



## The Role of MARPOL Annex V Implementation in Reducing Marine Litter in Indonesia: Challenges and Opportunities

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**Submitted :** 20/01/2025    **Revised :** 07/02/2025    **Accepted :** 07/06/2025    **Published :** 15/06/2025

### ABSTRACT

*The implementation of MARPOL Annex V, which regulates ship-generated waste to prevent marine pollution, demonstrates significant inconsistencies in Indonesia despite its ratification into national legislation. This study examines compliance gaps, operational challenges, and systemic barriers that impede effective enforcement aboard Indonesian-flagged vessels. The research identifies three primary challenges: insufficient crew awareness resulting from inadequate training programs, limited port waste reception facilities, and inadequate supervision and law enforcement by maritime authorities. Findings indicate a substantial disconnect between policy formulation and practical implementation, with only 30% of surveyed vessels meeting waste segregation and disposal requirements. To address these deficiencies, this study proposes a comprehensive multi-stakeholder strategy incorporating enhanced law enforcement mechanisms, standardized crew certification programs, and strategic investments in port waste infrastructure. These recommendations aim to strengthen Indonesia's alignment with global marine protection standards under MARPOL Annex V while providing valuable insights for other developing maritime nations facing similar challenges.*

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**Keywords:** MARPOL, Annex V, Ship waste compliance, Port reception facilities, Maritime law enforcement, Marine pollution prevention

### 1. INTRODUCTION

The International Convention for the Prevention of Pollution from Ships (MARPOL) represents a fundamental global commitment established by the International Maritime Organization (IMO), a specialized United Nations agency dedicated to maritime safety and marine pollution prevention. This convention aims to protect the marine environment from pollution caused by ships, whether intentional or incidental, arising from routine operations or maritime accidents [1], [2].

**Table 1. Timeline of MARPOL Annex Adoption**

Year	Annex	Regulatory Focus
1983	Annex I	Pollution by oil
1987	Annex II	Noxious liquid substances in bulk
1992	Annex III	Harmful substances in packaged form
1988	Annex V	Garbage from ships
2005	Annex IV	Sewage
2005	Annex VI	Air emissions

Indonesia, as the world's largest archipelagic state with a maritime area spanning 6.4 million square kilometers, bears considerable responsibility in

preserving marine ecosystems and serves as a critical node in global maritime logistics networks [3]. Indonesia's commitment to marine environmental protection is demonstrated through its ratification of MARPOL 73/78 via Presidential Regulation No. 21 of 2020, which adopts all annexes, including Annex V concerning ship waste management. However, IMO reports indicate that Indonesia's implementation performance remains below the global average, particularly in enforcement mechanisms and supporting infrastructure [4].

Statistical evidence reveals concerning compliance gaps. The Directorate General of Sea Transportation documented 47 cases of illegal ship waste discharge in Indonesian waters during 2022 [5]. Furthermore, interviews conducted with officials from the Ministry of Environment and Forestry (KLHK) in 2023 revealed that 65% of major ports lack adequate waste processing facilities [6]. A comprehensive study by Susanti et al. examining 100 Indonesian-flagged vessels found that only 30% complied with MARPOL Annex V's waste segregation standards [7]. This compliance deficit is exacerbated by overlapping jurisdictional authorities among five maritime enforcement bodies: the Indonesian Navy, Water Police Directorate (Polri), Ministry of Transportation (DGST), Ministry of Marine Affairs and Fisheries (DGCF), and the Maritime Security Agency (Bakamla) [8].

Existing literature tends to address isolated aspects such as port performance [6] or vessel compliance [9] without providing a comprehensive analysis of the triadic interaction between national regulatory frameworks, institutional capacity, and stakeholder engagement. Comparative studies, including Singapore's Maritime Green Initiative, demonstrate that successful MARPOL Annex V compliance (95% in Singapore) depends on the integration of these three elements [6], [9]. This analytical gap constitutes the primary focus of the present study.

This research contributes to both academic knowledge and practical policy development by analyzing implementation gaps in MARPOL Annex V through a mixed-methods approach, combining document audits, vessel surveys, and stakeholder interviews. The study employs the Institutional Analysis and Development (IAD) framework to evaluate technical, regulatory, and institutional barriers, and proposes an integrated, evidence-based policy model contextualized to Indonesia through adaptation of best practices from Malaysia and Singapore [10]. These findings are expected to contribute to the academic field of sustainable maritime governance while generating actionable policy recommendations for decision-makers.

## 2. METHODOLOGY

This study employs a qualitative research methodology that integrates systematic literature review and case study analysis to examine the implementation challenges of MARPOL Annex V in Indonesia. The literature review was conducted to identify existing regulatory frameworks, international best practices, and previous scholarly findings related to ship-generated waste management and international marine pollution prevention standards. Peer-reviewed journal articles, official IMO publications, and national government reports were systematically reviewed and analyzed to establish a robust theoretical foundation.

The case study approach analyzes real-world instances of MARPOL Annex V implementation in Indonesia. Case data were systematically collected from documented enforcement actions, port facility audits, and vessel compliance records spanning the period from 2020 to 2023. This dual-method strategy enables comprehensive understanding of both policy frameworks and practical enforcement challenges. The triangulation of literature and empirical case data enhances the validity and contextual relevance of the findings, offering insights that are both evidence-based and grounded in operational realities.

Data collection procedures included structured interviews with key stakeholders, document analysis of regulatory frameworks, and systematic review of compliance records. The Institutional Analysis and Development (IAD) framework was employed as the analytical lens to examine the complex interactions between formal rules, informal norms, and enforcement mechanisms within Indonesia's maritime governance system.

## 3. RESULTS AND DISCUSSION

### 3.1 Scope and Evolution of MARPOL Regulation

The regulatory scope of MARPOL extends beyond oil spills to encompass hazardous liquid and solid substances, domestic waste, food residues, plastic debris, and ship engine exhaust emissions [11]. Due to the complexity and diversity of pollution sources, MARPOL is structured into several specialized annexes, with Annex V specifically addressing the prevention of pollution by garbage from ships [12].

### 3.2 Historical Development of MARPOL

The development of MARPOL reflects growing global concern over deteriorating marine pollution resulting from shipping activities, particularly since the mid-20th century [13]. Key catalytic events include major oil spills from tankers (notably the Torrey Canyon incident in 1967), industrial waste discharge

from ships, and the exponential increase of marine plastic debris [14].

The foundational precedent for MARPOL can be traced to the 1954 Oil Pollution Convention initiated by the United Kingdom Government, which established the groundwork for comprehensive environmental regulation in maritime operations [15]. In 1973, the IMO convened an international conference that resulted in the MARPOL 1973 Convention. However, technical complexities and political challenges significantly delayed its entry into force [16].

To strengthen international commitment and address implementation challenges, an additional protocol was adopted in 1978, leading to the consolidation of the 1973 Convention and the 1978 Protocol into the MARPOL 73/78 agreement, which currently serves as the global standard for ship-source pollution prevention [17].

### **3.3 Significance and Impact of MARPOL Annex V**

Annex V has gained increasing relevance in addressing marine plastic pollution, with current estimates indicating approximately 5.25 trillion plastic particles in global oceans, of which 80% originate from maritime activities [18]. A comprehensive global prohibition on plastic discharge into marine environments has been in effect since 2013 [4].

Recent empirical studies demonstrate that rigorous enforcement of Annex V has resulted in a 12% reduction in marine debris in compliant regions [19]. Nevertheless, significant implementation challenges persist, particularly in developing countries such as Indonesia, where enforcement capacity and infrastructure constraints remain substantial barriers [12].

Contemporary research indicates that Annex V serves as a benchmark for integrating environmental accountability into maritime operations, especially as regulatory pressure intensifies on shipping companies to demonstrate Environmental, Social, and Governance (ESG) compliance [20]. These studies suggest that beyond regulatory adherence, Annex V has begun to influence corporate environmental responsibility frameworks within global shipping supply chains.

### **3.4 Implementation Challenges in Developing Maritime Nations**

Despite progressive developments in regulatory frameworks, significant implementation challenges persist, particularly for developing maritime nations such as Indonesia, where legal enforcement mechanisms, institutional coordination, and waste management infrastructure often prove inadequate for full compliance with Annex V provisions [21], [22]. Consequently, effective implementation of Annex V represents both a regulatory imperative and a developmental opportunity for enhancing sustainable maritime governance capacity.

The Indonesian case study reveals three primary implementation barriers: inadequate training and awareness programs for maritime personnel, insufficient port reception facilities for ship-generated waste, and fragmented enforcement mechanisms across multiple maritime authorities. These systemic challenges are compounded by limited financial resources, technological constraints, and coordination difficulties among various governmental agencies with overlapping jurisdictions.

## **4. CONCLUSION**

The implementation of MARPOL Annex V in Indonesia demonstrates a persistent disconnect between regulatory frameworks and practical enforcement mechanisms. Despite Indonesia's ratification of MARPOL 73/78, only 30% of Indonesian-flagged vessels achieve compliance with established waste management standards, highlighting critical deficiencies in crew training programs, port waste reception facilities, and institutional oversight mechanisms. These implementation challenges are further complicated by overlapping jurisdictional responsibilities among maritime authorities, resulting in inadequate coordination and enforcement effectiveness.

This study, utilizing a mixed-methods approach and the Institutional Analysis and Development (IAD) framework, underscores the necessity for an integrated, multi-stakeholder strategy to address these systemic challenges. Drawing insights from successful implementations in Singapore and Malaysia, the research proposes strengthened legal enforcement mechanisms, standardized certification programs for maritime personnel, and strategic infrastructure investments to enhance compliance rates.

The findings contribute significantly to the academic discourse on sustainable maritime governance while offering practical recommendations for improving marine environmental protection in Indonesia. Strengthening Annex V implementation is essential for aligning with international standards and safeguarding marine ecosystem health for future generations. The proposed framework provides a blueprint that may be applicable to other developing maritime nations facing similar implementation challenges.

Future research should focus on developing quantitative metrics for measuring implementation effectiveness and conducting longitudinal studies to assess the impact of proposed interventions on compliance rates and environmental outcomes.

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