



Reshaping Capabilities and Constructing Institutional Frameworks for Maritime Law Enforcement in the Era of Artificial Intelligence

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Abstract. This paper explores pathways for reshaping the capabilities and constructing institutional frameworks for maritime law enforcement in the era of artificial intelligence. It focuses on the practical challenges currently faced in maritime law enforcement development—including oversight, data integration, and decision support—as well as emerging challenges arising from intelligent transformation, such as systemic barriers, data security risks, and diminished autonomy. Research indicates that AI technologies can empower maritime law enforcement capabilities through patrol systems, data governance, and decision-making models, driving a shift from “experience-driven” to “intelligence-driven” operations. Accordingly, this paper proposes a systematic development framework centered on “institutional construction—ecosystem cultivation—capability restructuring.” This framework aims to build a modern AI-empowered maritime law enforcement force, contributing to the advancing the strategy of building a maritime power.

Keywords: maritime law enforcement; artificial intelligence; human-machine collaboration; public organization transformation; force capability development

1 Introduction

The report of the 20th CPC National Congress outlined the strategic deployment to “develop the marine economy, protect the marine ecological environment, and accelerate the building of a maritime power.”^[1]With far-sighted vision, the CPC Central Committee with Comrade Xi Jinping at its core has positioned the development of a maritime power as an integral part and important strategic task of advancing Chinese-style modernization, charting the course for advancing maritime power development and promoting comprehensive marine governance. Under this grand blueprint, advancing the modernization of law enforcement teams is a critical task that aligns with the demands of the times and underpins the implementation of the maritime power strategy. Concurrently, the report explicitly calls for “deepening the implementation of the strategy to build a talent powerhouse,” providing clear guidance for the development of maritime law enforcement teams. Driven by the convergence of multiple

strategies—including building a maritime power, a talent powerhouse, a cyber power, and a digital China—the modernization of maritime law enforcement teams has become a systemic endeavor. From the perspective of public organizational transformation, this development involves not only technological upgrades but also a systematic restructuring of existing organizational frameworks, authority-responsibility relationships, and personnel competency systems.

However, current maritime law enforcement faces numerous challenges. For instance, in overseeing vast maritime areas, reliance on traditional methods like vessel patrols and manual surveillance makes it difficult to achieve round-the-clock, comprehensive, and precise monitoring. In marine data processing, inconsistent standards and formats across departmental information systems hinder effective integration and sharing, resulting in widespread “data silos.” Vast data resources remain untapped as actionable enforcement support, constraining the scientific rigor and coordination of maritime decision-making. Regarding enforcement quality and efficiency, the absence of intelligent decision-support tools means on-site responses heavily depend on individual officers' experience. This makes it difficult for maritime law enforcement to effectively balance rapid response with precise judgment in complex scenarios.

Artificial intelligence technology, with its powerful capabilities in perception, reasoning, and decision-making^[2], offers a new pathway for advancing the modernization of law enforcement teams. By introducing AI technology, traditional enforcement models are poised for systemic transformation: maritime surveillance will evolve from “human patrols” to “intelligent patrols”; data processing will transition from fragmented silos to unified integration; and enforcement decision-making will achieve a revolutionary leap from “experience-based” to “precision-based.” This will comprehensively and fundamentally enhance the overall effectiveness of maritime law enforcement.

2 Efficiency Reconstruction: Ai-Driven Empowerment Mechanisms for Maritime Law Enforcement Capabilities

2.1 Transformation of Patrol Systems and Enhanced Early Warning Capabilities

Leveraging AI-driven capabilities, various maritime law enforcement patrol systems can intelligently analyze massive historical case data, marine environmental information, vessel navigation trajectories, and other dynamic maritime intelligence. This enables precise identification of high-risk maritime areas, peak activity periods, and evolving threat patterns, ultimately generating highly targeted predictive analytical reports. Typical practices include those of Tangshan Maritime Safety Administration, which deployed the DeepSeek-R1 large model locally to create an intelligent system named “Little Hai.” This system enables millisecond-level response for dynamic supervision and compliance review of construction vessels, achieving a qualitative shift from manual inspection to intelligent decision-making in vessel examinations. Supported by such technology, enforcement agencies can scientifically allocate resources

and proactively plan strategies in daily operations. This manifests as precise patrol and control of key monitoring areas, advance preparation of targeted response plans, and dynamic optimization of core enforcement resources. This transformation effectively supports a paradigm shift from the traditional "response after incidents" model to a "pre-emptive response" model, significantly freeing up limited maritime enforcement resources constrained by blind patrol operations.

2.2 Data Governance Innovation and Enhanced Interagency Collaboration

The introduction of AI technology offers a novel solution to the longstanding challenge of maritime data silos^[3]. Taking Daishan County as an example, the county has integrated information command systems such as fishery administration, port navigation, and maritime affairs, and integrated video surveillance of all maritime and fishing ports and docks in the county into the command center. AI algorithms are used to analyze ship trajectories and berthing status in real time, accurately identify suspected targets such as obstructed ships and "three no" ships, and achieve comprehensive control and intelligent supervision of the dynamic trajectories of more than 500 fishing boats and about 460 merchant ships per day. From this, it can be seen that artificial intelligence can perform targeted format normalization on multi-source heterogeneous data according to user needs.

Furthermore, AI enables the establishment of data authorization mechanisms. By intelligently regulating data flow paths and usage scopes based on predefined permissions, AI ensures maximum data sharing while safeguarding data security and subject rights. This significantly reduces the institutional costs and operational complexities of cross-departmental data sharing, thereby stimulating departments' intrinsic motivation for collaborative data utilization. This fundamentally propels law enforcement data from "passive sharing" toward a profound shift toward "proactive empowerment." This innovative data governance model enhances law enforcement teams' data literacy and collaborative capabilities while breaking down communication barriers between departments.

2.3 Decision-Making Model Transformation and Human-Machine Collaborative Decision-Making Capability Building

Currently, due to the widespread absence of intelligent decision support tools, maritime law enforcement personnel primarily rely on accumulated individual experience for subjective on-site judgments during field operations. Artificial intelligence technology can establish intelligent analysis platforms to perform real-time parsing and deep correlation of diverse information—including vessel characteristics, navigation trajectories, operational behaviors, and surrounding environments. Leveraging massive historical enforcement data and professional law enforcement experience models, these platforms rapidly generate standardized response recommendations.

A typical successful application is the Yangshan VTS+AI intelligent decision-making system. The system deeply integrates data from the jurisdictional waters and ships, building a comprehensive intelligent decision-making ecosystem. It is like

an tireless' electronic sentinel ', taking over complex and difficult to accurately judge analytical and decision-making tasks such as traffic flow pre control management, graded warning quantification output, single ship abnormal behavior recognition, and ship collision risk recognition, and successfully achieving a qualitative change in maritime traffic supervision from ' human surveillance 'to' AI pre control+human review '. It is not difficult to see that once this change is implemented, law enforcement personnel can be relieved from the heavy workload of information screening and pattern recognition tasks. This will not only significantly compress the time cycle from situational awareness to action execution for various event handling, but also effectively reduce the uncertainty of judgment caused by individual experience differences, cognitive biases, or continuous work fatigue of law enforcement personnel through standardized analysis frameworks, ultimately promoting maritime law enforcement to move from "experience dependent" to "data-driven".^[4]

3 Practical Challenges: Obstacles to Capability Transformation and Institutional Development

3.1 Rigid Institutional Integration and Fixed Coordination Mechanisms

The inflexible nature of compartmentalized systems may give rise to even more intractable “intelligent barriers” in the AI era. Should AI systems from maritime police, maritime safety, fisheries administration, and other agencies operate independently in terms of data standards, algorithmic logic, and decision-making rules, the challenges of cross-departmental coordination will escalate from past “information silos” to “systemic conflicts.” Take cross-domain, complex maritime emergencies as an example: different AI systems may generate contradictory or even opposing analytical conclusions based on their own logic, making it difficult for joint command centers to reach unified decisions. At best, this delays decision-making and misses critical response windows; at worst, command chaos could paralyze the entire command system during critical moments. Simultaneously, deep AI application without corresponding legal frameworks directly undermines the legitimacy and credibility of law enforcement, sparking dilemmas of “algorithmic abuse of power” and “liability vacuum.”^[5]

3.2 Dual Pressures of Data Security and Privacy Protection

While introducing AI technology offers novel pathways to resolve data integration challenges, it simultaneously introduces new risks and challenges^[6]. Integration centralizes vast amounts of highly sensitive data—including vessel information, crew identities, and navigation trajectories—within unified analytical platforms, significantly expanding data exposure. During data integration and sharing, the data subject identification and access control mechanisms relied upon by AI systems can intelligently regulate data flow paths and usage scopes based on predefined permissions. However, the screening and judgment foundations of these mechanisms are not always precise. Issues such as data bias, model flaws, or improper rule configurations may

trigger identification errors, potentially leading to risks like unauthorized access, illegal data exports, or external malicious attacks.

3.3 Risks of Technological Dependency and Eroded Agency

During the intelligent transformation of maritime patrol systems, excessive reliance on AI technology inevitably fosters a path dependency toward “algorithm-driven” decision-making within law enforcement agencies. Such high dependence renders systems exceptionally vulnerable to data contamination, attacks, or failures, potentially disrupting command chains and emergency response mechanisms during critical moments. While this provides crucial support for overcoming the long-standing reliance on individual experience in maritime law enforcement, once algorithmic dependence takes hold, it will inevitably erode the professional intuition and situational awareness accumulated by officers through years of practice. This, in turn, weakens their capacity for creative adaptation and emergency response when confronting sudden incidents, conflicting information, or situations not covered by established rules. Moreover, maritime law enforcement situations evolve rapidly. Algorithmic judgments, grounded in historical data and predefined models, inherently suffer from lag and inflexibility when confronting non-standard scenarios, potentially creating sharp contradictions with dynamic realities. In such circumstances, the absence of robust, independent human judgment grounded in deep experience to intervene and correct these systems risks not only failing to enhance enforcement effectiveness but also triggering misjudgments due to inappropriate responses and inflexible decision-making. Ultimately, this could lead to unforeseen adverse effects on the quality and efficacy of enforcement operations.^[6]

4 Path Selection: Exploring Solutions for Intelligent Development of Maritime Law Enforcement Forces

4.1 Institutional Framework: Establishing a System for Interagency Collaboration and Legal Safeguards

Efforts should focus on building a data-driven, human-machine collaborative system for interagency coordination and legal safeguards. First, in organizational design, the traditional model of joint departmental meetings should be replaced by establishing a permanent committee for intelligent maritime law enforcement development. This committee should be led by local governments, coordinating core maritime agencies such as the Coast Guard, Maritime Safety Administration, Fisheries Administration, and Customs, while incorporating AI experts and legal advisors. It should chart the technical development roadmap for AI applications and implement cross-departmental data standards and system interface specifications from the outset to eliminate risks of “system incompatibility” stemming from inconsistent standards. Second, regarding regulatory and standard improvements, legal development must synchronize with technological application. Specialized legislation should clarify AI's legal status, ap-

plication boundaries, and liability attribution in law enforcement activities. Corresponding national standards must be established to provide a clear, unified, and lawful framework for maritime law enforcement teams' intelligent development, strictly preventing "liability vacuums."^[7] Furthermore, the "command stick" role of budgeting and performance evaluation should be fully leveraged. This involves establishing dedicated funding budgets, strengthening the rigidity of budget execution, and incorporating intelligent collaboration efficiency into core performance indicator systems. Such measures transform cross-departmental coordination from a soft requirement into a hard constraint.

Hainan Province has promoted the establishment and improvement of a cross sectoral water traffic safety supervision mechanism by introducing the Working Procedures for Water Traffic Safety Information Notification in Hainan Province (for trial implementation), including "cross regional and cross sectoral notification of water traffic violations" into the first batch of regulatory application scene construction in the Action Plan for Deeply Promoting Cross sectoral Comprehensive Supervision (2024-2025), the five key tasks of "strengthening infrastructure and improving capacity" in the government's digital transformation in 2024, and the measures of deeply integrating the "dual system" and "Internet plus supervision" systems. This not only solves the problem of "insufficient regulatory accuracy" caused by lack of interoperability in the past, but also achieves efficient circulation of data among maritime departments by establishing a closed-loop reporting mechanism throughout the entire process.

4.2 Ecosystem Cultivation: Building a Secure, Controllable, and Value-Releasing Data Governance Framework

To address internal and external security risks during data integration, law enforcement agencies should build a new data governance ecosystem centered on privacy protection and authorization management while ensuring data sharing effectiveness. On one hand, integrate multi-source data to drive risk early warning and resource optimization. On the other hand, leverage cutting-edge privacy computing technologies to enable encrypted cross-departmental data computation and collaborative analysis without requiring plaintext aggregation of raw data. This fundamentally transforms traditional centralized data processing models, effectively controlling exposure risks at the source. Simultaneously, intelligent data application traceability mechanisms must be deeply embedded throughout the entire data flow chain. Real-time monitoring and dynamic tracking should be implemented across all stages—access, usage, and sharing—to establish comprehensive lifecycle oversight. Upon detecting abnormal access, unauthorized operations, or potential data breaches, the system automatically triggers a security circuit breaker to instantly sever risk pathways. Leveraging comprehensive traceability records, it rapidly pinpoints the source of issues and identifies responsible parties, enabling swift risk response and precise mitigation. This approach unleashes data value while establishing a trustworthy, controllable, and traceable data security framework. The DeepSeek-R1 localization deployment solution of Jiangsu Maritime Safety Administration achieves the core business data 'not leaving the domain' by

localizing the server deployment. Once a risk occurs, it can be quickly disconnected from the physical and network levels, effectively preventing external risks and network attacks.

4.3 Capability Reshaping: Establishing a Synergistic Development Mechanism for Technological Empowerment and Competency Enhancement

To fully leverage the decision-making advantages of AI while effectively mitigating systemic risks associated with diminished officer autonomy, maritime law enforcement agencies must establish a capability maintenance and enhancement mechanism aligned with the intelligent enforcement system. This mechanism centers on enabling officers to systematically elevate their professional competence and decision-making autonomy in human-machine collaborative environments through structured specialized training, practical exercises, and performance evaluations. Based on McClelland's competency model, job competencies must define the core qualities required for excellence [8]. Given the characteristics of AI applications, officers must possess algorithmic literacy at the cognitive level to evaluate the validity of intelligent systems' analytical recommendations. At the skill level, they should master human-machine interactive decision-making abilities, adeptly balancing intelligent assistance with manual judgment. At the trait level, they must possess essential on-site analytical and emergency response capabilities to ensure operational readiness during system failures or non-standard scenarios. A rigorous, cyclical training system should be established based on this competency model, ensuring all officers complete comprehensive training in cognition, skills, and traits within specified intervals. Highly realistic specialized drills should be designed and conducted to sustain and upgrade officers' professional capabilities within human-machine collaborative environments. Simultaneously, prioritize combat-ready exercises. Leveraging a "human-in-the-loop" decision-making mechanism, establish a structured "dual-track assessment-authoritative decision" exercise process to systematically enhance the intelligent decision-making capabilities of law enforcement teams. Furthermore, a new-generation law enforcement capability assessment system centered on "human-machine collaboration effectiveness" must be established. This system should incorporate practical outcomes such as the accuracy rate of intelligent alerts, the reasonable adoption rate of algorithmic recommendations, and the success rate of independent handling during system anomalies into evaluations. These metrics should be directly linked to promotions and performance rewards, ultimately establishing a clear capability development orientation for law enforcement teams based on "performance-driven competency assessment."

5 Conclusion

Building an intelligent patrol system driven by data and human-machine collaboration will shift law enforcement from reactive response to proactive early warning. Establishing a data governance ecosystem that is secure, controllable, and value-unlocking will break down data silos while fortifying security defenses. Developing a capability

framework centered on human-machine synergy and shared capacity will enhance decision-making efficiency while safeguarding the professional value of law enforcement entities. Moving forward, the path toward intelligent maritime law enforcement must consistently leverage technology as the vessel and human expertise as the helm. This approach embraces data-driven advantages while maintaining systemic resilience, harnesses technological dividends while mitigating potential risks, and ultimately establishes a new model of maritime law enforcement that is both highly efficient and precise, as well as robust and reliable. This framework will provide solid support for safeguarding national maritime rights and interests and ensuring maritime public safety.

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