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ARTIFICIAL INTELLIGENCE SOLUTIONS TO PAKISTAN'S MARITIME SECURITY CHALLENGES: COLLABORATION WITH CHINA

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ABSTRACT

Naval modernisation initiatives, increased geostrategic competitiveness, and the expanding usage of cutting-edge technology, such as artificial intelligence (AI), are the main causes of the Indian Ocean Region's (IOR) quick development. As the interests of China and the US, India, and other regional governments collide, superpowers are transforming crucial IOR Rivers into a conflict. Pakistan has several maritime security issues, including the ongoing presence of foreign forces in the area, growing nuclear and naval threats from India, and new concerns from resource scarcity and climate change. This study examines Pakistan's maritime security issues in the context of the changing IOR while assessing AI-based strategic defence solutions. Through foreign case studies, the research examines defence innovation tactics and environmental monitoring techniques in order to propose a comprehensive maritime security strategy that uses AI technology to defend Pakistan's oceans and coastlines. The cooperation with China, especially the joint efforts in the field of the AI-powered naval forces, surveillance tools, and maritime facilities, comes out as one of the keys to the reinforcement of the maritime security system in Pakistan.

Keywords: *Strategic Stability, Blue Economy, Artificial Intelligence, Climate Change, Nuclearisation, Maritime Security, Indian Ocean Region, Pakistan Navy.*

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INTRODUCTION

The Indian Ocean Region (IOR) has become one of the most significant geopolitical theatres of the twenty-first century due to its strategic location, wealth of natural resources, and significance in world marine trade. As global powers turn their attention to the Indo-Pacific, the IOR has evolved from a commercial route to a contested strategic region marked by power conflicts, military buildups, and evolving security challenges (Kapoor, 2021). Pakistan, a coastal country with a geostrategic location near the Strait of Hormuz and a critical interest in regional marine connectivity, needs to reconsider its maritime doctrine in light of the growing militarisation and climate fragility of the IOR.

The IOR stretches from the eastern coast of Africa to the western coasts of Australia and contains significant maritime chokepoints such as the Straits of Hormuz, Bab el-Mandeb, and Malacca. Because it manages more than 80% of the global seaborne oil trade, the Indian Ocean is crucial for both economic stability and energy security (Cordner, 2018). There is a complicated network of geopolitical interests because it is home to 38 littoral states and other extra-regional military sites. For a nation like Pakistan, which sits at the confluence of South Asia, Central Asia, and the Middle East, an increase in the naval presence of regional and global powers has urgent and important strategic implications (Brewster, 2020).

In contrast to its land-centric defence stance, Pakistan's maritime policy has historically lagged behind. Due to a strategic culture that is strongly focused on threats originating from its eastern land border, the Pakistan Navy (PN) has frequently received a lesser share of the defence budget than the army and air force. However, Pakistan is forced to reconsider its maritime priorities in light of the current security landscape, which is formed by India's modernising navy, the ongoing presence of extra-regional forces, and the weaponization of the seas. Pakistan faces strategic vulnerabilities and deterrent gaps in the maritime domain, namely due to the asymmetric rise of Indian naval force (Kumar, 2022).

India's procurement of aircraft carriers, nuclear submarines, and sophisticated maritime surveillance devices is indicative of its goal to build a blue-water navy that can project power outside of the subcontinent. India's naval doctrine has shifted from coastal defence to sea control and denial capabilities, with more than 150 ships and an ambitious goal of 175 ships by 2035 (Singh, 2020). Additionally, India's participation in security agreements like the Quadrilateral Security Dialogue (Quad), which it shares with the US, Japan, and Australia, strengthens its operational reach and maritime influence in the IOR (Mohan, 2021). The regional maritime balance is drastically changed by these events, and Pakistan is concerned about nuclear stability and strategic encirclement.

In the meantime, regional security has taken on a new dimension because of China's growing maritime presence under the auspices of the Belt and Road Initiative (BRI), particularly through the China-Pakistan Economic Corridor (CPEC). Pakistan gains geostrategic visibility and economic clout from the construction of Gwadar Port as a deep-sea centre, but it also becomes entangled in a great power rivalry (Small, 2020). Despite its economic advantages, Gwadar's dual-use potential makes it a possible hot spot in a conflict between China and the US or India. A sophisticated marine strategy that strikes a balance between military readiness and economic development is required due to this multi-layered complexity. China has also become a growing technological and strategic partner in maritime defence collaboration, in addition to infrastructure investments in CPEC. The development of AI-based surveillance, underwater vehicles, and shipbuilding joint ventures between the two countries is a prime moment when Pakistan can fill its capability gaps and enter a new era of a modern and strong navy (Ali & Khan, 2024).

Inadequate marine domain awareness (MDA), insufficient domestic military output, and technical deficiencies all contribute to Pakistan's maritime vulnerability. Without the necessary resources, the PN cannot continue to monitor its Exclusive Economic Zone (EEZ) and

beyond. Its capacity to identify and address risks like piracy, smuggling, and unauthorised foreign vessel incursions is limited by the inadequate intelligence, surveillance, and reconnaissance (ISR) capabilities (Ahmad, 2021). Furthermore, comprehensive maritime governance and crisis management are hampered by Pakistan's lack of integration between military players and civilian marine agencies.

Non-traditional security challenges are becoming important issues in the IOR, in addition to traditional threats. By increasing coastal vulnerabilities, upsetting fisheries, and endangering vital infrastructure, climate change is changing the paradigm of marine security. Sea level rise, coastal erosion, saline water intrusion, and extreme weather events are all posing a growing threat to Pakistan's coastline, especially the cities of Karachi and Gwadar. These changes impair operational preparedness and economic resilience by endangering both civilian populations and navy installations (Rashid & Qamar, 2023). These hazards are increased by the deterioration of mangrove habitats, which act as organic barriers against storm damage and tidal surges.

Food security and national sovereignty are still threatened by illicit activities including illegal, unreported, and unregulated (IUU) fishing, particularly by foreign trawlers in Pakistan's marine domain. It is challenging to implement laws and protect marine resources due to insufficient monitoring systems and bureaucratic fragmentation (Khan & Zeb, 2022). These difficulties show how crucial it is to incorporate environmental security into Pakistan's marine strategy.

AI is a game-changing instrument for marine security in this intricate web of conventional and unconventional threats. AI applications have the potential to completely transform marine decision-making, resource management, and threat identification. In order to identify trends, anticipate intrusions, and keep an eye on shipping lanes in real time, AI-enabled Maritime Domain Awareness systems, for example, are able to analyse vast amounts of sensor data from radars, satellites, and acoustic devices (Kania, 2019). Even with fewer platforms, the PN may be able to increase its monitoring footprint

thanks to such devices.

Furthermore, at a fraction of the expense of manned operations, the deployment of AI-aligned Autonomous Underwater Vehicles (AUVs), Unmanned Surface Vehicles (USVs), and Unmanned Aerial Vehicles (UAVs) can provide continuous surveillance of vital maritime zones. Additionally, these systems can be quickly re-deployed in times of crisis and lower the risk to human life (Singer, 2021). AI can also help with strategic simulations, logistics optimisation, and the creation of predictive models for the effects of climate change and maritime traffic patterns.

By identifying intrusions, controlling encryption, and delivering real-time threat intelligence, AI-driven solutions can improve the resilience of naval communication networks and command and control (C2) systems in the field of cyber defence. AI-based cybersecurity solutions can be vital force multipliers in light of the growing dependence on digital technologies and the risks of digital warfare (Scharre, 2018).

However, there are also operational, strategic, and ethical issues with the use of AI in military operations. Careful thought should be given to concerns about algorithmic bias, responsibility in the deployment of autonomous weapons, and the possibility of escalation brought on by incorrect interpretation of AI-generated data. Utilising AI's advantages while maintaining strong governance and human-in-the-loop decision-making processes is Pakistan's dilemma. To create specialised AI solutions, the military must be able to collaborate with the National Centre for Artificial Intelligence (NCAI) and other research and development organisations (Rizwan, 2021).

This essay delves deeper into these topics and makes the case that Pakistan has to include AI into its larger maritime strategy as a strategic imperative rather than just a technological fix. In an increasingly disputed IOR, Pakistan can safeguard its maritime borders, overcome resource limitations, and establish credible deterrence by incorporating AI into naval operations, maritime

governance, and climate resilience frameworks. The report offers a forward-thinking approach that blends military innovation, environmental sustainability, and international diplomacy by imagining the maritime security architecture of 2050.

All things considered, the interaction of great power competition, technology upheaval, and environmental uncertainty will influence the IOR's destiny. Pakistan's readiness to embrace innovation, bolster institutional capacity, and express strategic agency will determine its ability to navigate this tumultuous maritime environment. The best way to protect Pakistan's national interests in the Indian Ocean by the middle of the century is to have a future-ready maritime strategy based on AI, sustainability, and multilateralism.

Geopolitical Context 0f the Indian Ocean Region (IOR)

IOR has emerged as a strategic theatre of contestation among great powers due to its critical role in global trade, energy transit, and military deployments. Over 100,000 commercial vessels traverse the IOR annually, transporting more than 80% of global oil shipments and two-thirds of liquefied natural gas (LNG) (Cordesman, Ayers & Lin, 2022). The region's significance is further amplified by key chokepoints—such as the Strait of Hormuz, Bab el-Mandeb, and the Strait of Malacca—which make the IOR indispensable for maritime security, global commerce, and power projection. Consequently, the region has witnessed intensifying rivalries among traditional and emerging powers, each seeking to dominate strategic maritime corridors, ports, and influence zones.

Great Power Rivalries and the Indo-Pacific Strategic Convergence

The United States, which maintains a substantial military presence through the U.S. Fifth Fleet headquartered in Bahrain and bases in Diego Garcia, considers the IOR vital to its Indo-Pacific strategy. Washington's strategic focus on ensuring 'freedom of navigation,' countering Chinese assertiveness, and supporting regional partners underpins its increased engagement in naval exercises and

surveillance operations (Pant & Passi, 2017). At the same time, China's Belt and Road Initiative (BRI)—particularly its Maritime Silk Road component—has enabled Beijing to expand its economic and military footprint through strategic port acquisitions, such as Gwadar in Pakistan, Hambantota in Sri Lanka, and Djibouti, where it established its first overseas military base in 2017.

India, in response to perceived encirclement, has adopted a robust naval modernisation agenda, intensifying its presence across the IOR through bilateral defense agreements, naval diplomacy, and increased deployments in the Arabian Sea and Bay of Bengal. With aspirations to be the 'net security provider' in the IOR, New Delhi has focused on projecting blue-water capabilities, supported by partnerships such as the Quadrilateral Security Dialogue (QUAD) alongside the U.S., Japan, and Australia (Scott, 2018). This evolving security environment presents unique challenges for Pakistan, situated at the western edge of the IOR, as it is increasingly entangled in a multipolar contest for influence and deterrence.

Naval Militarization and Strategic Competition

The weaponisation of the IOR is marked by an arms build-up involving submarines, aircraft carriers, ballistic missile platforms, and anti-access/area-denial (A2/AD) capabilities. India's induction of nuclear-powered submarines (INS Arihant and INS Arighat), development of sea-launched ballistic missiles (K-series), and testing of hypersonic cruise missiles such as BrahMos-II significantly alter the regional balance (Kumar, 2022). These developments erode the credibility of Pakistan's sea-based second-strike capabilities and create an arms-race dynamic in the region. India's strategic triad, which now includes a growing naval nuclear force, introduces ambiguity and escalatory potential in South Asia's deterrence equation.

China's increasing naval engagement in the IOR further complicates the regional dynamics. With a rapidly modernising navy and a forward-deployed presence, Beijing seeks to secure its sea-lanes and

protect overseas interests. Its participation in anti-piracy missions, submarine patrols in the Arabian Sea, and intelligence gathering in the region has drawn concern from both India and the U.S. The growing presence of Chinese naval assets near Pakistan's maritime zones adds a layer of strategic assurance for Islamabad but also entangles it in the Sino-Indian maritime competition. The Military-Civil Fusion (MCF) approach used by China can serve as a blueprint that can help Pakistan to use AI in modernization of its navy. There are already joint ventures in AI-enabled radar systems, underwater drones (e.g. HSU-001 LDUUVs) and real-time ISR platforms, e.g. that used in Chinese Smart Ocean projects, which are already improving maritime situational awareness in Pakistan (Farooq & Qazi, 2023). The purchase of Type 054A/P frigates and future submarines by Pakistan covers AI-enabled combat and radar systems, and cooperative projects in the area of autonomous surface ships, simulator-based warship systems and joint training engagements are helping in operational preparedness and institutional capacity-building in the Pakistan Navy (Khan, Shah, Shah, & Iqbal, 2025).

Permanent Extra-Regional Military Presence

The IOR is also home to a permanent military presence of extra-regional actors, including the United Kingdom, France, Japan, and Australia. These powers maintain bases, logistic hubs, and naval task forces in the region, contributing to a complex security matrix. For example, France operates military installations in Réunion, Djibouti, and the UAE, while Japan has enhanced its naval cooperation with India and Australia. This militarisation has led to overlapping security architectures, including the Indian Ocean Naval Symposium (IONS), Combined Maritime Forces (CMF), and the Djibouti Code of Conduct, aimed at promoting maritime safety, anti-piracy, and information sharing (Bueger & Edmunds, 2020).

While such initiatives enhance maritime governance, they also reflect the deepening strategic fault lines that marginalise smaller regional states like Pakistan. These actors often lack influence in shaping norms, doctrines, and power-sharing arrangements in the IOR.

Consequently, Pakistan finds itself navigating a maritime space increasingly defined by competing security visions and technological asymmetries.

Implications for Regional Order and Strategic Stability

The strategic competition in the IOR undermines regional stability by creating multiple, intersecting lines of conflict and deterrence. Naval militarisation has outpaced the development of confidence-building measures (CBMs) and rules of engagement, increasing the risk of inadvertent escalation. Moreover, the deployment of dual-use technologies—such as unmanned underwater vehicles (UUVs), AI-enabled ISR platforms, and autonomous surface vessels—raises concerns about crisis mismanagement and strategic misperception.

For Pakistan, the consolidation of an exclusive Indian maritime security architecture risks marginalisation and strategic encirclement. Its limited blue-water capabilities, nascent maritime domain awareness (MDA), and vulnerability to sea-based coercion call for a recalibration of its maritime strategy. The IOR's emerging order is not merely military—it is technological and environmental, demanding integrated, future-ready approaches that include AI-powered capabilities, strategic partnerships, and non-traditional security cooperation. The deal showcases the collective interest of China and Pakistan in addressing regional asymmetries with the Chinese supply of AI-integrated frigates (Type 054A/P) and submarine combat systems that will provide the Pakistani military with access to the forefront encryption and autonomous targeting technologies (Shabbir & Yaseen, 2025).

PAKISTAN'S MARITIME SECURITY LANDSCAPE

Pakistan's maritime security posture is shaped by its geostrategic location at the nexus of the Arabian Sea and the broader Indian Ocean Region (IOR). With a coastline exceeding 1,000 km, access to critical sea lanes, and stewardship of strategically located ports—most notably the Gwadar Port—Pakistan's maritime domain is a key

determinant of its national security and economic prosperity. However, its naval capabilities, strategic planning, and maritime governance structures remain underdeveloped relative to the growing complexities of the regional maritime environment. Pakistan's vulnerabilities are compounded by conventional asymmetries with India, emerging technological threats, and the intersection of climate change with coastal security.

Maritime Doctrine and Naval Capabilities

The Pakistan Navy (PN) plays a critical role in safeguarding national maritime interests, but its force posture remains largely defensive, constrained by limited funding, dependence on foreign suppliers, and a lack of indigenous naval industrial capacity (Khan & Zeb, 2022). Pakistan's naval doctrine emphasizes sea denial rather than sea control, focusing on protecting coastal waters, exclusive economic zones (EEZs), and ensuring the security of maritime trade routes. The Navy has expanded its operational capabilities over the past decade, acquiring submarines, fast attack craft, multi-role frigates, and long-range maritime patrol aircraft.

A significant development in Pakistan's strategic calculus is the pursuit of a credible second-strike capability through sea-based deterrence. The reported deployment of nuclear-capable Babur-3 submarine-launched cruise missiles (SLCMs) launched from Agosta-class submarines indicates Islamabad's intent to ensure survivability of its nuclear forces amid India's shift toward full-spectrum deterrence. However, Pakistan's naval nuclear deterrent remains nascent, lacking robust command and control systems, survivable platforms, and advanced underwater sensors needed for effective deployment.

While the induction of new surface combatants and submarines from China and Turkey marks an improvement in fleet modernization, the PN still lags behind the Indian Navy in terms of tonnage, technological sophistication, and power projection capabilities. India's aircraft carriers, nuclear attack submarines (SSNs), and

surveillance satellites provide it with a significant edge, underscoring Pakistan's asymmetric disadvantage at sea (Joshi, 2022). The Chinese AI-enabled systems that have been purchased by Pakistan, namely unmanned surface vessels (USVs) and swarm drones, indicate a change towards asymmetric deterrence. This expanding cooperation also involves common naval exercises such as Sea Guardians, AI-powered war games, and the use of China BeiDou satellite system to target and sensing maritime in the domain (MDA) (Anwar & Atif, 2025). Chinese assistance in the construction of ships, integration of sensors and development of underwater drones has served to ameliorate key gaps in capabilities, providing credible deterrence value to Pakistan and developing enduring institutional capabilities in the application of AI to maritime operations.

Strategic Vulnerabilities: Gwadar Port, EEZ, and SLOCs

Gwadar Port, the linchpin of the China-Pakistan Economic Corridor (CPEC), represents both a strategic asset and a vulnerability. Situated near the Strait of Hormuz, it offers Pakistan and China access to energy corridors and commercial markets. However, its proximity to conflict-prone regions of Baluchistan and its exposure to Indian and Western naval forces render it susceptible to sabotage, surveillance, and blockade in times of conflict (Ali, 2020). Moreover, the lack of an integrated security and economic strategy for Gwadar limits its utility as a full-spectrum naval and commercial hub.

Pakistan's EEZ, covering approximately 240,000 square km, remains poorly monitored and regulated. Illegal fishing, environmental degradation, and maritime terrorism persist due to limited maritime domain awareness (MDA) and inadequate law enforcement mechanisms. The protection of sea lines of communication (SLOCs) is another strategic imperative, as nearly 95% of Pakistan's trade and energy supplies transit through maritime routes (Hassan, 2019). Any disruption—whether through piracy, naval blockade, or conflict escalation—can cripple the country's economic stability and national resilience.

India's expansion of naval infrastructure on islands such as the Andaman and Nicobar and the Lakshadweep chain enhances its ability to monitor and potentially interdict Pakistani vessels. Moreover, India's participation in real-time intelligence-sharing frameworks like the Quad's Indo-Pacific Maritime Domain Awareness (IPMDA) initiative could leave Pakistan further disadvantaged in information access and maritime situational awareness.

Emerging Threats: Cyber, Hybrid, and Non-Traditional Security Challenges

In the digital age, maritime security threats extend beyond physical platforms to include cyberattacks, misinformation campaigns, and data-driven warfare. The increasing digitisation of port operations, naval logistics, and command and control systems makes critical infrastructure vulnerable to cyber intrusions. Pakistan's lack of a coherent cyber-maritime doctrine or maritime cyber defense unit exposes its coastal and naval assets to potential sabotage from adversaries or non-state actors (Farooq, 2021).

Additionally, hybrid threats such as terrorism, transnational smuggling, human trafficking, and the use of fishing trawlers for reconnaissance or sabotage have increased in frequency. The 2008 Mumbai attacks demonstrated how maritime infiltration can be used for terrorism, prompting regional navies to heighten coastal surveillance. For Pakistan, the porous nature of its maritime frontier requires the development of both hard and soft security measures, including community policing, AI-enhanced surveillance, and regional intelligence-sharing. International AI-cyber defense projects such as the Chinese adaptation of the Great Firewall to naval C2 systems may be used to protect Pakistan ports and communication systems against AI spoofing (Ali & Khan, 2024).

Institutional Challenges and Maritime Governance Deficit

Pakistan's maritime security governance is fragmented among multiple institutions, including the Pakistan Navy, Maritime Security

Agency (MSA), Ministry of Maritime Affairs, and provincial authorities. This lack of coordination results in jurisdictional ambiguities, duplication of efforts, and inefficiencies in crisis response. The absence of a comprehensive National Maritime Policy (NMP) and a maritime-specific cyber-security strategy further weakens Pakistan's ability to formulate long-term strategic objectives.

Investment in maritime research, shipbuilding, and indigenous innovation remains minimal. Unlike India, which has invested heavily in the Defence Research and Development Organisation (DRDO) and partnerships with private-sector naval industries, Pakistan continues to rely on foreign suppliers and technology transfer with limited local capacity-building. Addressing these institutional deficits is essential for developing a resilient maritime strategy that aligns with national security priorities and the evolving geostrategic landscape.

AI AND THE FUTURE OF MARITIME SECURITY

AI is revolutionising modern military operations, reshaping decision-making, surveillance, deterrence, and combat dynamics. In the maritime domain, AI-enabled systems are redefining naval warfare, ocean monitoring, threat detection, and autonomous operations, offering both opportunities and challenges for developing navies like Pakistan's. As the Indian Ocean Region (IOR) becomes a hub of strategic competition, AI integration into maritime security architectures is no longer optional—it is imperative for ensuring situational awareness, maintaining deterrence credibility, and addressing asymmetric threats.

AI Applications in Naval Warfare and Maritime Operations

The global shift toward intelligent naval systems is centered around five core domains: perception, decision-making, autonomy, cooperation, and cyber resilience (Boulanin & Verbruggen, 2017). AI enables faster and more accurate threat identification, route optimisation, and vessel tracking, empowering naval platforms with

predictive capabilities. Machine learning algorithms can process vast streams of sonar, radar, and satellite data to detect hostile submarines, identify illegal fishing fleets, or anticipate piracy incidents with greater speed and accuracy than human analysts.

In particular, AI-powered Maritime Domain Awareness (MDA) platforms utilise automated identification system (AIS) data, synthetic aperture radar (SAR), and geospatial intelligence to monitor vast oceanic expanses with minimal human input (Kraska, 2020). AI-driven unmanned surface and underwater vehicles (USVs/UUVs) offer stealth, endurance, and the ability to operate in denied environments, supporting surveillance, mine countermeasures, and anti-submarine warfare (ASW). The U.S. Navy's Sea Hunter program and China's 'Great Underwater Wall' are leading examples of AI-enhanced underwater surveillance and deterrence capabilities (Murray, 2021).

For Pakistan, AI integration can bridge critical capability gaps in areas where it cannot match India's conventional superiority. AI-enhanced command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems can facilitate rapid decision-making and allow real-time collaboration between naval units, shore command, and allied partners. In conflict scenarios, AI can assist with scenario simulations, red-teaming, and electronic warfare coordination, allowing for adaptive and informed naval responses.

Potential Military Applications for Pakistan

Pakistan's naval modernisation can benefit significantly from AI in the following areas:

Surveillance and MDA: Deployment of AI-powered sensor fusion platforms to integrate data from coastal radars, satellites, and sonar arrays will improve domain awareness and threat anticipation. Low-cost autonomous drones and fixed-wing UAVs can be used for 24/7 surveillance of critical zones, such as around Gwadar and Karachi. Pakistan has collaborated with china on smart drone swarms,

predictive analytics on a naval operation, and AI-enabled coastal defence systems, thus allowing Pakistan to operationalise asymmetric strategies on scale (Farooq & Qazi, 2023).

Autonomous Underwater Vehicles (AUVs): AI-enabled AUVs can be deployed for underwater surveillance, port security, and mine detection. These systems can operate with minimal logistical burden and provide early warning against incursions by Indian submarines or hostile AUVs.

Decision Support and War Gaming: AI can support strategic decision-making by simulating multiple combat scenarios and suggesting optimal responses. AI-assisted war gaming and digital twin simulations allow naval planners to rehearse and refine operational tactics against technologically superior adversaries.

Cybersecurity and Electronic Warfare: AI can enhance Pakistan's ability to detect and counter cyber threats targeting naval infrastructure, ships, and logistics networks. Algorithms trained to detect anomalies in network traffic can prevent breaches and protect critical command-and-control assets.

Predictive Maintenance and Logistics: AI can optimise fleet readiness through predictive maintenance systems that detect equipment degradation before failure, increasing operational availability and reducing costs (McKinsey Global Institute, 2017). Logistics chains can also be automated to ensure timely support for forward-deployed units.

A case study of China where it has been able to utilize AI and sensors at the seabed to track Indian submarines is the so-called Great Underwater Wall which should serve as a guide to Pakistan. Collaboration on the creation of affordable AI sonobuoys and forecasting analytics systems would enable Pakistan to fill in their sea-based surveillance gaps.

AI-Driven Asymmetry Against India's Naval Edge

India's naval modernisation—including nuclear-powered submarines, carrier strike groups, and satellite reconnaissance—places it at a distinct advantage. However, AI offers Pakistan an avenue to exploit asymmetries and develop niche capabilities. By investing in agile, smart, and mobile AI-powered systems, Pakistan can deny India freedom of manoeuvre in key zones, complicating its operational planning. Swarm drones, decoy technologies, and intelligent countermeasures can disrupt Indian targeting and delay force application during a crisis (Horowitz et al., 2018).

Moreover, AI can enhance Pakistan's nuclear command and control by improving early warning and ensuring survivability through mobility and deception. Smart sensors, encrypted networks, and real-time analysis reduce the chances of miscalculation and enable a more credible sea-based deterrent.

Barriers to AI Adoption in Pakistan's Naval Strategy

Despite the promise of AI, Pakistan faces numerous barriers to its adoption:

- ***Lack of domestic AI R&D capacity:*** Pakistan's technological ecosystem is underdeveloped, with limited public-private partnerships, research infrastructure, and AI education initiatives focused on defense innovation.
- ***Resource constraints and sanctions exposure:*** Defense procurement is often impacted by economic instability and international technology restrictions, limiting access to cutting-edge AI systems.
- ***Institutional Inertia:*** The military's bureaucratic structure and lack of doctrinal clarity on AI integration create slow adoption and underutilisation of available tools.
- ***Cyber insecurity and digital vulnerabilities:*** Weak cybersecurity frameworks expose AI systems to adversarial

manipulation, raising the risk of spoofing, data poisoning, and algorithmic errors.

Global Lessons for Pakistan's AI Maritime Ambitions

Pakistan can draw lessons from AI integration strategies adopted by countries like China, which has pursued military-civil fusion (MCF) to accelerate defense innovation, and the U.S., which has invested in Joint Artificial Intelligence Centers (JAIC) to coordinate AI deployment across services. Similarly, NATO's DIANA initiative and India's iDEX platform provide models for dual-use innovation and start-up engagement (Sayler, 2020). Pakistan can take inspiration in China and create Military-Civil Fusion (MCF) strategy through the creation of dual-use tech hubs like Pak-China AI Labs at Karachi University to jointly develop swarm drones, smart mines, and other maritime AI solutions fitting the operating conditions in the Arabian Sea. Still at an advanced stage, such as the handoff of AI-augmented radar systems, live ISR structures, and machine-learning code to detect underwater challenges, are signs of the breadth of bilateral defense tech collaboration (Khan et al., 2025). To capitalise on this momentum, Pakistan needs to come up with a national defense AI strategy, invest in local innovation ecosystems, and focus on dual-use maritime technologies. Joint ventures with China, Turkey, and the Gulf states should be expanded to co-development, academia, and defense start-up incubators and this will help make Pakistan a regional hub of intelligent maritime systems (Shabbir & Yaseen, 2025).

CLIMATE CHANGE, ENVIRONMENTAL STRESSORS, AND MARITIME INSECURITY

The Indian Ocean Region (IOR) is not only a geopolitical hotspot but also one of the most climate-vulnerable maritime zones in the world. Pakistan, with its extensive coastline, heavily populated coastal cities, and dependence on maritime trade, faces a confluence of environmental threats that directly undermine its maritime security. Climate change acts as a threat multiplier, exacerbating traditional

and non-traditional security risks—ranging from natural disasters and resource scarcity to displacement and critical infrastructure degradation. These environmental stressors complicate Pakistan's strategic calculus in the IOR and demand urgent integration of climate resilience into maritime security frameworks.

Rising Sea Levels and Coastal Vulnerability

Pakistan's coastal regions, particularly Karachi, Ormara, and Gwadar, are highly susceptible to sea-level rise, coastal erosion, and saline water intrusion. According to the Intergovernmental Panel on Climate Change (IPCC), the Arabian Sea is warming faster than the global average, increasing the frequency and severity of storm surges and tropical cyclones (IPCC, 2021). Rising sea levels not only threaten residential communities and economic zones but also pose direct risks to naval installations, ports, and logistical hubs.

Karachi—Pakistan's economic lifeline and naval headquarters—sits precariously close to the sea and is already experiencing recurrent urban flooding, infrastructure strain, and waterlogging. The loss or damage to critical infrastructure such as shipyards, communication systems, and command centers due to climate-induced disasters could severely disrupt naval operations during crises. Pakistan's limited disaster-response capabilities and under-resourced coastal management systems further exacerbate the vulnerability of its maritime security apparatus.

Ocean Acidification, Fisheries Depletion, and Blue Economy Risks

Ocean acidification and warming waters have led to significant changes in marine biodiversity, disrupting traditional fishing grounds and reducing fish stocks. These environmental changes directly affect Pakistan's coastal communities and the sustainability of its blue economy. According to the World Bank (2020), over one million people in Pakistan are directly employed in fisheries and maritime-related industries. Climate-induced migration from degraded coastal zones could contribute to urban instability, unemployment, and the growth of unregulated informal economies.

Moreover, depleted fish stocks and competition for marine resources increase the likelihood of conflict at sea, particularly in disputed or overlapping Exclusive Economic Zones (EEZs). The Arabian Sea has witnessed a surge in illegal, unreported, and unregulated (IUU) fishing, often involving foreign trawlers violating Pakistan's maritime boundaries (WWF Pakistan, 2021). Without enhanced monitoring and ecological enforcement mechanisms, environmental degradation could translate into maritime insecurity and diplomatic friction.

Climate Security Nexus and Naval Readiness

Climate change alters the very nature of maritime operations, requiring navies to adapt to new missions, such as humanitarian assistance, disaster relief (HADR), environmental monitoring, and infrastructure protection. For Pakistan, the shifting climate-security nexus mandates the development of climate-resilient naval strategies, including the fortification of coastal bases, integration of environmental intelligence, and expansion of non-traditional security roles.

Naval readiness must increasingly account for climate-triggered events, including disruptions to supply chains, storm damage to vessels, and operational delays caused by extreme weather. The Pakistan Navy, in coordination with civilian agencies, must build dual-capacity platforms capable of both defense and climate response. Joint exercises with regional partners focused on HADR, coastal evacuation, and maritime search-and-rescue (SAR) can enhance resilience while improving diplomatic engagement.

Green Maritime Strategies and Environmental Governance

A future-ready maritime security strategy for Pakistan must include environmental stewardship. This involves transitioning toward 'green ports' with sustainable energy usage, waste management, and carbon footprint reduction. Gwadar, in particular, must adopt environmentally sustainable development models to ensure long-term viability as a commercial and naval hub. The collaboration with

China is also related to the sustainable development of the sea and Chinese firms are investing in smart port technologies in Gwadar, which will be based on AI to manage refuse, optimise logistics, and monitor the environment in real-time. The CPEC climate-resilient infrastructure aspirations will accommodate the projects such as IoT-based coast monitoring stations and renewable energy microgrids in the Digital Silk Road. These alliances could also be expanded to include AI-based disaster response fleets that would offer humanitarian assistance and disaster relief (HADR) (Anwar & Atif, 2025).

Pakistan must also update its maritime laws and environmental regulations to reflect emerging climate realities. Strengthening the role of institutions such as the Pakistan Maritime Security Agency (PMSA) and Marine Fisheries Department (MFD) in ecosystem protection, marine pollution control, and disaster preparedness is critical. At the international level, Pakistan should actively participate in frameworks such as the Indian Ocean Rim Association (IORA) and the Indian Ocean Commission (IOC) to shape regional climate and maritime policies.

Climate Diplomacy and Regional Confidence Building

Environmental challenges provide a unique opportunity for regional cooperation in an otherwise adversarial security environment. Shared vulnerabilities—such as coastal flooding, coral reef degradation, and monsoon variability—can act as drivers for confidence-building measures between India, Pakistan, and other IOR littoral states. Pakistan should propose climate security dialogues, joint scientific missions, and disaster relief protocols under the auspices of IORA or UN bodies.

Moreover, integrating AI tools into climate modelling, maritime environmental monitoring, and disaster forecasting can improve Pakistan's early warning systems and enhance its ability to anticipate and mitigate climate impacts. Investment in ocean sensors, satellite imagery, and automated reporting systems is essential for developing

a comprehensive, AI-enhanced climate surveillance strategy.

Policy Recommendations: AI-Driven Solutions and Strategic Options for Pakistan

In an era defined by intensifying geopolitical rivalries, technological disruption, and environmental degradation, Pakistan's maritime strategy must undergo a transformative shift. It is no longer sufficient to focus solely on conventional naval parity or reactive security postures. Pakistan must adopt a proactive, adaptive, and innovation-driven approach—integrating AI, climate resilience, and multilateral cooperation into a coherent long-term vision. Below are comprehensive military and non-military policy recommendations to enhance Pakistan's maritime security by 2050.

Military Policy Recommendations

a. *Establish a National AI Maritime Task Force*

Pakistan must create a National AI Maritime Task Force comprising stakeholders from the Pakistan Navy, Ministry of Defence Production, academia, and the tech industry. This task force should develop a maritime AI roadmap to:

- Identify AI use cases in naval operations, logistics, and cyberdefense.
- Foster civil-military partnerships for R&D in unmanned systems and intelligent surveillance.
- Secure funding for dual-use technologies under strategic innovation programs.

This institutional mechanism would streamline AI adoption, reduce duplication, and create an ecosystem for long-term capability development.

b. *Develop AI-Powered Maritime Domain Awareness (MDA)*

Pakistan should invest in a next-generation MDA platform powered by AI to enhance real-time threat detection, sea traffic monitoring,

and illegal activity tracking. This can include:

- Automated satellite image analysis for vessel classification.
- AI-driven anomaly detection in AIS and radar data.
- Machine learning-based prediction of maritime chokepoint congestion or potential flashpoints.

China, Turkey and Malaysia should be collaborated to develop an indigenous architecture of MDA as per the requirement of Pakistan. MDA using AI can be facilitated with collaborative initiatives with the Chinese Beidou satellite network and radar data analytics platforms to satisfy Pakistan geostrategic interests (Khan et al., 2025).

c. *Strengthen Naval AI Capabilities Through Unmanned Systems*

To overcome numerical and technological inferiority vis-à-vis India, Pakistan must adopt an asymmetric maritime strategy using:

- *Autonomous Underwater Vehicles (AUVs)* for mine countermeasures, surveillance, and anti-submarine warfare (ASW).
- *Unmanned Surface Vessels (USVs)* for persistent patrols, anti-piracy, and SLOC monitoring.
- *Swarm drones* for electronic deception, decoy tactics, and saturation attacks.

The local manufacture of AI-enabled AUVs and swarm drones that can be used to defend the EEZ of Pakistan can be possible through joint R&D efforts with Chinese defense technology companies (Ali & Khan, 2024). A special military tech innovation fund should locally prototype cost-effective unmanned systems by local firms and universities.

d. *Establish Cyber and AI Warfare Units Within the Pakistan Navy*

Cyber and information warfare are increasingly central to maritime operations. A Cyber-AI Warfare Division within the Navy can be

tasked with:

- Securing AI-powered systems from adversarial machine learning attacks and spoofing.
- Developing offensive capabilities to disrupt hostile maritime systems.
- Enhancing command and control systems through secure, AI-enhanced decision support platforms.

Cyber deterrence must be institutionalised as part of Pakistan's strategic doctrine.

e. ***Integrate AI in Naval Nuclear Command-and-Control***

Given the pursuit of a sea-based second-strike capability, AI can assist in improving:

- Early warning and decision-support frameworks.
- Command survivability through smart decoys and mobile communication nodes.
- Scenario-based simulations to test nuclear thresholds and crisis escalation patterns.

Such integration must be cautious, transparent, and embedded within robust human-in-the-loop safeguards to prevent algorithmic escalation.

Non-Military and Soft Power Policy Options

a. ***Launch a 'Blue AI Initiative' for Climate Resilience and Maritime Governance***

Pakistan should lead a regional Blue AI Initiative aimed at using AI for:

- Predictive modelling of sea-level rise, coastal erosion, and climate migration.

- Monitoring illegal fishing and marine pollution using drones and satellite analytics.
- Enhancing humanitarian response through AI-based disaster early warning systems.

This initiative can be hosted under the Ministry of Maritime Affairs and attract funding from global climate and tech foundations.

b. ***Promote Maritime Diplomacy through Regional AI and Climate Forums***

Pakistan can use AI and climate security as a platform to engage adversaries and regional actors by:

- Proposing a South Asia Maritime AI Dialogue under IORA or the UNESCAP.
- Hosting regional workshops on AI ethics, autonomous weapons governance, and naval arms control.
- Initiating confidence-building measures (CBMs) with India focused on ocean pollution reduction, joint SAR exercises, or anti-piracy patrols.

Such engagements offer non-threatening avenues for diplomacy and normalisation.

c. ***Reform Maritime Governance and Legal Frameworks***

Pakistan's maritime laws and institutional mechanisms must be overhauled to:

- Include legal provisions for AI use in maritime law enforcement, privacy, and liability.
- Expand the Pakistan Maritime Security Agency's (PMSA) mandate to include climate monitoring and cyber defense.

- Empower provincial authorities to participate in coastal resilience and marine economy planning.

A robust legal and institutional foundation is essential to sustain long-term security strategies.

d. ***Build Indigenous AI and Naval Tech Ecosystem***

To reduce foreign dependency, Pakistan must:

- Establish maritime innovation hubs in coastal universities to promote research in AI, robotics, and oceanography.
- Provide incentives for start-ups to develop AI-based maritime solutions.
- Partner with countries like China and Turkey for tech transfer and co-development under the Strategic Trade and Technology Partnership model.

The China-Pakistan Strategic Partnership Agreement should be expanded to involve bilateral cooperation with Chinese AI companies and defense universities in the development of co-funded innovation labs dedicated to the use of AI in the maritime environment. Knowledge-based autonomy is the key to strategic resilience.

e. ***Invest in Green Ports and Sustainable Blue Economy***

Sustainability must be central to maritime modernisation. Pakistan should:

- Transform Gwadar into a green port with renewable energy infrastructure, smart logistics, and eco-friendly practices.
- Promote eco-tourism, aquaculture, and marine biotechnology to diversify the blue economy.
- Work with international organisations to gain access to green finance for maritime sustainability projects.

Suggest a Blue AI Corridor project as a part of CPEC, in which the super-modern oceanographic AI systems practiced in China, including the Qingdao National Laboratory for Marine Science, will be integrated with the coast surveillance network that Pakistan already has, to address the issues of illegal fishing and marine pollution by fusing the data in real-time and predicting the trends. This would reduce ecological degradation while expanding maritime prosperity.

CONCLUSION: NAVIGATING TOWARDS 2050 — STRATEGIC VISION FOR PAKISTAN

As the Indian Ocean Region (IOR) approaches the midpoint of the 21st century, it is rapidly transforming into a complex geopolitical and geostrategic arena, where the interplay of great power rivalry, emerging technologies, and environmental fragility is reshaping the maritime security calculus. For Pakistan, these developments are neither distant nor abstract—they are urgent, multidimensional challenges that directly impact its national security, economic prosperity, and strategic autonomy.

India's accelerated naval modernisation, including the induction of nuclear-powered submarines, aircraft carriers, and enhanced ISR capabilities, has tilted the strategic balance in the IOR. Coupled with the growing presence of extra-regional forces such as the United States, China, and increasingly France and Australia, the Indian Ocean is becoming saturated with power projection platforms, autonomous systems, and surveillance networks. This dynamic not only erodes Pakistan's deterrence posture but also restricts its freedom of navigation, access to sea lines of communication (SLOCs), and capacity to defend its exclusive economic zone (EEZ). Moreover, the steady nuclearisation of the maritime domain—evidenced by India's sea-based deterrent ambitions—exacerbates crisis instability and lowers the threshold for conflict escalation, particularly in South Asia.

Simultaneously, Pakistan is confronted with the existential threats posed by climate change. Rising sea levels, coastal flooding, resource depletion, and ecological degradation are already affecting major coastal cities like Karachi and Gwadar. These phenomena threaten critical infrastructure, disrupt naval readiness, and fuel economic insecurity for coastal communities. Left unaddressed, these non-traditional security challenges could spiral into humanitarian crises, migration surges, and internal instability.

However, amid these daunting trends lies a transformative opportunity: the strategic integration of AI into Pakistan's maritime security architecture. AI is not a silver bullet, but it offers an array of tools that can enhance domain awareness, optimise decision-making, improve crisis response, and enable asymmetric strategies that compensate for Pakistan's conventional disadvantages. By leveraging AI in areas such as autonomous surveillance, cybersecurity, logistics, and climate modelling, Pakistan can transition from a reactive maritime actor to a proactive and predictive force in the IOR.

To realise this vision, Pakistan must pursue a dual-track approach. Militarily, it must adopt an AI-driven modernisation strategy that focuses on low-cost, high-impact technologies—unmanned systems, smart sensors, and digital war-gaming platforms—that strengthen deterrence and enhance maritime situational awareness. Simultaneously, it must build a cyber-resilient, climate-adaptive naval force capable of operating in contested, congested, and climate-stressed environments. This also includes integrating AI into sea-based nuclear command-and-control systems with robust safeguards and transparency measures.

Non-militarily, Pakistan must embrace a maritime grand strategy that embeds AI within its broader national security, environmental, and economic frameworks. This includes establishing a national AI maritime task force, investing in indigenous R&D ecosystems, and promoting regional diplomacy through climate security and AI governance dialogues. Pakistan should lead initiatives such as a Blue AI Alliance for sustainable ocean development and work with

international institutions to secure green finance for maritime resilience projects.

Sino-Pakistan cooperation in the AI-enabled maritime ecosystems (smart ports, autonomous fleet, ISR) is potentially reshaping the paradigms of regional security through the combination of Chinese technological skills and Pakistani geostrategic interests by 2050. China, being a central collaborator in this transition, not only offers financial and infrastructural support but also plays a significant role in integrating AI in all the naval systems. This partnership should be institutionalised and expanded to the magnitude of a strategic maritime vision of Pakistan to achieve long-term results.

The path ahead is not without obstacles—ranging from technological underdevelopment and institutional inertia to geopolitical constraints and fiscal limitations. But with strategic clarity, policy coherence, and long-term investments, Pakistan can navigate the turbulent waters of the Indian Ocean with foresight and resilience. By 2050, a technologically empowered, climate-resilient, and diplomatically engaged Pakistan Navy can serve not only as a guarantor of national security but also as a regional force for stability, sustainability, and strategic innovation.

In this envisioned future, 'smart seas' will not merely signify technologically surveilled waters but intelligent, adaptive, and collaborative governance of maritime spaces. 'Secure shores' will not only refer to well-defended coastlines but also to climate-resilient infrastructure, empowered coastal communities, and sustainable blue economies. Through strategic foresight and innovation, Pakistan can seize the tides of transformation—and chart a secure and sovereign course in the weaponised and warming waters of the Indian Ocean.

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