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Enhancing Maritime Safety Through Integrated Policy Networks

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Abstract
Maritime safety is a pressing issue in Indonesia, given the frequent accidents causing substantial human and economic losses. This study examines the disjointed management of marine safety information systems and poor stakeholder coordination as key impediments to effective safety governance. Utilizing a qualitative case study approach, data were gathered via in-depth interviews, field observations, and document analysis. The findings indicate that information systems, scattered across multiple directorates under the Directorate General of Sea Transportation, result in operational inefficiencies and delayed decision-making, policy gaps, including weak inter-agency collaboration and inadequate auditing mechanisms, further compound these challenges. The study proposes an integrated policy network model to enhance collaboration among government bodies, regulatory authorities, and private entities. This framework promotes advanced technology adoption and a robust knowledge-sharing culture to enhance situational awareness and response capabilities, aiming to strengthen Indonesia's maritime safety framework, reduce accident risks, and enhance overall safety outcomes.
Keywords: *Maritime Safety, Maritime Information, Data Integration, Knowledge-sharing, Integrated Policy Network.*

1. INTRODUCTION

Maritime safety is a critical aspect of the maritime industry due to the serious consequences that maritime accidents can have, such as financial losses, property damage, and fatalities. A report by the European Maritime Safety Agency (2018) indicated that between 2011 and 2018, there were 426 accidents resulting in 696 fatalities, with crew members being the most frequent victims. In Indonesia, data from the National Transportation Safety Committee (KNKT) reveals that between 2016 and 2020, there were 127 maritime accidents, with sinking and fire/explosion accidents being the most predominant. These accidents often occur in confined waters, such as straits, lakes, and rivers, rather than in open seas, highlighting the complexity of the risks faced in Indonesia's water environments.

Previous studies, such as those by Chae, Kim, and Kang (2021) and Khan, Yin, and Mustafa (2021), identify several contributing factors to maritime accidents, including overloading, poor decision-making by ship managers and crews, and a lack of experience in responding to critical situations. Furthermore, adverse natural conditions and bad weather also play significant roles in the occurrence of maritime accidents (Gao, Wu, Yu, & Dai, 2024). In this context, an accurate and up-to-date information system becomes a crucial element in mitigating accident risks by providing relevant data for decision-making, particularly in emergencies.

However, even though the maritime information system in Indonesia is regulated by Law No. 17 of 2008 on Shipping, the current management of this information remains poorly integrated. The naval information system in Indonesia consists of several components managed by various institutions under the Directorate General of Sea Transportation (Ditjen Hubla), including the Management Information System for the Sea and Coastal Guard Units (SIMKPLP), managed by the Directorate of Sea and Coastal Guard Units (KPLP); the Maritime Traffic and Transport Management Information System (SIMLALA) and Inaportnet, managed by the Directorate of Maritime Traffic and Transport (Ditlala); the Shipping and Seafaring Management Information System (SIMKAPEL), managed by the Directorate of Shipping and Seafaring; the Vessel Traffic Service (VTS), managed by the Directorate of Navigation; the Port Management Information System (SIMPEL), managed by the Directorate of Ports; and the Maritime Safety Equipment Information System (SIMAKESPEL), managed by the Maritime Safety Technology Center (BTKP). This list does not yet include the data distributed across the 296 Port Operational Units within the Directorate General of Sea Transportation. Unfortunately, this data is not well-connected and

is often out of sync. The fragmented and hard-to-access data becomes a significant obstacle in efforts to improve maritime safety in Indonesia.

Data from the National Transportation Safety Committee reveals that the majority of maritime accidents are caused by technical and human factors, with the captain, as the key decision-maker on the ship, being the most critical element. In this context, the existence of an integrated information system would greatly assist the captain in making faster and more accurate decisions, especially in high-risk situations.

The urgency of integrating maritime information has also been highlighted by studies from Puisa, Lin, Bolbot, and Vassalos (2018) and Chauvin, Lardjane, Morel, Clostermann, and Langard (2013), which states that the weak link between the management of maritime information systems and maritime safety policies is a contributing factor to accidents. This is consistent with the situation in Indonesia, where, although the information available in various institutions could serve as important references for anticipating risks, its utilization has been suboptimal due to the lack of integration. Therefore, it is crucial to integrate data and provide broader access to relevant stakeholders so that maritime safety policies can be implemented more effectively.

This study aims to discuss the current condition of non-integrated data management in Indonesia and identify the barriers to integrating maritime safety information. Drawing on information integration theory, knowledge management, and integrated policy networks, this research also seeks to develop a maritime safety policy model based on integrated policy networks, with a focus on better information management to improve maritime safety. This research offers novelty by proposing the integration of the fragmented maritime safety information systems in Indonesia through a policy model based on integrated policy networks (IPN), which strengthens collaboration among the relevant institutions. Through this approach, the study aims to propose a proactive and integrative policy model to enhance maritime safety in Indonesia.

Maritime safety is a critical issue due to the far-reaching consequences of maritime accidents, which not only result in material losses but also fatalities and environmental damage. Previous studies have shown that the causes of maritime accidents in Indonesia can be categorized into three main factors: human, technical, and environmental. (Wang, Wang, Zhang, & Wang, 2023; Yip & Sahin, 2020; Zhou, Ruan, Wang, & Zhou, 2023). Although many maritime safety policies have been implemented, one of the biggest challenges faced in Indonesia is the lack of integration of maritime safety information systems. This non-integrated system hinders rapid and accurate decision-making during emergency situations, potentially exacerbating the risk of accidents (Dominguez-Péry, Tassabehji, Vuddaraju, & Duffour, 2021; Ye et al., 2024).

Human, technical, and environmental factors all play a key role in maritime safety. Research by Chae et al. (2021) and Khan et al. (2021) indicates that human factors, such as insufficient training, experience, and the decision-making capabilities of the captain, are major contributors to accidents. Technical factors, such as equipment failures or engine malfunctions, also significantly impact maritime safety (Yip & Sahin, 2020). Additionally, environmental factors such as adverse weather conditions, high waves, and low visibility contribute to the worsening of situations (Gao et al., 2024; Wu, Pelot, & Hilliard, 2005).

In the context of maritime safety, effective information management is crucial to preventing accidents (Melnyk, Onishchenko, Onyshchenko, Bernevek, & Burlachenko, 2024). According to Law No. 17 of 2008 on Shipping, the maritime information system in Indonesia includes data related to transport in waterways, ports, maritime safety and security, environmental protection, and human resources. Unfortunately, despite the availability of important safety-related information, its management in Indonesia remains fragmented across various institutions under the coordination of the Directorate General of Sea Transportation. This fragmentation leads to inefficiencies in information utilization and inconsistencies in decision-making.

Information Integration Theory and Knowledge Sharing

The theory used in this study to understand the challenges in managing maritime safety information is Information Integration Theory (IIT). IIT was first introduced by Anderson and Shanteau (1970) to explain how individuals or organizations integrate information from various sources to make decisions. In the context of maritime safety, integrating information scattered across different institutions under the coordination of the Directorate General of Sea Transportation is crucial to generating integrated information that can be accessed by all stakeholders. This process of information integration reduces decision-making errors and enhances situational awareness (Chen, Seng, Smith, & Ang, 2024).

Furthermore, this theory is used to map the process of how available information can be unified and used effectively to improve maritime safety. In this context, the first step is the understanding of the available information, followed by the establishment of necessary standards to display integrated information (Haas, 2006). Subsequently, the information will be tailored to specific needs and eventually integrated into systems that can facilitate rapid and accurate decision-making (Haas, 2006).

Integrated Policy Model to Improve Maritime Safety

Subsequently, the integrated policy network approach can also be utilized to address the issue of fragmented maritime safety information management. According to Barnett (2003) and Teye (2013), an integrated policy network refers to the integration of policies through networks formed among various social actors with shared interests. In the context of maritime safety, these actors include the government, maritime regulatory agencies, shipping companies, and other stakeholders involved in maritime policy. Integrated policy network focuses on the importance of collaboration among these actors to develop comprehensive and integrated policies (Carriedo, Cairney, Barquera, & Hawkins, 2023; Teye, 2013). This model avoids reliance on centralized policies and prioritizes the interaction among actors with common interests.

2. METHOD

This study adopts a qualitative approach with a case study design to explore issues related to the non-integration of maritime safety information systems in Indonesia. This approach was selected as it provides an in-depth understanding of the factors influencing information integration in the maritime sector, as well as its impact on maritime safety. The case study focuses on analysing the barriers to integrating maritime information in Indonesia and the country's maritime safety policies.

Data were collected through three main techniques: in-depth interviews with key informants who have knowledge of maritime policy and information systems, field observations related to data and information management, and document analysis covering policies, regulations, and reports related to maritime safety. Purposive and snowball sampling techniques were used to select informants from various backgrounds, including officials at the Directorate General of Sea Transportation, shipping companies, and other relevant parties. The collected data were analysed thematically to identify barriers in maritime information integration and to formulate solutions for improving the maritime safety information management system in Indonesia.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Lack of Integration in Maritime Safety Information

One of the key findings of this study is the lack of integration in Indonesia's maritime safety information systems. Within the Directorate General of Sea Transportation, the existing information systems are still fragmented across various directorates. For example, the SIMKAPEL system manages data related to shipping and maritime affairs, SIMLALA focuses on maritime traffic management, and several other applications are managed separately by each directorate. This fragmentation causes confusion among users and complicates access to the necessary information to support maritime safety. One informant explained, "Yes, the information available right now, the systems we have, can be said to be many. It is quite confusing for us at the Port Operational Units. Sometimes we forget what system pertains to port management. The Directorate of Shipping has its own system, the Directorate of Sea and Coastal Guard has its own system, and even Human Resources has its system. So, it's less effective when we need to find this information" (B3-A). This fragmentation hinders coordination between various units and increases operational complexity.

Currently, although there are initiatives to develop a more integrated system through the Perhubungan Network application and the Single Sign-On (SSO) system, effective implementation requires time and support from various parties. Another informant noted, "The data integration efforts to improve maritime safety should not only be carried out within the Ministry of Transportation but should also involve other related agencies such as the Meteorology, Climatology, and Geophysics Agency, the Maritime Security Agency, and the Indonesian Navy" (A1-A).

However, despite the initiation of integration efforts, their implementation is still constrained by significant structural and technical barriers. This situation creates gaps in data management and potentially increases the risk of information inconsistency, which could be detrimental to decision-making

on the ground. The presence of separate information systems leads to disrupted data flows and complicates access to information needed by various parties, especially in situations that require a rapid and coordinated response.

3.1.2 Barriers to Integrating Maritime Safety Information

Several significant barriers to the integration of maritime safety information were identified through this study. The first barrier is related to the technology and infrastructure used by various directorates. The fragmentation of these information systems results in obstructed data flow, creating difficulties in making swift and accurate decisions. One informant stated, "Currently, the systems within the Ministry of Transportation are still largely fragmented or segmented. This causes us to be at risk, primarily because of data issues, there is a lot of duplication or overlap in the data" (A1-H). When data is dispersed across different systems without integration, the potential for data overlap increases, which can reduce operational effectiveness and even add complexity to the management of maritime safety.

Additionally, there are over 60 applications managed by various directorates, with more than 300 types of permits, creating disorder in data management. As explained by an informant, "Our current information system has applications that are owned by each directorate. There are about 60 applications across all directorates, and around 300 permits. Efforts are underway this year to consolidate them into a Single Sign-On (SSO)" (A1-A). Although there are efforts to consolidate systems through SSO, technical challenges in integrating these various applications remain significant, considering the number of applications that need to be synchronized and the technical standards that need alignment.

Another barrier identified is the lack of commitment from the leaders in promoting inter-institutional cooperation and knowledge sharing between agencies. In this case, the weak culture of knowledge sharing among directorates and between the Directorate General of Sea Transportation and other agencies, such as the Meteorology, Climatology, and Geophysics Agency, the Maritime Security Agency, and the Indonesian Navy, emerged as a key challenge. The lack of incentive mechanisms to encourage collaboration between agencies, as well as an organizational culture that does not fully support information sharing, became major obstacles. As one informant pointed out, "On an individual level, this is rarely done because, within other institutions, they work with administrative principles, and they are governed by rules that they must adhere to. Therefore, coordination on an individual level is very limited" (B2-B). This highlights that the rigid bureaucratic structure and reliance on administrative regulations hinder flexibility in sharing information effectively.

3.1.3 Weak Coordination Among Stakeholders in Maritime Safety

Coordination among stakeholders in maritime safety in Indonesia still shows significant weaknesses. According to Article 246 of Law No. 17/2008 on Shipping, everyone aboard a vessel is obligated to provide assistance and report accidents to the captain. Article 247 further mandates that the captain take actions to manage the accident, disseminate news, and request or provide assistance. However, despite the heavy responsibilities placed on the captain, there is no explicit regulation regarding coordination mechanisms that involve external parties, such as port authorities, harbour masters, or search and rescue agencies, in emergency situations.

This regulation suggests that, although rules emphasize individual responsibility aboard the vessel, there is an inadequate policy network to integrate the roles of various external parties in maritime accident management. According to the integrated policy network theory, the success of a policy is highly dependent on effective communication networks among the involved actors. Without clear regulations for coordination, as reflected in Article 219, which only requires the harbour master to issue a Sailing Approval Letter based on the vessel's seaworthiness, without any obligation to coordinate with relevant agencies during emergencies, the implementation of maritime safety becomes less effective.

3.1.4 Implementation Standards and Maritime Safety Audits

Although maritime safety regulations in Indonesia provide detailed provisions on ship inspections and testing, it has been found that the implementation and auditing mechanisms often lack sufficient independence. Government Regulation No. 51 of 2002, Articles 54 and 55, outline various types of ship safety inspections, including initial, annual, and renewal inspections, whose results serve as the basis for issuing ship safety certificates. However, there are no explicit provisions ensuring an independent audit mechanism for the implementation of these safety inspections. This lack of oversight potentially introduces biases in the assessment and certification process and reduces accountability in ensuring compliance with safety standards.

A similar issue is found in Minister of Transportation Regulation No. 57 of 2021 concerning Procedures for Ship Inspection, Testing, and Safety Certification. Article 4 of this regulation only specifies the inspection stages without mandating follow-up audits to ensure that inspections are conducted consistently and according to established standards. Furthermore, although Minister of Transportation Regulation No. 44 of 2021 on Ship Stability, Article 33, regulates ship stability testing methods, there are no provisions requiring periodic audits of these test results. Without stricter auditing mechanisms, the validity of the test results may be questionable, potentially undermining the effectiveness of maritime safety enhancement efforts.

3.1.5 Port and Ship Quality in Supporting Compliance with Maritime Safety Regulations

Port facilities and ships play a crucial role in supporting compliance with maritime safety regulations. Although various regulations concerning port and ship facilities are in place, their implementation in the field still reveals significant shortcomings. For instance, Minister of Transportation Regulation No. 115 of 2016 on Procedures for Transporting Vehicles on Ships, Article 3, mandates that every port used for vehicle transportation must provide weighing equipment to ensure that vehicle weight aligns with the ship's capacity. However, there are no clear provisions on the supervision mechanisms to ensure that the weighing equipment is functioning properly and used consistently. This lack of oversight increases the risk of overloading, which can compromise ship stability during voyages.

Additionally, in terms of pollution prevention, although Article 227 of Law No. 17 of 2008 on Shipping obligates ship crews to prevent environmental pollution, and Minister of Transportation Regulation No. 58 of 2013 on Pollution Control in Waters and Ports, Article 10, requires ports to have containment equipment such as oil booms, shortages of these facilities have been reported in several small ports, or in some cases, they are entirely unavailable. Oversight of the availability and functionality of these containment tools remains insufficient, making it difficult to minimize environmental pollution in the event of a spill.

3.1.6 Maritime Worker Safety and Welfare

Provisions regarding the safety and welfare of maritime workers are outlined in Law No. 17 of 2008 on Shipping. Article 151 states that every crew member is entitled to welfare benefits, including wages, working hours, guaranteed embarkation and repatriation, accident compensation, as well as health and employment insurance. However, in practice, oversight of the fulfilment of maritime workers' welfare rights remains highly limited. For example, although Article 224 of Law No. 17 of 2008 mandates that crew members must be certified by the harbour master based on a seafarer's employment agreement, this regulation primarily focuses on administrative aspects rather than ensuring the substantial protection of maritime workers' rights.

Furthermore, this regulation does not provide a detailed mechanism for monitoring the implementation of seafarers' employment agreements, which should safeguard crew welfare. This lack of oversight poses risks of violations of maritime workers' rights, potentially leading to welfare issues such as fatigue, stress, and poor working conditions. Strengthening supervision and enforcing sanctions against shipping companies that fail to comply with maritime worker welfare regulations is therefore essential.

3.1.7 Maritime Safety Policy Network

The policy network in maritime safety in Indonesia needs to be strengthened to operate more effectively and in an integrated manner. According to Law No. 17 of 2008, the harbour master plays a central role in ensuring that ships departing from ports meet safety requirements, while Article 224 mandates that the harbour master must verify that crew members hold the necessary documents and certifications. However, despite the regulatory framework defining these roles, the relationships between key actors in this policy network, such as harbour masters, classification societies, and shipping companies, remain weak and sectoral. This lack of coordination among actors creates gaps in the implementation of maritime safety policies.

For example, in the area of competency certification, although Minister of Transportation Regulation No. 70 of 2013 on Education and Training establishes certification standards for crew members, it does not outline how harbour masters, regulatory agencies, and educational institutions should collaborate to ensure that seafarers receive training that meets international standards. This policy fragmentation hinders the formation of a cohesive policy network that should support the comprehensive and coordinated implementation of maritime safety regulations.

3.2 DISCUSSION

3.2.1 Integration of Maritime Safety Information Systems, Challenges, and Solutions for Enhancing Maritime Safety in Indonesia

This study highlights significant findings regarding the lack of integration in Indonesia's maritime safety information system, which is one of the main factors hindering efforts to improve maritime safety in the country. The fragmentation of existing information systems, which are dispersed across various directorates under the Directorate General of Sea Transportation, creates significant difficulties in accessing critical information needed by various stakeholders involved in maritime safety management. These findings align with previous research indicating that inefficiencies in data management often serve as a major barrier to swift and accurate decision-making in emergencies (Velikova et al., 2014). Although integration efforts, such as the implementation of the Perhubungan Network application and the Single Sign-On (SSO) system, have been initiated, substantial technical and structural challenges persist. Overcoming these challenges requires collaborative support from multiple stakeholders.

On a global scale, similar issues can be observed in other countries with large maritime sectors, such as India and the Philippines. In these nations, despite advancements in maritime safety regulations, information fragmentation among relevant agencies remains a major obstacle to improving maritime safety (Caesar & Tamakloe, 2024; Claramunt et al., 2017). Furthermore, a study by Park and Kim (2015) found that fragmented information management can hinder rapid responses to emergencies, ultimately increasing the risk of accidents. Thus, the challenges faced by Indonesia in integrating its maritime safety information system are not only relevant at the national level but also reflect broader challenges in global maritime safety management.

Moreover, the technical challenges in integrating the numerous existing applications, more than 60 systems managed by various directorates, underscore the importance of adopting advanced technologies to unify scattered information. Research by Anderson and Shanteau (1970) on information integration theory suggests that consolidating data from multiple sources can reduce errors in decision-making while enhancing situational awareness. By leveraging emerging technologies such as AI and blockchain, Indonesia can minimize data redundancy and accelerate information access, particularly in situations that require rapid response (Shen et al., 2023). Blockchain, for example, can be used to ensure the integrity of data shared across agencies (Salah, Rehman, Nizamuddin, & Al-Fuqaha, 2019). While AI can facilitate real-time data analysis, providing more accurate recommendations for decision-making (Shen et al., 2023).

3.2.2 Cultural and Institutional Challenges in Maritime Safety in Indonesia

This study reveals that cultural and institutional challenges are significant barriers to improving maritime safety in Indonesia. One of the key issues identified is the lack of a culture of information and knowledge sharing among various institutions involved in marine safety management. Although agencies such as the Directorate General of Sea Transportation, the Meteorology, Climatology, and Geophysics Agency, the Maritime Security Agency, and the Indonesian Navy possess critical information to support maritime safety, effective mechanisms for information sharing remain highly limited. This reflects weaknesses in the organizational culture, which prioritizes information silos and isolated work rather than cross-agency collaboration (Ley et al., 2014). Research by Bukowitz and Williams (1999) and Li, Lee, Jin, and Chong (2022) Knowledge-sharing management suggests that within an organizational context, sharing information and knowledge is essential to enhancing an organization's capacity to address complex challenges. Without a strong knowledge-sharing culture, the effectiveness of maritime safety policies will remain constrained, as decisions are made without comprehensive and up-to-date information.

Furthermore, the study indicates that Indonesia's rigid bureaucratic structure significantly hinders flexibility in sharing information among agencies responsible for maritime safety. The reliance on strict administrative regulations and lengthy formal procedures reduces the ability of these institutions to quickly adapt to situations requiring immediate responses (Kaufmann, Taggart, & Bozeman, 2019). Research by Teece, Pisano, and Shuen (1997) on organizational capabilities in responding to change suggests that highly structured and rigid organizations tend to be slow in innovating and adapting to evolving circumstances. In this context, the weaknesses in Indonesia's bureaucratic structure impede the development of a fast and responsive system for managing maritime accidents, which requires rapid collaboration and coordination among various stakeholders.

This cultural challenge is also evident in the inability of relevant institutions to engage in proactive collaboration. For instance, although data integration efforts have begun through the development of the Perhubungan Network application and the Single Sign-On (SSO) system, many stakeholders perceive that inter-agency cooperation remains hindered by a lack of leadership-driven initiatives to foster cross-sectoral

synergy. This aligns with the findings of Park and Kim (2015) and Casareale, Marincioni, and Kendra (2021), which indicates that inter-agency cooperation in maritime safety policies is often obstructed by organizational cultures that prioritize internal interests over collective goals. Without strong commitment from institutional leaders to shift this paradigm, efforts to build an integrated and effective maritime safety system will continue to face obstacles.

Additionally, another institutional challenge identified in this study is the lack of adequate incentives for individuals and institutions to actively participate in information sharing and collaboration. Without clear incentives, whether in the form of rewards or sanctions, relevant agencies tend to continue operating within their respective silos (Ley et al., 2014). In knowledge-sharing management, incentives are crucial in encouraging individuals and organizations to exchange information and collaborate (Pais & Santos, 2014; Samuel, Zheng, & Mookerjee, 2023). If existing policies fail to provide mechanisms that incentivize knowledge sharing, these policies will be ineffective in driving the cultural change necessary to establish a more integrated maritime safety system.

Moving forward, Indonesia must design policies that not only focus on technical or structural aspects but also address these cultural and institutional challenges. To achieve this, policies that foster a knowledge-sharing culture—such as developing reward systems for inter-agency collaboration and providing training to enhance cross-sectoral understanding—are essential. This aligns with the research of Haapasaari et al. (2015), which highlights the importance of creating policies that promote interaction among various actors in maritime safety governance. These policies must ensure that institutions involved in maritime safety understand their roles within a larger system and that they are guided by principles of collaboration, transparency, and shared responsibility. Strengthening the culture of collaboration and knowledge sharing among institutions will thus serve as a fundamental pillar in building a more effective and sustainable maritime safety system in Indonesia.

3.2.3 Policy Gaps in Indonesia's Maritime Safety Management

One of the key findings of this study is the existence of significant policy gaps in Indonesia's maritime safety management. These gaps are particularly evident in the lack of effective coordination mechanisms among relevant institutions, despite the fact that regulations such as Law No. 17 of 2008 provide a clear legal framework regarding safety responsibilities on board. In practice, existing policies have not sufficiently accommodated the need for cross-institutional collaboration, as reflected in the absence of explicit provisions on coordination among authorities in emergency situations. Consequently, responses to maritime accidents are often delayed and poorly coordinated, increasing the potential for material losses and casualties. Research by Barnett (2003) on integrated policy networks suggests that effective safety policies rely heavily on the presence of strong communication networks among various policy actors. Without a clearly defined coordination mechanism between external actors, such as port authorities and search and rescue agencies, maritime safety policies become less effective.

These policy gaps are further exacerbated by ambiguities in defining responsibilities and procedures at the operational level. Although Law No. 17 of 2008 mandates that ship captains must take action to mitigate accidents, the regulation does not provide adequate guidance on mechanisms for cooperation with external agencies in emergencies. Studies by Wu et al. (2005) and Panahi, Ng, Afenyo, and Haeri (2020) emphasize that well-structured inter-agency coordination is crucial for handling critical situations, particularly when accidents involve multiple stakeholders. Without explicit regulations governing institutional cooperation, existing maritime safety policies remain fragmented and ineffective. Therefore, Indonesia needs to strengthen policies that regulate cross-institutional coordination mechanisms in maritime accident management.

Furthermore, policy gaps have also been identified in the areas of monitoring and accountability for the implementation of maritime safety regulations. Although clear provisions exist regarding ship safety inspections, this study finds that independent auditing and oversight mechanisms for these inspections remain weak. Without independent audits, the outcomes of ship safety inspections may be subject to subjective influences, which could undermine accountability and reduce the effectiveness of policies (Desai, 2024). These findings align with Velikova et al. (2014), who suggest that improving the quality of maritime safety policies requires stricter oversight and auditing mechanisms with transparent and well-defined standards. Policies that reinforce independent auditing mechanisms and ensure that safety inspections adhere to international standards would enhance the credibility and effectiveness of Indonesia's maritime safety regulations (Desai, 2024).

Another critical policy gap pertains to the insufficient utilization of technology in supporting maritime safety policies. Currently, maritime safety management in Indonesia still relies on fragmented systems, which complicate coordination among agencies. This indicates that existing policies have not been sufficiently responsive to technological advancements that could enable real-time and integrated data management. Research by Park and Kim (2015) and Shen et al. (2023) highlights that the adoption of technologies such as cloud computing, AI, and blockchain in maritime safety information systems can accelerate decision-making processes, improve data accuracy, and minimize accident risks. However, Indonesia's current policies do not adequately support the implementation of these advanced technologies in maritime safety management. Therefore, Indonesia must develop policies that promote the adoption of technology in maritime safety systems to address existing challenges and enhance decision-making efficiency in emergency situations.

Finally, a significant policy gap is also observed in the area of human resource (HR) development within the maritime safety sector. While existing regulations establish competency standards for captains and crew members, policies related to training and HR development in the context of maritime safety require further enhancement. Research by Chae et al. (2021) and Türkistanli and Kuleyin (2022) indicates that the quality of training and human competency, particularly in decision-making under emergency conditions, plays a crucial role in reducing maritime accidents. Thus, Indonesia needs to develop policies that ensure training programs for captains and crew members encompass not only technical skills but also risk management and decision-making capabilities under pressure. By strengthening more comprehensive training policies, Indonesia can improve the capacity of its maritime workforce to manage emergency situations more effectively, ultimately enhancing overall maritime safety.

Overall, this study demonstrates that policy gaps in Indonesia's maritime safety management affect the effectiveness of safety governance and increase accident risks. Therefore, to improve maritime safety policies, Indonesia must focus on strengthening inter-agency coordination, introducing independent audit mechanisms, supporting technology adoption, and enhancing HR development policies. Only by addressing these policy gaps can Indonesia build a more effective and sustainable maritime safety system.

3.2.4 Designing an Integrated Policy Network Model for a Proactive and Integrative Maritime Safety Policy

One of the key solutions to address the challenges in Indonesia's maritime safety policy is the development of an integrated policy network model that strengthens inter-agency collaboration while integrating maritime safety information systems and policies. This model enables policies to be more responsive to field needs by involving various actors, including government agencies, regulatory bodies, the Indonesian Navy, the Maritime Security Agency, as well as private sector entities and the public. For instance, the establishment of a centralized task force involving all key actors in maritime safety would ensure better coordination in emergency situations and facilitate real-time data sharing among relevant agencies. Such a model has proven effective in European countries, where maritime authorities collaborate closely to respond to maritime safety threats (Larsson & Widen, 2024).

The importance of inter-agency coordination in maritime safety policy aligns with the network governance concept, which emphasizes the need for collaboration among actors to achieve better outcomes than if they were to operate independently (Barnett, 2003). In the context of Indonesia's maritime safety, the integration of fragmented information systems would accelerate decision-making processes and improve responsiveness to accidents. For example, through the implementation of a unified dashboard platform that enables direct data access, various agencies could monitor maritime conditions in real time and communicate more effectively during disasters. This approach would enhance situational awareness, enabling faster and more accurate decision-making, ultimately reducing accident risks and associated losses (Velikova et al., 2014).

However, to ensure the success of the integrated policy network model, institutional capacity-building and cultural transformation within the involved agencies are essential. According to institutional theory, the successful implementation of policies largely depends on an institution's ability to adapt to change and operate within a more collaborative framework (Amenta & Ramsey, 2010). Therefore, it is crucial not only to design policies that reinforce inter-agency coordination but also to foster a culture that encourages knowledge and information sharing across sectors. Incentives, whether in the form of rewards or leaders' support, will be critical in shifting work paradigms from sectoral silos toward greater collaboration (Lee & Puranam, 2017). This shift can be facilitated through cross-sectoral training programs and strengthened inter-agency communication, with a shared goal of improving maritime safety.

Additionally, in order to optimize maritime safety policies based on an integrated policy network, the adoption of advanced technologies must be prioritized. Technologies such as cloud computing, big data analytics, and blockchain play a crucial role in integrating disparate information systems. Cloud computing, for instance, provides a secure platform for real-time data storage and access by all relevant agencies. Meanwhile, big data analytics can analyse large datasets to detect patterns that help predict and mitigate accident risks. Blockchain technology, on the other hand, ensures the security and integrity of shared data, thereby accelerating data-driven decision-making based on accurate and reliable information (Salah et al., 2019).

Finally, to realize a more proactive and integrative maritime safety policy, the Indonesian government must develop regulations that support the adoption of advanced technologies and foster stronger collaboration between government agencies and the private sector. Furthermore, these policies should allow room for continuous evaluation and refinement to ensure that the mechanisms in place remain adaptable to evolving challenges and emerging needs. As noted by Haapasaari et al. (2015), proactive policies do not merely respond to incidents after they occur but rather act pre-emptively by leveraging available technology and data for risk prediction and mitigation. By adopting a policy approach based on the integrated policy network model, Indonesia can establish a more adaptive, responsive, and collaborative maritime safety system, ultimately contributing to a significant reduction in maritime accident rates in the country.

4. CONCLUSION

This study identifies that the management of maritime safety information systems in Indonesia remains fragmented, posing a major obstacle to rapid and accurate decision-making, particularly in emergency situations. Despite ongoing efforts to integrate various information systems through the Perhubungan Network application and the Single Sign-On (SSO) system, technical and structural challenges continue to hinder their effective implementation. The fragmentation of existing data increases operational complexity and reduces efficiency. At the same time, the importance of inter-agency coordination in maritime safety policymaking has become increasingly recognized. The adoption of advanced technologies, such as AI and blockchain, alongside human resource capacity development and fostering a culture of cross-agency information sharing, is are critical step needed to enhance maritime safety in Indonesia.

Based on the findings of this study, several recommendations can be proposed to improve maritime safety in Indonesia. First, the government must accelerate the integration of information systems by ensuring synchronization among various applications managed by different directorates. Consolidating data into a single platform accessible to all stakeholders will facilitate faster decision-making, particularly in emergencies. Second, the adoption of advanced technologies such as AI and blockchain should be encouraged to enable real-time data management, enhance data accuracy, and expedite responses to potential risks. Third, strengthening inter-agency collaboration is essential to fostering a stronger culture of cooperation among relevant institutions, such as the Meteorology, Climatology, and Geophysics Agency, the Maritime Security Agency, the Indonesian Navy, and other stakeholders. This can be achieved by introducing incentives for individuals and institutions that successfully collaborate in strengthening the maritime safety policy network. Fourth, enhancing human resource capacity through a more comprehensive training policy for ship captains and crew members is crucial. Training programs should emphasize effective decision-making in emergencies and include both technical and non-technical aspects to improve risk management capabilities.

While this study provides valuable insights into the challenges of maritime safety management in Indonesia, several limitations must be acknowledged. First, this study employs a case study approach that focuses on selected institutions under the Directorate General of Sea Transportation, making its scope relatively limited. Future research should expand its coverage to include a broader range of agencies involved in maritime safety to obtain a more comprehensive understanding. Second, data collection through interviews and observations presents potential constraints, as the information provided by selected informants may not fully reflect the broader perspectives or experiences of all stakeholders. By addressing these limitations, future research should aim to conduct broader and more in-depth investigations to gain a holistic understanding of maritime safety policies in Indonesia.

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