International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Analysis of the Effectiveness of Indonesia's Maritime Monitoring System Based on Information Systems and Maritime Domain Awareness Approaches

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Abstract

As an archipelagic state, Indonesia faces diverse maritime threats that necessitate an effective monitoring system for early detection and strategic decision-making. The Indonesian Maritime Monitoring System (SPMI), managed by Pusinfomar TNI, functions as a strategic information platform to build Maritime Domain Awareness (MDA). This study analyzes SPMI's effectiveness through information systems and MDA frameworks. Employing a descriptive qualitative single-case study design, data were collected via in-depth interviews, literature reviews, and document analysis, then examined using NVivo-assisted thematic analysis. Results indicate SPMI enhances surveillance by integrating AIS, radar, satellite imagery, and sensor data—improving situational awareness and threat detection. However, effectiveness remains constrained by limited inter-system interoperability, information quality issues, human resource limits, and inter-agency coordination hurdles. Evaluated under DeLone & McLean, TAM, and MDA models, SPMI delivers solid operational utility but remains sub-optimal for strategic decision support, requiring improved data integration, analytical capability, and institutional governance.

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Keywords: Indonesian Maritime Monitoring System (SPMI), Maritime Domain Awareness (MDA), Information Systems, Maritime Security, Early Detection of Maritime Threats.

INTRODUCTION

Maritime security has become a strategic issue in defense and security studies due to the rise of non-traditional threats in maritime domains. Bueger (2015) explains that maritime security is no longer confined to national defense against military threats it also encompasses protection against illegal fishing, smuggling, human trafficking, marine pollution, and violations of territorial sovereignty. In line with this, Das (2021) asserts that a nation's capacity to build Maritime Domain Awareness (MDA) serves as the primary foundation for early detection and rapid decision-making in response to evolving threats in the maritime domain.

Indonesia possesses a unique geographic profile as the world's largest archipelagic state. Situated between the Indian and Pacific Oceans and flanked by the Asian and Australian continents, the nation serves as a primary international maritime shipping route (Sitepu et al., 2024). This position simultaneously places Indonesia as a critical actor in regional geopolitical dynamics (Kusumawardhana, 2023). However, such geographic advantages also heighten its vulnerability to diverse maritime threats, including violations of sovereignty, illegal fishing, smuggling, non-cooperative foreign vessel activities, and the abuse of transit rights within the Indonesian Archipelagic Sea Lanes (ALKI) (Hattu, 2021).

This phenomenon shows that maritime threats are no longer hypothetical, but have become a real challenge in maintaining the security of Indonesia's maritime areas. Based on the operational report of the TNI Pusinfomar, foreign warships, foreign survey ships, *dark vessels*, and ships that deliberately turn off the Automatic Identification System (AIS) when operating in Indonesia's strategic areas are still found. Aryani (2021) explained that ships that do not activate AIS will complicate the identification and tracking process, increasing the risk of violations of the law at sea. Therefore, the integration of radar, AIS, satellite imagery, and various maritime sensors becoming increasingly important to generate accurate information and support early detection of suspicious activity (Santosa et al., 2024).

According to Hidayat and Riyadi (2021), the establishment of Pusinfomar is part of the development of a maritime early warning system that integrates various cross-agency information sources. Fadli et al. (2022) added that Pusinfomar functions as a center for the collection, processing, analysis, and distribution of maritime information to support the implementation of defense operations. This integration also allows the formation of *a common*

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operating picture so that various agencies have a common perception of the maritime security situation (Sajidin et al., 2023).

Although it has a strategic function, the implementation of SPMI still faces various challenges. Aryani (2021) stated that the distribution of coastal radar and AIS stations has not reached all regions of Indonesia so that there are still *blind spots* for surveillance, especially in the eastern region of Indonesia. In addition, the quality of monitoring data can be affected by atmospheric disturbances, limited communication networks, and latency of information transmission from remote areas (Putra & Hidayat, 2020). Other challenges come from the aspects of human resources and governance. According to Kodar et al. (2020), the competence of operators in operating modern monitoring technology is still uneven, while Hattu (2021) assesses that inter-agency interoperability is not fully optimal, affecting the effectiveness of coordination in handling maritime threats.

A number of previous studies have discussed the use of radar, AIS, satellite imagery, and remote sensing technology to improve the ability to monitor marine areas. However, research evaluating SPMI as a strategic information system is still relatively limited. DeLone and McLean (2003) stated that the success of an information system is influenced by the quality of the system, the quality of information, the quality of service, the level of use, user satisfaction, and the benefits produced by the organization. From the perspective of users, Davis (1989) explained that the perception of the ease of use and benefits of the system will determine the level of acceptance of technology in the organization. In the context of maritime security, the effectiveness of information systems must ultimately be able to build *Maritime Domain Awareness* so that the information generated can support the early detection process and appropriate decision-making (Das, 2021).

Departing from these gaps, this study aims to analyze the effectiveness of the Indonesian Maritime Monitoring System through an information system approach and *Maritime Domain Awareness*. In contrast to previous research that focused more on the aspect of monitoring technology, this study integrates the DeLone and McLean Information System Success Model, Technology Acceptance Model (TAM), and the concept of Maritime Domain Awareness as an analytical framework to evaluate the effectiveness of SPMI. This approach is expected to make a conceptual contribution to the development of defense information system studies as well as an input for strengthening the national maritime monitoring system.

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METHODS

This study uses a descriptive qualitative approach with a single case study *design* to analyze the effectiveness of the Indonesian Maritime Monitoring System (SPMI) managed by the TNI Maritime Information Center (Pusinfomar) in supporting the early detection of maritime threats in Indonesian waters. The qualitative approach was chosen because this study aims to gain an in-depth understanding of the actual conditions of SPMI implementation, system quality, information quality, technology utilization, as well as human and institutional factors that affect the effectiveness of maritime monitoring systems.

The object of this research is the Indonesian Maritime Monitoring System (SPMI) operated by the TNI Pusinfomar as a center for the collection, processing, analysis, and distribution of maritime information. The research was conducted by looking at SPMI as a strategic information system that supports the establishment of *Maritime Domain Awareness* (MDA) through the integration of various maritime monitoring data sources.

Data collection was carried out through *in-depth interviews*, literature studies, and documentation studies. Interviews were conducted with informants who had direct involvement with the management and use of SPMI to obtain information on system operational conditions, implementation constraints, information quality, and system contribution in supporting the early detection process of maritime threats. Literature studies are used to strengthen the theoretical foundation of the research, while documentation studies are conducted on documents related to the policy, implementation, and development of maritime monitoring systems.

Interview and documentation data were analyzed using a thematic analysis approach with the help of NVivo software. The analysis stage is carried out through the coding process, categorization, identification of main themes, and interpretation of the relationship between themes related to the effectiveness of SPMI. In this study, the results of NVivo analysis were used to identify the main aspects that affect the effectiveness of the system, including technology dimensions, information quality, human resources, and institutional governance.

The interpretation of the results of the study was carried out using the DeLone and McLean Information Systems Success Model approach, the Technology Acceptance Model (TAM), and the concept of Maritime Domain Awareness (MDA). The approach is used to evaluate the effectiveness of SPMI not only based on technological aspects, but also on the quality of the information generated, user acceptance, the benefits of the system, and its contribution to the formation of maritime situational awareness.

The validity of the research data was checked through triangulation techniques by

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comparing the results of interviews, documentation studies, and supporting literature. The process is carried out to ensure the consistency of information and increase the credibility of the research results. Through this method, the research is expected to be able to provide a comprehensive overview of the effectiveness of SPMI as a strategic information system in supporting the early detection of Indonesian maritime threats.

RESULTS

Overview of the Implementation of the Indonesian Maritime Monitoring System (SPMI)

The Indonesian Maritime Monitoring System (SPMI) is one of the strategic instruments in supporting the ability to monitor and secure Indonesian waters. This system was developed to improve the country's ability to obtain, process, and distribute maritime information as a basis for decision-making on various potential threats at sea. In the context of archipelagic countries with large water areas, the existence of an information-based monitoring system is an important need to build comprehensive *Maritime Domain Awareness (MDA*).



Figure 1. The Concept of Integration of the Indonesian Maritime Monitoring System (SPMI).
(Source: Processed by researcher, 2026)

SPMI, which is managed by the Maritime Information Center (Pusinfomar) of the TNI,

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functions as a maritime information integration center by utilizing various monitoring data sources. This system combines data from sensing and monitoring technologies such as *the Automatic Identification System* (AIS), coastal radar, satellite imagery, and other supporting information sources to produce a comprehensive picture of the maritime situation (*common operating picture*). The integration of these various data sources allows the process of identifying ship activities, monitoring movement patterns, and early detection of activities that have indications of threats to maritime security.

The existence of SPMI has an important role in supporting the change in maritime surveillance patterns from a reactive approach to an information-based and early detection approach. Through the ability to collect and analyze data in an integrated manner, this system provides information support for decision-makers in determining the operational steps needed for various dynamics in Indonesian waters. Thus, the effectiveness of SPMI is not only seen from its technological capabilities, but also from its ability to generate information of strategic value for maritime security operations.

Based on the results of the study, the implementation of SPMI shows that the system already has the main components in supporting maritime monitoring, namely the ability to acquire data, process information, analyze the situation, and disseminate information to related users. However, the effectiveness of the system is still influenced by several supporting factors, such as the quality of integration between data sources, the readiness of technological infrastructure, the ability of human resources, and the coordination mechanism between agencies involved in maritime security management.

From the perspective of *Maritime Domain Awareness*, the existence of SPMI is an important element in building a comprehensive understanding of activities that take place in the marine area. The information generated by the system not only serves as monitoring data, but also as a basis for understanding patterns of maritime activity, identifying potential risks, and supporting timely decision-making. Therefore, evaluation of the effectiveness of SPMI is important to determine the extent to which the system is able to carry out its strategic function in supporting Indonesia's maritime security.

Problems of the Effectiveness of the Indonesian Maritime Monitoring System (SPMI)

The results of the study show that the implementation of the Indonesian Maritime Monitoring System (SPMI) has contributed to supporting the supervision of territorial waters and the provision of maritime information. However, the effectiveness of the system in supporting

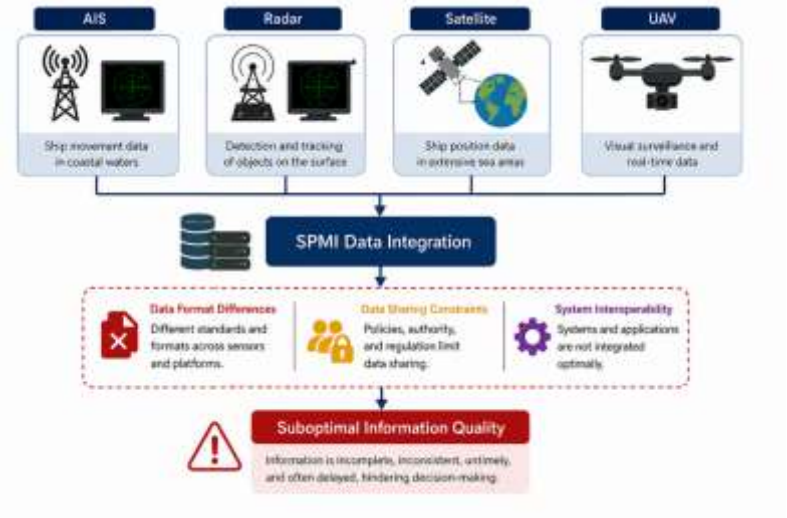
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the early detection of maritime threats still faces several problems related to technological aspects, information quality, human resources, and institutional governance. Based on the results of interview data processing using NVivo software, several main themes were found that affect the level of effectiveness of SPMI, namely the limitations of data integration, information quality, system interoperability, and human resource readiness.

Limitations of Data Integration and System Interoperability

The main problems in the implementation of SPMI is the lack of optimal integration of various maritime monitoring data sources. SPMI has utilized various sources of information such as the Automatic Identification System (AIS), radar, satellite imagery, and other sensors. However, the diversity of data formats, information exchange mechanisms, and different systems used by each agency are still challenges in building a fully integrated maritime information system.

Figure 2. Data Integration Problems in the Indonesian Maritime Monitoring System (Source: Processed by Researcher, 2026)



This condition causes the information processing process to still require adjustment and validation stages before it can be used as a basis for decision-making. In the context of information systems, data integration is an important factor because the quality of a system does not only depend on the ability to collect data, but also on the ability to process various sources of information into information that has operational value.

These findings show that the effectiveness of SPMI is still influenced by the level of interoperability between systems and institutions involved in maritime security. The better the

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data integration capability, the faster the system can produce an accurate picture of the maritime situation and support the early detection process.

Information Quality as a Determining Factor for the Effectiveness of SPMI

In addition to the technological aspect, the effectiveness of SPMI is also greatly influenced by the quality of the information produced. Maritime monitoring systems not only serve as a data collection medium, but must be able to produce accurate, relevant, and timely information to support decision-making.

The results show that the availability of large amounts of data does not necessarily guarantee the effectiveness of the system if the information produced has not gone through an optimal analysis and validation process. Ship position data, movement patterns, and indications of abnormal activity require an interpretation process in order to provide a clearer picture of the threat.

In the perspective of the DeLone and McLean Information Systems Success Model, information quality is one of the main components that determine the success of an information system. Information that has a high level of accuracy, relevance, and timeliness will increase the benefits of the system for the organization.

Based on these findings, increasing the effectiveness of SPMI not only requires the addition of monitoring technology, but also the strengthening of information processing and analysis mechanisms so that system outputs can provide strategic value for users.

Human Resources and Governance Factors

Human factors are another important aspect in determining the effectiveness of SPMI implementation. Monitoring systems with complex technology require operators and analysts who have competence in understanding data, analyzing situations, and generating information that can be used by decision-makers.

The results of the study show that the ability of human resources to operate and utilize the system is one of the factors that affect the optimization of the use of SPMI. Differences in competency levels, operator experience, and capacity building needs are challenges in ensuring that the system can be used optimally.

In addition to the human resource factor, the aspect of institutional coordination also affects the effectiveness of the system. Maritime security involves various actors and agencies so that an effective information exchange mechanism is needed to build a common perception of

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the maritime situation.

In the perspective of *the Technology Acceptance Model* (TAM), the success of technology implementation is also influenced by users' perception of the benefits and ease of use of the system. Therefore, increasing user capacity is an important part of ensuring that SPMI technology truly provides operational benefits.

The problem of SPMI's effectiveness does not only come from the technological aspect, but is a combination of system, information, human, and governance factors. The findings suggest that the effectiveness of maritime monitoring systems should be understood as a relationship between the ability of technology to provide data, the ability of organizations to process information, and the ability of users to utilize the results of analysis to support operational decisions.

Identification of Factors Affecting the Effectiveness of the Indonesian Maritime Monitoring System (SPMI)

Based on the results of the analysis of interview data using NVivo software, several main themes were found that described the actual conditions of the implementation of the Indonesian Maritime Monitoring System (SPMI). The results *of word cloud* show that words that have a high frequency of occurrence are related to aspects of systems, information, technology, maritime, surveillance, integration, sensors, regions, and decision-making. The findings show that the effectiveness of SPMI is not only influenced by the ability of monitoring technology, but also related to the system's ability to process information as the basis for strategic decision-making.



(a) **(b)** **(c)**

Figure 3. (a) Word cloud general conditions, (b) Word cloud Limitations/Problems, (c) Word cloud technologies and policies
(Source: Processed research, 2026)

The results of the analysis show that SPMI has played an important role in supporting the

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monitoring, early detection, and situational *awareness function* in Indonesia's maritime domain. This system has been used to identify various ship activities, including foreign warships, foreign government vessels, foreign survey vessels, foreign fishing vessels, non-cooperative vessels, as well as vessel movement patterns that have anomalous indications in Indonesia's strategic areas.

However, the results of the study show that the effectiveness of SPMI is still not fully optimal, especially when the system is directed to support strategic needs. The main problem lies not in the absence of monitoring technology, but in the system's ability to integrate various data sources, generate quality information, and connect this information with cross-institutional response mechanisms.

DISCUSSION

Data Integration and System Interoperability

One of the dominant themes that emerged from the NVivo analysis was integration. This shows that the ability to combine various sources of information is an important factor in the effectiveness of SPMI.

SPMI has utilized various monitoring data sources such as AIS, radar, satellite imagery, and other sensors. However, the diversity of data sources still faces challenges in the form of differences in information formats, data exchange mechanisms, and limited interoperability between systems.

This condition causes the system to still require additional processing and validation before the information can be used as a basis for decision-making. Thus, the effectiveness of SPMI is not only determined by the number of sensors available, but also by the system's ability to integrate data into maritime information that has strategic value.

Information Quality and Maritime Data Processing

In addition to system integration, the results of the analysis show that the information aspect is one of the most dominant themes. This shows that the success of SPMI is highly dependent on the system's ability to produce accurate, relevant, and timely information.

The monitoring data obtained from various sensors has not directly became strategic information. The data requires an analysis process to identify ship activity patterns, detect anomalies, and determine the level of potential threats.

Based on the perspective of the DeLone and McLean Information Systems Success Model, information quality is an important component in determining the success of an information system. In the context of SPMI, the quality of information will determine the extent to which the

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system is able to provide benefits to users in the maritime security decision-making process.

Operational Support and Decision Making

The themes of operational, supervision, and decision-making are also an important part of the results of NVivo's analysis. This shows that the existence of SPMI is not only aimed at monitoring, but also provides information support for the implementation of maritime security operations.

The results of the study show that SPMI has provided benefits in improving the observation ability of maritime activities and supporting the early identification process of potential threats. However, the system's ability to support integrated responses still needs strengthening, especially in terms of information distribution and coordination between stakeholders.

SPMI already has a fairly good operational function, but it still needs to be developed to be able to become a *strategic decision support system* in national maritime security.

Human Resources and Governance Factors

In addition to the technological aspect, the results of the study also show that there are human and institutional factors that affect the effectiveness of SPMI. Themes such as coordination, personnel, and policies show that the effectiveness of the system does not depend solely on the capabilities of technological devices.

Operators and analysts have a critical role to play in transforming data into valuable information. Therefore, improving human resource competence, standardizing procedures, and strengthening cross-agency coordination are important factors so that the benefits of SPMI can be maximized.

Based on the results of NVivo's analysis, the effectiveness of SPMI is influenced by the relationship between technological capabilities, information quality, human resource readiness, and institutional governance. SPMI already has a strong operational foundation in supporting the monitoring and early detection of maritime threats, but still needs to be strengthened in terms of data integration, information processing, interoperability, and cross-agency coordination to achieve a more optimal level of effectiveness.

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Analysis of the Effectiveness of the Indonesian Maritime Monitoring System (SPMI) Based on the Perspective of the Information System

The effectiveness of an information system is not only determined by the existence of the technology used, but also by the system's ability to produce quality information, be accepted by users, and provide benefits to the organization. Based on the DeLone and McLean Information Systems Success Model, the success of a system can be seen through several main dimensions, namely system *quality*, information *quality*, service *quality*, system use, *user satisfaction*, and *net benefit*) (DeLone & McLean, 2003).

In this study, the effectiveness of SPMI was analyzed through several dimensions that are directly related to the function of the maritime monitoring system, namely system quality, information quality, user acceptance, and system benefits in supporting early detection of maritime threats.

System Quality

System quality describes the technical ability of a system to provide the functions that users need. In the context of SPMI, system quality is related to the system's ability to integrate various monitoring data sources, process information, and provide a view of the maritime situation that can be used by operators.

The results of the study show that SPMI already has basic capabilities as a maritime monitoring system through the use of various technologies such as AIS, radar, satellites, and other supporting sensors. This integration capability allows the TNI Pusinfomar to monitor various ship activities and build a broader picture of the maritime situation.

However, the results of the analysis show that the quality of the system still faces some limitations. Indonesia's wide geographical factors cause the censorship coverage to not be fully able to reach all regions optimally. In addition, differences in system characteristics and data sources between agencies cause the integration process to still require an adjustment mechanism.

The findings show that the quality of the SPMI system has supported operational functions, but still needs to be strengthened in terms of interoperability, expansion of sensor coverage, and improvement of data integration capabilities so that the system is able to provide more optimal support at a strategic level.

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Table 1. SPMI System Quality Analysis

Indicator	Research Findings	Analysis
Technology integration	Using AIS, radar, satellite, sensor	Supports maritime monitoring
System reliability	The system is capable of generating monitoring information	Supports daily operations
System coverage	There are still certain regional limitations	Need sensor reinforcement
Interoperability	Integration between systems is not optimal	Limiting strategic effectiveness

(Source: Processed by Researcher, 2026)

Information Quality

Information quality is an important factor because SPMI's main goal is not only to collect data, but to produce information that can be used to support maritime security decisions.

The results of the study show that SPMI is able to provide a variety of information regarding ship activities, movement patterns, and indications of abnormal activities in Indonesian waters. This information is the basis for early identification of potential maritime threats.

However, the effectiveness of the information generated is still influenced by several factors, such as data consistency, information validation, transmission delays, and the need for advanced analysis before the information is used as a basis for decisions.

In the perspective of DeLone and McLean (2003), quality information must meet the elements of accuracy, relevance, completeness, and timeliness. Based on the results of the study, SPMI has fulfilled some of these aspects, especially in providing monitoring information, but still needs improvement in converting raw data into maritime intelligence information that is more strategically valuable.

Table 2. SPMI Information Quality Analysis

Indicator	Research Findings	Analysis
Accuracy	Data comes from various sensors	Requires validation
Relevance	Supports vessel activity identification	As per operational requirements
Punctuality	Information available for monitoring	Need to increase the speed of distribution

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Strategic value	Supports early detection	The need for more intelligence analysis

(Source: Processed by Researcher, 2026)

User Acceptance dan Human Factor

In addition to the technological aspect, the success of SPMI implementation is greatly influenced by user factors. Based on the Technology Acceptance Model (TAM) developed by Davis (1989), technology acceptance is influenced by users' perception of benefits (*perceived* usefulness) and perceived *ease of use*.

The results of the study showed that personnel who used SPMI understood the benefits of the system in supporting maritime situation monitoring and analysis tasks. The system provides ease in obtaining information that previously required a manual collection process.

However, the level of optimization of system use is still influenced by user competence, operator experience, and the need to increase human resource capacity. High-tech systems require personnel who are able to understand data characteristics, perform analysis, and produce information that suits operational needs.

Thus, the effectiveness of SPMI does not only depend on technology development, but also on the readiness of the organization in building user competencies.

Net Benefit

The last dimension is the benefits that the organization derives from the existence of the system. In the context of SPMI, the main benefits of the system can be seen from improved monitoring capabilities, early detection, and support for maritime security decision-making.

The results of the study show that SPMI has contributed to the formation of *situational awareness* by providing information about conditions and activities in Indonesian waters. The system also helps users identify potential threats early so that it can support the preparation of response steps.

However, the strategic benefits of SPMI can still be increased if the system is able to develop from just a monitoring system to a *maritime intelligence decision support system*.

The Role of the Indonesian Maritime Monitoring System (SPMI) in Supporting Maritime Domain Awareness

Maritime Domain Awareness (MDA) is the ability of a country to comprehensively

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understand various activities, conditions, and potential threats that occur in the maritime area through the process of collecting, integrating, analyzing, and disseminating information. The MDA concept emphasizes not only the ability to detect the presence of objects in the ocean, but also how that information can be used to understand activity patterns, identify risks, and support timely decision-making.

In the context of Indonesia as an archipelagic country with a large sea area, the ability to build MDA is a strategic need in maintaining national maritime security. The existence of various threats such as non-cooperative vessel activities, territorial violations, *illegal fishing*, and other illegal maritime activities requires an information system that is able to provide a comprehensive picture of the sea situation.

The results of the study show that SPMI has an important contribution in supporting the formation of MDA through three main functions, namely information collection, situational awareness development, and *decision support*.

SPMI as an Instrument for Maritime Information Collection and Integration

The initial stage in building an MDA is the ability to obtain accurate information about the condition of the marine area. Based on the results of the research, SPMI has carried out this function through the integration of various monitoring data sources such as AIS, radar, satellite imagery, UAVs, and other sensors.

The integration of these various sources allows the TNI Pusinfomar to obtain information about the identity of the ship, its position, movement patterns, and indications of abnormal activities that occur in Indonesian waters. This ability is the basis for building an initial understanding of the conditions of the maritime domain.

However, the results of the study also show that the information integration process still faces several challenges. Differences in data characteristics, limited connectivity, and suboptimal information exchange between agencies are factors that affect the system's ability to produce a comprehensive picture of the maritime situation.

SPMI has acted as a maritime information collection center, but improved data interoperability is still needed for MDA's capabilities to develop optimally.

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Figure 4. SPMI's Contribution in the Establishment of Maritime Domain Awareness (Source: Processed Researcher, 2026)

SPMI in Building Maritime Situational Awareness

One of the indicators of MDA's success is the ability of a system to generate *situational awareness* or situational awareness of maritime environmental conditions.

The results of the study show that SPMI has contributed to improving the monitoring capabilities of various ship activities in Indonesia's strategic areas. The system is able to provide information about the existence of foreign ships, non-cooperative vessels, as well as movement patterns that have certain indications so that it can be the basis for further analysis.

In the context of maritime security, the ability to know "what's happening at sea" is an important first step before deciding on action. Information that was previously scattered across various sources can be consolidated so that users have a better understanding of the actual condition of the water area.

However, the formation of *situational awareness* does not only depend on the availability of data, but also on the ability of human and organizational analysis to interpret the information. Therefore, strengthening maritime intelligence analysis capabilities is an important factor to increase the strategic value of SPMI.

SPMI as a Facilitator of Early Detection and Decision-Making

The final stage of MDA is the ability to turn information into decisions that support

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operational actions.

Based on the results of the research, SPMI has provided benefits in supporting the early detection process of various potential maritime threats. The information generated by the system helps users in making initial identification, determining the level of risk, and providing early recommendations for activities that require attention.

However, research shows that SPMI's capabilities are still more dominant in the monitoring and early detection function than in the strategic decision support function. This is due to the limitations in cross-agency integration, information sharing mechanisms, and data processing into maritime intelligence products.

This condition shows that the future development of SPMI is not only oriented towards improving sensor capabilities, but must also be directed at strengthening the analysis system, institutional integration, and the use of information as a basis for strategic decision-making.

SPMI's Contribution Model to Maritime Domain Awareness

Based on the results of the study, the relationship between SPMI and MDA can be described as follows:



Figure 5. Relationship between SPMI and MDA
(Sumer: Processed by Research, 2026)

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The model shows that SPMI functions as an *enabling system* that connects monitoring data with maritime security decision-making needs. The effectiveness of SPMI in supporting MDA is highly dependent on the system's ability to integrate data, produce quality information, and ensure that the information can be used by relevant stakeholders.

SPMI has made a significant contribution to building Indonesia's *Maritime Domain Awareness capabilities* through monitoring, information integration, and early detection support functions. However, the level of strategic effectiveness of the system still needs to be strengthened through increased data interoperability, development of maritime intelligence analysis capabilities, and strengthening cross-agency coordination. With this strengthening, SPMI has the potential to develop from a monitoring system to a strategic decision support system in national maritime security.

The Gap in the Effectiveness of the Indonesian Maritime Monitoring System (SPMI)

The results of the study show that the Indonesian Maritime Monitoring System (SPMI) has an important role in supporting the surveillance of Indonesian waters through monitoring capabilities, information integration, and early detection of various maritime activities. However, when viewed from the perspective of information systems and *Maritime Domain Awareness* (MDA), the effectiveness of SPMI still shows some gaps between the capabilities of the current system and the ideal needs as a strategic decision support system.

The gap is not only related to technological aspects, but also includes information quality, analytical capabilities, human resource readiness, and coordination mechanisms between agencies. Thus, the effectiveness of SPMI needs to be understood as the result of the interaction between technical aspects and interrelated organizational aspects.

Data Integration Gap and System Interoperability

Under ideal conditions, a maritime monitoring system should be able to integrate various data sources in real-time so as to produce a complete and accurate picture of the maritime situation. This integration is the main foundation in building *Maritime Domain Awareness* because the information scattered from various sensors must be able to be combined into a single unit of information that is easy for users to understand.

The results of the study show that SPMI still faces limitations in terms of interoperability. Although it has utilized various data sources such as AIS, radar, satellites, and other sensors, the information integration process is still influenced by system differences, data characteristics, and

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information exchange mechanisms between agencies.

This condition shows that there is a gap between the ideal concept of *an integrated maritime surveillance system* and the actual implementation of SPMI. The system already has data collection capabilities, but it still needs to be strengthened to be able to produce faster, more flexible, and more sustainable information integration.

Table 3. SPMI Data Integration Gap

Ideal Conditions	**Actual Condition**	**Gap**
All data sources are integrated in real-time	Integration still faces differences in data systems and formats	Interoperability is not optimal
Information available in a single overview of the maritime situation	Data still needs processing and validation	Information processing time increased
Effective interagency information sharing	Coordination still needs a strengthening mechanism	The use of information has not been maximized

(Source: Processed Researcher, 2026)

Information Quality Gap Towards Maritime Intelligence

One of the main goals of a maritime monitoring system is not only to provide data, but to produce information that has strategic value for decision-making. From the perspective of information systems, data quality must develop into information quality through the process of analysis, interpretation, and presentation that suits the needs of users.

The results of the study show that SPMI has been able to produce information about the activities and movement patterns of ships. However, there is still a gap between monitoring *information* and *maritime intelligence products* that can be directly used to support strategic decisions.

These problems show that increasing the effectiveness of SPMI is not enough only through the addition of sensors or increasing the amount of data, but also requires strengthening analytical capabilities to convert data into information that has predictive value.

System Support Gap to Strategic Decision Making

Based on the results of the research, SPMI has made a real contribution in supporting

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operational functions, especially in monitoring and early detection of maritime activities. However, the system's ability to support strategic decision-making still needs to be strengthened.

The results of the study show that the function of SPMI is still more dominant as a *monitoring system* than a *decision support system*. This is influenced by the limitations of information integration, analysis processes, and coordination mechanisms across institutions.

Human Resources Capacity Gap and Governance

The effectiveness of monitoring technology is highly dependent on the organization's ability to manage and utilize the system. The results of the study show that human resource and governance factors are important aspects that affect the optimization of SPMI.

Operators and analysts have a strategic role in interpreting the information generated by the system. Therefore, improving competence, standardizing work procedures, and strengthening coordination between agencies are supporting factors so that the available technology can produce maximum benefits.

In the perspective of *the Technology Acceptance Model* (TAM), the success of technology implementation is influenced by the extent to which users understand the benefits and ease of use of the system. Therefore, human capacity development needs to go hand in hand with technological development.

Synthesis of SPMI Effectiveness Gap

Based on the results of the analysis, it can be concluded that SPMI has a strong foundation as a national maritime monitoring system. The system has been able to support the functions of supervision, early detection, and the formation of *situational awareness*. However, there is a gap between current operational capabilities and the needs of modern maritime security systems that demand information integration, predictive analysis, and strategic decision support.

Table 4. Synthesis of SPMI Effectiveness Gap

Aspects	Current Conditions	Ideal Needs
Technology	Sensors and monitoring systems are already available	Wider and interoperable sensor integration
Information	Monitoring data available	Predictive maritime intelligence information

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Operation	Supports early monitoring and detection	Supporting strategic decisions
HR	The operator has used the system	Analyst with high maritime intelligence capabilities
Governance	Coordination has been ongoing	Stronger cross-agency integration

(Source: Processed Researcher, 2026)

This study shows that the effectiveness of SPMI is quite good in operational functions, especially in supporting monitoring and early detection of maritime threats. However, to achieve a level of strategic effectiveness as part of the national *Maritime Domain Awareness system*, it is necessary to strengthen the aspects of data integration, information quality, analytical capabilities, and institutional coordination.

CONCLUSION

This study shows that the Indonesian Maritime Monitoring System (SPMI) has a strategic role in supporting national maritime security through the functions of monitoring, information integration, and early detection of various activities in Indonesian waters. The implementation of SPMI has contributed to building *situational awareness* by utilizing various data sources such as the Automatic Identification System (AIS), radar, satellite imagery, and other supporting sensors to produce a more comprehensive picture of the maritime situation.

Based on the analysis using the perspective of information systems and *Maritime Domain Awareness*, the effectiveness of SPMI is influenced by several main factors, namely system quality, information quality, user acceptance, and the benefits of the system for operational needs. In terms of system quality, SPMI has the ability to integrate various monitoring sources, but still faces challenges in the form of limited interoperability, sensor coverage, and interagency data integration. In terms of information quality, the system has been able to provide information that supports the identification and monitoring process of maritime activities, but still needs to be strengthened in the aspects of validation, analysis, and development of information into maritime intelligence products.

The results of the study also show that SPMI has been effective in supporting operational functions, especially in the aspects of monitoring and early detection of maritime threats. However, the effectiveness of the system is not fully optimal at the strategic level because there are still gaps in converting monitoring data into information that can support fast, integrated, and analytics-based decision-making. Human resource factors, cross-agency coordination, and

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information governance are important aspects that also determine the success of SPMI implementation.

This research contributes to the development of maritime security studies by showing that the effectiveness of maritime monitoring systems is not only determined by technological capabilities, but also by the quality of information, user readiness, and the ability of organizations to utilize information to build *Maritime Domain Awareness*. Therefore, strengthening SPMI needs to be directed at increasing data interoperability, developing maritime intelligence analysis capabilities, improving human resource competence, and strengthening cross-agency coordination mechanisms so that SPMI can develop into a strategic decision support system in Indonesia's maritime security.

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