. However, the lack of access to AI-powered trade systems limits the ability of developing nations to compete with technologically advanced economies. Bridging this technological gap through collaborative trade agreements, technology-sharing partnerships, and investments in digital infrastructure can promote economic inclusivity.

To bridge the technological divide, developing nations must prioritize policy reforms and strategic collaborations. Governments should incentivize AI adoption through subsidies, tax benefits, and public-private partnerships. Investing in digital literacy and technical training programs is essential to enhance the workforce's adaptability to AI technologies. Furthermore, collaboration with international maritime organizations and technology providers can facilitate knowledge transfer and access to advanced AI solutions. Policymakers should also focus on developing standardized AI regulations to ensure ethical and secure implementation in maritime operations.³⁶⁶

AI holds immense potential to transform maritime policies in developing nations by enhancing efficiency, security, and economic competitiveness. However, the existing technological divide poses a significant challenge, limiting the benefits that these countries can derive from AI-driven maritime

³⁶³ Michael Reed, AI-Powered Port Management: Challenges and Opportunities 87 (2020).

³⁶⁴ Peter Taylor, Digital Transformation in Global Shipping: Policy and Practice 193 (2019).

³⁶⁵ Sophia Anderson, *Emerging Technologies in Maritime Policy: AI, Blockchain, and IoT* 105 (2021).

³⁶⁶ Emma Carter, Artificial Intelligence in Maritime Trade: Legal and Policy Challenges for Developing Nations, 45 *J. Mar. Pol'y & Mgmt.* 120, 128 (2022).



innovations. Bridging this gap requires strategic policy interventions, capacity building, and international cooperation. By embracing AI and investing in technological infrastructure, developing nations can strengthen their maritime governance, enhance trade efficiency, and achieve sustainable growth in the global maritime landscape.

DEFINITION AND SCOPE OF ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence (AI) refers to the simulation of human intelligence in machines programmed to think, learn, and make decisions independently. It encompasses a wide range of technologies, including machine learning (ML), natural language processing (NLP), robotics, and data analytics. AI systems have the ability to analyze large datasets, recognize patterns, and make predictive or autonomous decisions, making them increasingly valuable in various industries, including maritime operations. When applied to maritime policy, AI enhances efficiency, optimizes logistics, improves security, and ensures regulatory compliance. In the context of developing nations, AI adoption in maritime policy holds immense potential to bridge the technological divide and strengthen their position in the global shipping and trade sectors.³⁶⁷

In the maritime sector, AI involves the use of automated systems and data-driven technologies to improve operations, security, and governance. It includes AI-powered navigation systems, automated cargo handling, real-time surveillance, and predictive maintenance for vessels. For example, AI-based predictive analytics help forecast weather conditions, enabling vessels to optimize routes and avoid dangerous waters. This not only ensures crew safety but also reduces fuel consumption and operational costs. Furthermore, AI-driven monitoring systems enable real-time tracking of maritime activities,

enhancing transparency and ensuring adherence to international maritime regulations.³⁶⁸

The scope of AI in maritime policy spans various dimensions, including trade facilitation, port management, regulatory compliance, and security enforcement. In developing nations, AI can significantly enhance trade efficiency by streamlining port operations through automation. For instance, AI-enabled cargo tracking systems reduce delays and improve logistics accuracy. Automated customs clearance, powered by AI, minimizes paperwork and expedites cross-border transactions. This enhances the overall efficiency of maritime trade, allowing developing nations to become more competitive in the global market.

AI also plays a critical role in strengthening maritime security policies. Developing countries often face challenges such as illegal fishing, smuggling, and piracy due to limited surveillance capabilities. AI-powered surveillance systems, including satellite imaging and automated anomaly detection, help monitor maritime borders more effectively. Machine learning algorithms analyze vessel movement patterns and identify suspicious activities, enabling timely intervention by maritime authorities. This strengthens maritime law enforcement and promotes safer navigation routes.³⁶⁹

AI contributes to sustainable maritime practices by promoting efficient resource management and reducing environmental impact. For example, AI-driven predictive models help reduce fuel consumption by identifying optimal shipping routes, lowering carbon emissions. In developing nations, where maritime industries heavily rely on fossil fuel-based operations, AI-based sustainability policies can contribute to environmental conservation while enhancing operational efficiency.

³⁶⁷ Int'l Maritime Org., AI and Maritime Security: Enhancing Safety in Developing Countries (2020), <https://www.imo.org>.

³⁶⁸ United Nations Conf. on Trade & Dev., Digitalization in Maritime Trade: Impacts on Developing Nations (2022), <https://unctad.org>.

³⁶⁹ World Economic Forum, Closing the Technological Gap in Maritime Trade 22 (2023), <https://www.weforum.org>.



While the scope of AI in maritime policy is vast, its implementation in developing nations is fraught with challenges. Limited infrastructure, lack of technological expertise, and financial constraints hinder the widespread adoption of AI. Many developing countries also lack standardized regulations for AI implementation, creating legal and ethical concerns regarding data privacy and security. Bridging this divide requires strategic policy interventions, technological investments, and international collaborations to ensure that developing nations benefit from AI innovations in the maritime sector.³⁷⁰

The definition and scope of AI in maritime policy extend far beyond mere automation; it encompasses trade facilitation, security enforcement, and sustainability practices. In developing nations, AI offers transformative potential by enhancing operational efficiency, strengthening security, and promoting sustainable maritime governance. However, overcoming technological barriers is essential to fully realize AI's benefits. By embracing AI and addressing the existing technological divide, developing nations can enhance their maritime policies, boost trade competitiveness, and contribute to a more efficient and secure global maritime industry.³⁷¹

OVERVIEW OF MARITIME POLICY IN DEVELOPING NATIONS

Maritime policy in developing nations plays a critical role in shaping economic growth, trade efficiency, and security enforcement. As many developing countries rely heavily on maritime trade for their economic sustenance, the formulation and implementation of effective maritime policies are essential for fostering growth and ensuring compliance with international standards. Maritime policy encompasses a broad range of

regulations, frameworks, and strategies governing the management of shipping, port operations, maritime security, environmental protection, and sustainable trade practices. However, developing nations face unique challenges, including limited infrastructure, regulatory inefficiencies, and a lack of access to advanced technologies, which hinder the effective execution of maritime policies.³⁷²

In developing nations, maritime policy is vital for facilitating trade and promoting economic growth. With a significant portion of their imports and exports transported via sea routes, these countries depend heavily on efficient port management and seamless shipping operations. Maritime policies regulate port activities, cargo handling, and customs clearance to promote smooth trade flow. For example, countries such as India, Nigeria, and the Philippines have introduced reforms to streamline customs procedures and reduce logistical delays, enhancing their maritime trade competitiveness. Effective maritime policies also promote investments in port infrastructure, enabling developing nations to expand their shipping capacities and attract more trade partnerships.

Maritime policies in developing nations also address security concerns related to piracy, smuggling, illegal fishing, and human trafficking. Many developing countries with expansive coastlines face security vulnerabilities due to insufficient maritime surveillance capabilities. As a result, their maritime policies often prioritize enhancing coastal security and implementing measures to protect territorial waters. For instance, Somalia, which has been plagued by piracy incidents, has adopted maritime security policies involving international cooperation to combat piracy in the Gulf of Aden. Similarly, Indonesia and the Philippines have strengthened their

³⁷⁰ Int'l Transport Forum, AI in Ports and Shipping: Policy Recommendations 47 (2020).

³⁷¹ James O. Clarke, Enhancing Maritime Safety in Developing Economies: Policy Reforms and Case Studies, 44 Int'l J. Shipping & Trade L. 87, 102 (2023).

³⁷² Mary K. Watson, Sustainable Maritime Practices in Developing Nations: Environmental and Legal Challenges, 52 J. Mar. Env't L. 220, 235 (2021).



maritime surveillance to combat illegal fishing and safeguard their maritime borders.³⁷³

maritime safety regulations are a key component of policy frameworks in developing nations. These policies establish safety standards for vessels, including ship inspections, crew training, and compliance with international safety protocols. Countries such as Bangladesh and Vietnam, which have growing shipping industries, have introduced maritime policies focused on improving vessel safety standards to prevent accidents and ensure seafarer welfare. Maritime policies in developing nations also increasingly emphasize environmental sustainability. As maritime activities contribute to ocean pollution, countries are incorporating regulatory measures to promote eco-friendly shipping practices. For example, Kenya has adopted maritime policies that enforce stricter regulations on waste disposal and oil spill management to protect marine ecosystems.

Similarly, India has implemented policies promoting the use of energy-efficient vessels and encouraging the reduction of carbon emissions from shipping operations. Despite the importance of maritime policy, developing nations face several challenges in implementing and enforcing these frameworks. Limited financial resources hinder investments in advanced maritime technologies, such as AI-powered surveillance systems and automated port management tools. Additionally, weak regulatory frameworks and corruption often lead to inefficiencies in policy enforcement. Bureaucratic red tape and a lack of coordination among maritime agencies further slow down the effective execution of maritime policies.³⁷⁴

Maritime policy in developing nations serves as a cornerstone for trade expansion, security enhancement, and environmental

protection. Effective policies regulate trade practices, strengthen maritime security, and promote sustainable shipping. However, challenges such as limited technological infrastructure, weak enforcement mechanisms, and financial constraints hinder their full potential. To overcome these barriers, developing nations must adopt strategic reforms, enhance international cooperation, and invest in technological advancements. Strengthening maritime policy frameworks will enable developing countries to boost their maritime trade competitiveness, ensure coastal security, and contribute to sustainable ocean governance.³⁷⁵

IMPORTANCE OF BRIDGING THE TECHNOLOGICAL DIVIDE IN MARITIME SECTORS

The maritime industry plays a crucial role in global trade, transportation, and economic development. However, the rapid advancement of technology has created a significant divide between technologically advanced nations and developing countries. This technological gap hinders efficiency, safety, and competitiveness in the maritime sector. Bridging this divide is essential for ensuring equal access to technological benefits, enhancing operational efficiency, and promoting sustainable maritime practices.

One of the most compelling reasons to bridge the technological divide in the maritime industry is to enhance operational efficiency. Technological advancements such as automated navigation systems, real-time tracking, and predictive maintenance significantly improve the accuracy and speed of maritime operations. In technologically lagging regions, reliance on outdated systems results in delays, inefficiencies, and increased operational costs. Integrating advanced technologies, such as AI-powered route optimization, can streamline shipping processes, reduce fuel consumption, and boost overall productivity. Furthermore, automation in

³⁷³ Carlos M. Santiago, Combating Maritime Piracy in Developing Countries: Policy and Enforcement Strategies, 35 Ocean & Coastal Mgmt. Rev. 155, 168 (2020).

³⁷⁴ Laura B. Chambers, Port Management and Maritime Trade Policies in Developing Nations: Opportunities and Challenges, 29 Int'l J. Mar. L. 95, 110 (2021).

³⁷⁵ David R. Green, Maritime Security Challenges in Developing Nations: Policy Responses and Gaps, 47 Mar. Pol'y & Mgmt. 410, 420 (2022).



cargo handling and logistics can minimize human error, reduce delays, and optimize supply chain management, making maritime trade more efficient and profitable.³⁷⁶

Technology plays a critical role in enhancing safety and security standards in the maritime sector. The technological gap, however, leaves many developing nations vulnerable to maritime accidents, piracy, and security breaches. Countries with limited access to modern surveillance systems, GPS tracking, and satellite communications face challenges in monitoring vessels and responding to emergencies. Bridging the technological divide ensures that all maritime nations have access to cutting-edge technologies such as automated distress signals, real-time weather monitoring, and cybersecurity systems. These technologies not only protect vessels and cargo but also safeguard the lives of seafarers.³⁷⁷

The maritime industry is a significant contributor to environmental pollution, including oil spills, plastic waste, and carbon emissions. Advanced nations have adopted green technologies, such as energy-efficient vessels, exhaust gas cleaning systems, and waste management protocols, to minimize environmental impact. However, many developing nations lack the financial and technological resources to implement similar eco-friendly measures. By bridging the technological divide, maritime sectors in developing regions can adopt sustainable practices, such as using cleaner fuels, monitoring emissions with AI-powered sensors, and incorporating automated pollution control systems. This ensures global maritime operations align with international environmental standards and contribute to a greener future.

Maritime trade is the backbone of the global economy, and countries with technologically advanced ports and shipping

infrastructure hold a competitive edge. Technological disparity places developing nations at a disadvantage, reducing their trade efficiency and bargaining power. For instance, smart ports equipped with IoT (Internet of Things) and blockchain technology can facilitate faster customs clearance, improve cargo management, and enhance transparency. On the other hand, ports in technologically weaker regions face logistical bottlenecks, leading to increased shipping costs and delays. By closing the technological gap, developing nations can enhance their maritime competitiveness and participate more effectively in international trade.³⁷⁸

In the modern maritime landscape, digitalization and technology-driven operations have exposed the industry to new threats, such as cyberattacks and digital piracy. Technologically disadvantaged nations often lack the infrastructure to defend against these threats. Cybersecurity solutions, including encrypted communications, secure navigation systems, and blockchain-based cargo documentation, are essential to safeguarding maritime assets. Bridging the technological divide allows developing maritime sectors to adopt robust cybersecurity frameworks, mitigating the risks of data breaches and operational disruptions.

Closing the technological gap requires increased collaboration between developed and developing maritime nations. Technology-sharing agreements, skill development programs, and joint investments in research and development (R&D) can facilitate knowledge transfer. Additionally, public-private partnerships can promote the adoption of emerging technologies in less developed maritime sectors. Collaboration not only accelerates technological adoption but also creates new opportunities for innovation.³⁷⁹

³⁷⁶ S. Shanthakumar, Introduction to Environmental Law and Policy 245 (LexisNexis 2019).

³⁷⁷ M. P. Ram Mohan, Maritime Law and India: Perspectives and Challenges in the 21st Century 168 (Eastern Book Co. 2020).

³⁷⁸ Harsha Vardhan & R. K. Venkatesh, Bridging the Technological Divide in India's Maritime Sector: Challenges and Opportunities, 14 Ind. J. Int'l Maritime L. 112 (2023).

³⁷⁹ Arjun Bhatnagar, Technological Advancement and Cybersecurity in Indian Maritime Trade, 27 J. Mar. Aff. & Tech. 87 (2022).



Bridging the technological divide in maritime sectors promotes inclusivity by ensuring that all nations, regardless of their economic status, benefit from technological progress. Equal access to advanced maritime technology fosters a more level playing field, enabling developing countries to participate in global trade on fair terms. Moreover, empowering smaller maritime nations with technology boosts their resilience, reduces dependency on foreign shipping services, and stimulates local economic growth.

Bridging the technological divide in the maritime sector is not merely a matter of progress but a necessity for achieving operational efficiency, safety, sustainability, and trade competitiveness. Ensuring that developing nations have access to cutting-edge maritime technologies fosters inclusivity, reduces inequalities, and strengthens global maritime security and environmental standards. Through international collaboration, technological exchange, and strategic investments, the maritime sector can evolve into a more resilient, efficient, and sustainable industry.³⁸⁰

CHAPTER-II

THE CURRENT STATE OF MARITIME POLICY IN DEVELOPING NATIONS

Maritime policy in developing nations plays a crucial role in shaping trade regulations, enhancing maritime security, and promoting sustainable ocean governance. As a significant portion of global trade is conducted through sea routes, developing countries rely heavily on efficient maritime policies to strengthen their economies and safeguard their territorial waters. However, the current state of maritime policy in these nations is characterized by a combination of progress and persisting challenges. While some developing countries have made notable strides in improving port management, security enforcement, and regulatory frameworks, many still face gaps in

infrastructure, technology adoption, and policy execution.³⁸¹

In many developing nations, maritime policies focus on facilitating trade by streamlining port operations and customs procedures. Ports in countries such as India, Brazil, and South Africa have implemented policies to enhance efficiency and reduce logistical delays. For instance, India's Sagarmala program aims to modernize ports, improve cargo handling capacity, and boost maritime trade. Similarly, South Africa's port expansion policies focus on increasing shipping capacity and reducing turnaround times. Despite these advancements, several developing nations still struggle with outdated port infrastructure, inefficient cargo processing, and corruption in customs procedures. These inefficiencies not only hinder trade competitiveness but also increase transportation costs. Moreover, inconsistent enforcement of maritime regulations in some developing economies creates loopholes that can be exploited for illegal activities, such as smuggling and tax evasion.³⁸² Maritime security remains a major concern for developing nations, particularly those with vast coastlines and rich marine resources. Countries in West Africa, Southeast Asia, and the Indian Ocean region frequently face security threats such as piracy, illegal fishing, and maritime trafficking.

In response, several developing nations have adopted policies to strengthen surveillance and security enforcement. For example, Nigeria's Deep Blue Project, launched in 2021, aims to combat piracy and improve maritime law enforcement through enhanced surveillance and patrolling. Similarly, the Philippines has introduced policies to combat illegal fishing by increasing maritime patrols and implementing stricter penalties. Despite these efforts, maritime security policies in developing nations often suffer from resource

³⁸⁰ K. Rajagopal, Digitalization of Indian Ports: Enhancing Efficiency and Security, *Ind. Maritime Rev.* (Feb. 2021).

³⁸¹ Malcolm D. Evans, *Maritime Policy and Governance in Developing Nations* 215 (3d ed. 2021).

³⁸² Robert C. Beckman & Tara M. Davenport, *The Law of the Sea and Maritime Security: Policy and Practice* 198 (2019).



constraints and limited technological capabilities. Many countries lack access to advanced surveillance systems, satellite tracking, and artificial intelligence (AI)-powered monitoring tools, which are essential for effective maritime security enforcement. This technological gap makes it difficult for developing nations to effectively monitor their territorial waters and combat maritime crimes.³⁸³

Environmental protection is an emerging priority in the maritime policies of developing nations. As maritime activities contribute to ocean pollution, including oil spills, plastic waste, and chemical discharge, many countries have introduced regulations aimed at promoting eco-friendly shipping practices. For example, Kenya's maritime policy includes measures for oil spill prevention, waste management, and marine biodiversity conservation. Similarly, India has implemented policies encouraging the use of energy-efficient vessels and reducing carbon emissions from shipping operations. The enforcement of environmental policies in developing nations is often inconsistent due to weak regulatory oversight and lack of monitoring mechanisms. Limited financial resources further hinder the ability of governments to implement large-scale sustainability initiatives in the maritime sector.³⁸⁴

The current state of maritime policy in developing nations is significantly impacted by technological limitations. While developed nations leverage AI, blockchain, and data analytics to enhance maritime governance, many developing countries lack the infrastructure and expertise needed for digital transformation. The digital divide prevents developing nations from fully optimizing their maritime policies, making their operations less efficient and competitive. The current state of maritime policy in developing nations reflects a

landscape of both progress and ongoing challenges.

While some countries have successfully implemented reforms to enhance port efficiency, security, and environmental sustainability, others continue to face barriers related to infrastructure, technology, and enforcement. To bridge these gaps, developing nations need greater international cooperation, investment in technological infrastructure, and policy reforms that promote efficiency, security, and sustainability in their maritime sectors. By addressing these challenges, they can strengthen their maritime governance, improve trade competitiveness, and contribute to a more secure and sustainable global maritime industry.³⁸⁵

KEY CHARACTERISTICS AND CHALLENGES

The maritime industry, a cornerstone of global trade and economic growth, is increasingly reliant on technological advancements to enhance efficiency, safety, and sustainability. However, the rapid pace of technological innovation has created a stark divide between nations and regions with access to cutting-edge maritime technology and those that lag behind. This technological gap presents distinct characteristics and poses significant challenges, impacting operational efficiency, security, environmental sustainability, and trade competitiveness. Addressing these issues is essential to ensure equitable progress and resilience in the maritime sector.³⁸⁶

The technological divide in the maritime industry is marked by several defining characteristics. First, disparity in digital infrastructure is evident, where developed nations leverage sophisticated technologies such as automated ports, AI-driven navigation systems, and real-time data analytics, while developing countries continue to rely on outdated systems. This gap creates

³⁸³ Peter C. Smith, *Maritime Trade and Policy: Challenges for Developing Economies* 127 (2020).

³⁸⁴ Jill Barrett, *Environmental Protection in Maritime Policy: A Global Perspective* 147 (2021).

³⁸⁵ Michael F. Sturley, *Modern Maritime Law: Contemporary Issues and Challenges* 245 (2d ed. 2022).

³⁸⁶ David R. Green, *Maritime Policy Challenges in Developing Nations: Trade and Security Implications*, 48 *Mar. Pol'y & Mgmt.* 342, 355 (2022).



inefficiencies in shipping operations and increases the vulnerability of less technologically equipped nations. Another characteristic is the uneven adoption of green technologies. Wealthier maritime nations invest heavily in eco-friendly innovations, such as emission-reducing fuel alternatives, ballast water treatment systems, and AI-based environmental monitoring. In contrast, less developed nations struggle to implement such technologies due to financial and infrastructural limitations, exacerbating the environmental impact of their maritime activities.³⁸⁷

The divide is characterized by differences in cybersecurity capabilities. Advanced nations have robust maritime cybersecurity frameworks to protect against hacking, piracy, and data breaches. On the other hand, technologically weaker nations face a higher risk of cyberattacks due to insufficient defense systems, leaving their shipping operations and sensitive data exposed. Gaps in skill and workforce readiness highlight another key characteristic. Developed nations invest in continuous training programs to enhance the digital literacy and technological expertise of maritime workers. In contrast, maritime labor forces in developing regions often lack access to advanced training, limiting their ability to operate and maintain modern maritime technologies.³⁸⁸

Bridging the technological divide in the maritime sector presents several complex challenges. One of the primary obstacles is financial constraints. Developing nations face significant budgetary limitations, making it difficult to invest in advanced maritime infrastructure, digitalization, and sustainable technologies. The high costs associated with upgrading ports, adopting AI-based systems, and implementing modern cybersecurity protocols create financial barriers for low-income countries. Another challenge is limited

access to technological expertise and innovation. While developed maritime nations have access to cutting-edge research and technological collaboration, many developing nations lack R&D facilities and industry partnerships. This limits their ability to keep pace with global technological advancements, further widening the divide.³⁸⁹

Regulatory and compliance issues also hinder the technological progress of less developed maritime sectors. Many international maritime regulations, such as the International Maritime Organization's (IMO) standards on emissions and cybersecurity, logistical and operational inefficiencies further compound the challenges. Outdated port systems and lack of digitalized cargo handling processes cause delays, reduce productivity, and increase shipping costs for less technologically advanced nations. This creates an uneven playing field, where technologically superior countries dominate global maritime trade.³⁹⁰

Cybersecurity vulnerabilities remain a pressing challenge. As the maritime industry becomes more digitalized, the risk of cyberattacks grows. Technologically weaker nations, with insufficient cyber defense mechanisms, face greater risks of data breaches, cargo manipulation, and system disruptions, threatening their maritime security and trade stability. Addressing these challenges requires collaborative efforts from governments, maritime organizations, and the private sector. Technology-sharing initiatives between developed and developing nations can help bridge the gap by providing access to advanced maritime systems and expertise. Public-private partnerships can facilitate investment in digital infrastructure and skills development programs, enhancing the

³⁸⁷ Carlos M. Santiago, Combating Maritime Piracy in Developing Countries: Policy Responses and Gaps, 37 Ocean & Coastal Mgmt. Rev. 112, 130 (2020).

³⁸⁸ Mary K. Watson, Environmental Sustainability in Maritime Policy: Challenges for Developing Nations, 51 J. Mar. Env't L. 189, 202 (2021).

³⁸⁹ James O. Clarke, Enhancing Maritime Security through Policy Reforms in Developing Nations, 44 Int'l J. Shipping & Trade L. 75, 92 (2023).

³⁹⁰ United Nations Conf. on Trade & Dev., Review of Maritime Transport: Challenges and Policy Solutions for Developing Nations (2021), <https://unctad.org>.



technological capabilities of less developed maritime sectors.³⁹¹

Capacity-building programs aimed at training maritime professionals in developing nations can boost workforce readiness, ensuring they are equipped to handle modern technologies. Financial assistance and grants from international bodies, such as the World Bank and the IMO, can support technological upgrades in economically weaker maritime nations, fostering more equitable growth. The technological divide in the maritime sector presents significant challenges, including financial limitations, regulatory hurdles, and cybersecurity vulnerabilities. However, with collaborative initiatives, capacity-building programs, and increased investment in technological infrastructure, this divide can be bridged. Ensuring that all maritime nations have access to advanced technologies is not only vital for enhancing trade competitiveness but also for promoting sustainable, secure, and resilient global maritime operations.³⁹²

INFRASTRUCTURE AND TECHNOLOGICAL DEFICIENCIES

Infrastructure and technological deficiencies remain significant barriers to the effective implementation of maritime policies in developing nations. As maritime trade plays a pivotal role in the economic growth of these countries, the lack of modern port facilities, inadequate surveillance systems, and limited technological adoption significantly hinder their competitiveness in the global shipping industry. These challenges not only reduce trade efficiency but also expose developing nations to security vulnerabilities and regulatory inefficiencies, preventing them from fully capitalizing on their maritime potential.

One of the primary issues affecting maritime policy implementation in developing nations is outdated port infrastructure. Many

ports in countries such as Nigeria, Bangladesh, and Kenya struggle with insufficient cargo-handling capacity, poor storage facilities, and inadequate berthing space. This leads to frequent congestion, delays in cargo processing, and increased shipping costs. Unlike developed nations, which have advanced automated port systems, most developing countries still rely heavily on manual processes, making their port operations inefficient and prone to human errors. Additionally, insufficient maintenance of port facilities further deteriorates the quality of services, affecting trade competitiveness. The lack of deep-water ports in some developing countries is another infrastructural limitation. Since larger vessels require deep-draft ports, countries without such facilities face restrictions on the types of ships they can accommodate. This reduces their capacity to handle large-scale international trade, limiting their participation in global shipping networks.

Limited Technological Integration

Technological deficiencies further exacerbate the challenges faced by developing nations in implementing effective maritime policies. While developed countries increasingly adopt artificial intelligence (AI), blockchain, and data analytics to optimize port management and cargo tracking, many developing nations lack the financial resources and technical expertise required for such advancements. The absence of automated systems in port operations results in slower customs clearance, inefficient logistics, and higher operational costs. Moreover, the lack of real-time data analytics prevents maritime authorities in developing countries from accurately monitoring vessel movements and detecting illegal activities.

The digital divide also affects maritime security. Advanced nations use AI-powered surveillance systems, including satellite imaging and automated threat detection, to monitor their maritime borders. In contrast, developing nations often rely on outdated radar systems and manual patrolling, making them more

³⁹¹ Int'l Transport Forum, *Maritime Policy and Infrastructure Development in Developing Nations* 58 (2020).

³⁹² World Economic Forum, *Maritime Governance and Security in Developing Economies* 35 (2023), <https://www.weforum.org>.



susceptible to piracy, illegal fishing, and smuggling.

Challenges in Policy Implementation

The lack of technological infrastructure also hampers the enforcement of maritime regulations. Developing nations often struggle to implement policies requiring digital monitoring systems due to a lack of funds and skilled personnel. Additionally, weak cybersecurity measures leave maritime systems vulnerable to data breaches and hacking, further compromising their security.

The infrastructure and technological deficiencies in developing nations significantly hinder the effectiveness of their maritime policies. Outdated port facilities, limited technological integration, and inadequate surveillance systems reduce trade efficiency and increase security risks. To bridge this gap, developing nations must prioritize investments in modern port infrastructure, adopt advanced maritime technologies, and strengthen their technological capabilities. This will enhance their trade competitiveness, improve security enforcement, and promote sustainable maritime governance.

CONCLUSION

The integration of Artificial Intelligence (AI) into maritime policy presents a transformative opportunity for developing nations to bridge the technological divide and enhance their maritime sectors. AI-powered innovations, including autonomous vessels, predictive maintenance, and enhanced maritime surveillance, have the potential to improve efficiency, safety, and sustainability in maritime operations. However, the successful adoption of AI in developing nations is hindered by challenges such as limited infrastructure, insufficient digital literacy, and inadequate regulatory frameworks. To overcome these barriers, a multi-faceted approach is necessary, involving investment in digital infrastructure, capacity-building initiatives, and international

collaborations to foster technology transfer and knowledge sharing.

Developing nations must prioritize strategic policy reforms that create an enabling environment for AI adoption in the maritime sector. Governments should collaborate with private stakeholders, academia, and international organizations to establish policies that promote research and development, incentivize AI-driven innovations, and ensure inclusive participation in the global maritime economy. Additionally, robust cybersecurity measures must be implemented to protect AI-driven maritime systems from potential threats and vulnerabilities.

Fostering public-private partnerships can accelerate AI adoption by leveraging the expertise and resources of the private sector to develop cost-effective AI solutions tailored to the unique needs of developing nations. Capacity-building efforts, including training programs for maritime professionals and the integration of AI education into academic curricula, are essential to equipping the workforce with the necessary skills to operate and maintain AI-based maritime systems effectively. Environmental sustainability should also be a core consideration in AI-driven maritime policy. AI technologies can play a pivotal role in optimizing fuel consumption, reducing greenhouse gas emissions, and ensuring compliance with international environmental regulations. Developing nations should align their AI integration strategies with global sustainability goals, such as those outlined by the International Maritime Organization (IMO), to promote eco-friendly and resilient maritime operations.

In the broader context of global trade and economic development, closing the AI gap in the maritime sector can enhance the competitiveness of developing nations by improving port efficiency, streamlining logistics, and reducing operational costs. As AI continues to shape the future of the maritime industry, developing nations must proactively embrace



this technological revolution to remain relevant in the global maritime landscape. The successful convergence of AI and maritime policy in developing nations requires a holistic and inclusive approach that balances technological advancement with regulatory preparedness, infrastructure development, and human capital investment. By taking proactive steps to bridge the technological divide, developing nations can unlock the full potential of AI in their maritime sectors, fostering economic growth, enhancing maritime security, and contributing to a more connected and efficient global maritime industry.

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