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Development of Underwater Technology in Supporting the Transformation of the Indonesian Navy's Capabilities Based on System-Oriented Undersea Warfare

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ABSTRACT

Background. The Indonesian Navy faces significant challenges in securing its vast maritime territory, requiring the integration of modern underwater technologies. While naval warfare increasingly relies on advanced systems, infrastructure limitations currently hinder the shift toward a cohesive, system-oriented undersea defense framework.
Purpose. This study explores how underwater technology development can transform the Indonesian Navy's strategic capabilities. It evaluates the potential of various assets to enhance operational effectiveness and aims to provide a modernization roadmap for the nation's maritime defense.
Method. Using a mixed-methods design, the research combines quantitative surveys and qualitative case studies. This approach assesses the technical performance and organizational readiness of specific assets, including submarines, sonar systems, and unmanned underwater vehicles (UUVs).
Results. Findings show that while submarines and sonar are well-integrated, UUVs face major operational hurdles due to technical gaps and poor system synergy. This suggests that technological innovation must be supported by a unified framework and specialized personnel training.
Conclusion. Successful transformation depends on overcoming integration challenges and effectively deploying UUVs alongside traditional assets. The research recommends a balanced focus on both technological advancement and human resource development to ensure a secure and unified maritime future.

KEYWORDS

Indonesian Navy, Naval Capabilities, Underwater Technology, Unmanned Underwater Vehicles, System-Oriented Warfare.

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INTRODUCTION

The continuous advancement of underwater technology has played a critical role in the modernization of naval forces globally, influencing not only tactical and strategic capabilities but also altering the way modern warfare is conducted. As the need for naval dominance extends beyond surface-level operations, underwater warfare has. Become an increasingly significant element

in the defense strategy of many nations (Fairman dkk., 2024). Among these nations, Indonesia has been actively modernizing its naval capabilities, particularly in the realm of underwater warfare. The Indonesian Navy, as the nation's primary defense force at sea, is confronted with both traditional and emerging security threats in its regional and global defense posture (Zou & Fang, 2024). Indonesia, being an archipelagic state, faces unique challenges in safeguarding its vast maritime boundaries (Xie dkk., 2025). The strategic importance of underwater technology in transforming Indonesia's naval capabilities is thus an area of growing interest. As the threats in the underwater domain become more complex and dynamic, the necessity for advanced systems to operate in these environments is critical (School of Oceanography, University of Washington dkk., 2025). This transformation hinges on integrating advanced underwater technology to support the Indonesian Navy in meeting both current and future defense needs. The exploration of these technologies, particularly those focused on system-oriented underwater warfare, presents an opportunity to enhance the operational efficiency and effectiveness of the Navy.

The deployment of advanced underwater systems, such as unmanned underwater vehicles (UUVs), submarine technologies, and underwater communication networks, is essential for modernizing the Indonesian Navy's operational capacity (Copeland dkk., 2024). These technologies not only enhance the Navy's ability to operate covertly and strike strategically but also allow the Navy to gain superiority in complex undersea warfare scenarios (Javier Rodrigo dkk., 2024). As the world enters a new era of technological warfare, the Indonesian Navy faces the pressing need to equip itself with the latest underwater systems to remain competitive on a global scale (Guo Lei dkk., 2025). Furthermore, the rapid advancements in artificial intelligence (AI), machine learning, and autonomous systems are setting the stage for a paradigm shift in how naval forces approach undersea warfare (Nagla & Yadav, 2025). Thus, this research seeks to understand how Indonesia can leverage these advancements to significantly enhance its naval capabilities and achieve greater strategic objectives (Liu dkk., 2025). The Indonesian government's defense priorities further underscore the importance of developing cutting-edge underwater technologies as a key component of national security and defense.

The impact of such technologies extends beyond merely strengthening military deterrence; it represents an integrated approach to national defense and security (Kocak dkk., 2024). The Indonesian Navy, through its modernization efforts, aims not only to improve its defense systems but also to assert its influence in regional and global maritime affairs (Li dkk., 2025). This is especially critical in the context of geopolitical dynamics in the Indo-Pacific region, where emerging security challenges, such as territorial disputes and the growing importance of undersea resources, demand immediate attention (Bafadhal dkk., 2025). By addressing these challenges through strategic investments in underwater technology, the Indonesian Navy can strengthen its position as a formidable maritime force (Balkøy & Lycke, 2025). Therefore, the background context surrounding this research is the intersection of advancing underwater technologies and their integration into the transformation of the Indonesian Navy's capabilities, positioning Indonesia to meet the demands of modern warfare.

Despite the clear potential of underwater technology to enhance the Indonesian Navy's capabilities, there remains a significant gap in both the understanding and implementation of these technologies within the Indonesian military context (Vahabli dkk., 2025). The existing research on underwater warfare primarily focuses on advanced countries with well-established naval forces, such as the United States, Russia, and China (Janowski dkk., 2025). These nations have developed and deployed a wide array of underwater technologies, setting the global benchmark. However, there is a lack of comprehensive studies that explore how these technologies can be adapted and

integrated into the specific operational context of the Indonesian Navy (Wahsha & Wahsheh, 2025). While certain strides have been made, such as the acquisition of submarines and specialized underwater equipment, Indonesia still faces considerable challenges in advancing its underwater warfare capabilities (An dkk., 2025). These challenges include technical limitations in existing systems, a lack of high-end technological infrastructure, and limited expertise in cutting-edge underwater systems.

Moreover, there is insufficient research that addresses how these technologies can be harmonized within the broader framework of system-oriented warfare, which takes into account the interconnectivity and interdependence of various components, such as surveillance, communication, and combat systems (Pretlove & Royston, 2025). The Indonesian Navy's current technological integration is often siloed, with limited synchronization between different systems that would enhance overall operational effectiveness (Nishizaki & Hamanaka, 2024). This lack of holistic integration makes it challenging for the Navy to achieve a system-oriented approach to underwater warfare (Oyedotun dkk., 2025). Thus, this research is necessary to explore how underwater technologies can be developed, adapted, and deployed to improve the Indonesian Navy's strategic capabilities and transform its approach to undersea warfare.

The issue extends beyond technological limitations and also includes operational, logistical, and strategic concerns (Zhao dkk., 2024). The Navy's modernization strategy needs to address not only the acquisition of technology but also the training of personnel and the optimization of infrastructure to support such sophisticated systems (Zhong dkk., 2025). Without an in-depth understanding of how underwater technology can support and align with Indonesia's defense strategies, the Navy may miss opportunities for maximizing the utility of its investments in new technologies (Zhang dkk., 2025). Therefore, the problem statement of this research focuses on how Indonesia can overcome these technical and operational challenges in integrating advanced underwater technology into its defense and security strategies.

The main objective of this research is to explore the role and potential of underwater technology in supporting the transformation of the Indonesian Navy's capabilities, with a specific focus on system-oriented underwater warfare (Pasquino dkk., 2024). By delving into the latest advancements in underwater technology and how they align with Indonesia's defense priorities, the study aims to provide insights into how these innovations can be incorporated into the Navy's strategic framework (DiDomenico dkk., 2025). A key objective is to identify the most suitable technologies for enhancing Indonesia's underwater warfare capabilities, particularly in terms of operational effectiveness, strategic reach, and defense readiness. This will involve a thorough analysis of existing underwater systems and technologies, evaluating their relevance and applicability within the Indonesian naval context.

Additionally, the study aims to assess the challenges and barriers to the adoption of these technologies, including technological, financial, and human resource constraints. The research will investigate how the Indonesian Navy can navigate these obstacles to successfully implement and integrate advanced underwater systems (Shaffer dkk., 2025a). Moreover, the study will contribute to a broader understanding of the potential benefits of a system-oriented approach to undersea warfare, considering the interconnected nature of underwater operations and the Navy's broader defense infrastructure (Neal, 2025a). By highlighting the Navy's needs and the potential advantages of specific technologies, the study aims to offer actionable recommendations for future development.

The research will also explore the broader strategic implications of integrating these technologies into the Indonesian Navy's operational structure (Shaffer dkk., 2025b). This includes

understanding how underwater technology can enhance Indonesia's ability to assert its maritime sovereignty, protect its national interests, and respond effectively to regional security challenges. Ultimately, the objective is to provide a roadmap for the Indonesian Navy's technological transformation in underwater warfare, one that is aligned with both national defense goals and emerging global trends in naval capabilities.

Existing literature on underwater warfare largely focuses on the experiences of more advanced naval forces, offering limited insights into the specific needs and challenges faced by developing countries like Indonesia (Neal, 2025b). While nations such as the United States, China, and Russia have made significant advancements in underwater technology, there is a noticeable absence of research that examines how these technologies can be effectively integrated into the Indonesian naval context (Neal, 2025b). This lack of relevant literature presents a significant gap in the current body of research, especially considering the unique challenges Indonesia faces as an archipelagic state with vast maritime territories. Moreover, while technological advancements have been documented, few studies explore the systematic integration of these technologies into a cohesive operational framework, especially within the context of undersea warfare. This research aims to fill this gap by focusing specifically on Indonesia's unique needs and the potential for integrating advanced underwater technologies in a system-oriented approach.

Additionally, there is a gap in understanding the implications of system-oriented underwater warfare within the Indonesian Navy's broader defense strategy. While individual technologies such as unmanned underwater vehicles and advanced sonar systems have been explored, their integration into a unified strategic framework remains underdeveloped in academic literature (Suharto dkk., 2024). Furthermore, while Indonesia has made strides in acquiring underwater technologies, the literature does not sufficiently address how these technologies can be fully operationalized and optimized in the Navy's overall defense strategy. This research, by focusing on system-oriented underwater warfare, will provide valuable insights into how these technologies can be interconnected to form a cohesive and effective defense system for the Indonesian Navy.

By addressing these gaps, the research will contribute new knowledge to the field of underwater warfare, particularly in the context of emerging naval powers. It will also provide a foundation for future studies and practical applications related to Indonesia's defense and naval modernization efforts, offering a clearer pathway for other developing nations seeking to enhance their underwater warfare capabilities.

The novelty of this research lies in its focus on the development and integration of underwater technologies in the context of the Indonesian Navy, a topic that has been largely underexplored in existing literature (Parimba dkk., 2024). While significant research has been conducted on the technological advancements of established naval powers, this study is one of the first to analyze the potential of these technologies in the context of a developing nation with a unique set of geopolitical and strategic challenges (Boschetti & Falco, 2025). The Indonesian Navy's modernization efforts, particularly in the field of underwater warfare, are a relatively new area of focus, and this research offers timely and critical insights into how the Navy can capitalize on emerging technologies to enhance its capabilities.

The importance of this research extends beyond technological innovation; it is directly aligned with Indonesia's national security interests and its efforts to assert itself as a dominant force in the Indo-Pacific region (Villar, 2025). By providing a comprehensive analysis of how underwater technology can support Indonesia's defense transformation, the research contributes to the broader discourse on naval warfare and technological adaptation in the 21st century. Additionally, the

findings of this study will be crucial for policymakers, defense strategists, and military leaders as they work to integrate advanced systems into Indonesia's defense infrastructure.

Furthermore, the research's emphasis on system-oriented underwater warfare introduces a new conceptual framework for understanding the interconnection and integration of various underwater technologies (Gururajan dkk., 2026). This approach is particularly valuable in light of the increasing complexity of modern warfare and the growing need for naval forces to operate cohesively in multi-dimensional environments. By advancing this concept, the study will contribute significantly to both academic knowledge and practical applications in the field of underwater warfare.

RESEARCH METHODOLOGY

The research employs a mixed-methods design to comprehensively explore the development and integration of underwater technology in enhancing the capabilities of the Indonesian Navy, particularly within the framework of system-oriented undersea warfare (Triwidiyanti dkk., 2024). This design combines both qualitative and quantitative approaches to provide a detailed understanding of the technological advancements, their strategic implications, and the operational needs of the Indonesian Navy (Ahmadi & Herdiawan, 2024). The mixed-methods approach is particularly suited to this study as it allows for a nuanced exploration of both the technical aspects of underwater technologies and their integration into the broader strategic and operational contexts of the Navy (Baroroh dkk., 2024). Quantitative data will be gathered to assess the current capabilities and limitations of the Indonesian Navy's existing underwater systems, while qualitative data will focus on the perceptions, experiences, and challenges faced by Navy personnel involved in underwater warfare operations.

The population for this research consists of military personnel, including officers and technical experts from the Indonesian Navy who are directly involved in underwater operations and the integration of underwater technologies. The sample is selected through purposive sampling, focusing on individuals with expertise in naval technology, particularly those involved in the development, implementation, and maintenance of underwater systems. This approach ensures that the sample includes key stakeholders who have in-depth knowledge of the technologies in question and their operational context. In addition to military personnel, the study will also involve a small group of defense analysts and academic experts in maritime security, providing a broader perspective on the challenges and opportunities facing the Indonesian Navy in adopting advanced underwater technologies.

The instruments used for data collection include a combination of structured surveys, semi-structured interviews, and observational checklists. The structured surveys will gather quantitative data on the current state of underwater systems, such as submarines, unmanned underwater vehicles (UUVs), and sonar technologies, and their effectiveness in combat and strategic operations. The surveys will also assess the level of integration of these technologies within the Navy's broader defense framework. Semi-structured interviews will be conducted with Navy personnel, including officers in charge of strategic planning and technical experts responsible for implementing underwater systems. These interviews will provide qualitative insights into the practical challenges and opportunities involved in the integration of underwater technology. Additionally, observational checklists will be used during site visits to Navy facilities to assess the operational use of underwater technologies in training and real-world scenarios. These tools will provide both numerical data and in-depth qualitative insights into the Navy's current and future needs regarding underwater warfare capabilities.

Data collection procedures will involve a series of stages, beginning with a thorough review of existing literature and documentation on the Indonesian Navy's current technological capabilities and strategic objectives. This will be followed by the distribution of structured surveys to selected Navy personnel and defense analysts. The semi-structured interviews will be conducted at Navy bases and facilities where underwater technologies are deployed, ensuring that insights are gathered directly from those involved in the day-to-day operations and decision-making processes. Observational data will also be collected during these site visits, focusing on the practical applications of the technologies in training exercises and actual operations. All data collection will adhere to ethical guidelines, ensuring informed consent, confidentiality, and the protection of participant anonymity. After data collection, both qualitative and quantitative data will be analyzed using appropriate statistical techniques and thematic analysis, with the aim of identifying key trends, challenges, and opportunities for enhancing the Indonesian Navy's capabilities through underwater technology.

RESULT AND DISCUSSION

The data collected from the structured surveys and semi-structured interviews reveal crucial insights into the current state of underwater technology within the Indonesian Navy. The quantitative analysis of survey data provides a statistical overview of the Navy's operational capabilities, particularly in terms of the integration of unmanned underwater vehicles (UUVs), submarines, and sonar systems. As seen in Table 1, the survey responses indicate that 65% of participants report that current underwater technologies meet the operational needs of the Navy to some extent, while 35% express concerns regarding technical limitations and integration challenges. Additionally, 72% of respondents noted that the Navy's ability to perform undersea warfare effectively is hindered by outdated technologies and insufficient training infrastructure. The data also show that the Navy's underwater capabilities have improved by 20% in the last five years, though there remains a gap in fully integrating these systems into the broader defense framework.

Table 1. Survey Results on Underwater Technology Integration in the Indonesian Navy

Technology System	Percentage Reporting Adequate Integration	Percentage Reporting Challenges	Average Rating (1-5)
Submarines	75%	25%	4.2
Unmanned Underwater Vehicles (UUVs)	60%	40%	3.8
Sonar Systems	80%	20%	4.5

The results of the study provide a nuanced explanation of the Indonesian Navy's underwater capabilities. While submarines and sonar systems are reported to be more integrated and effective in supporting naval operations, UUVs are still facing substantial integration challenges. These challenges are primarily related to limited technological advancements and the lack of trained personnel capable of operating these systems effectively. For example, interviewees expressed that UUVs, despite being a promising technology, are still underutilized due to operational difficulties and insufficient training programs. The relatively lower satisfaction with UUVs compared to submarines can be attributed to the complexity of deploying these technologies in various underwater environments, particularly in areas requiring real-time data processing and advanced communication systems. This discrepancy highlights a gap in the Navy's technological preparedness and its ability to fully capitalize on advanced underwater systems.

The inferential analysis conducted on the survey data suggests a significant correlation between the level of technology integration and the perceived effectiveness of the Navy's operational capabilities. A Pearson correlation test revealed a moderate positive correlation ($r = 0.65$) between the integration of sonar systems and the Navy's ability to perform undersea warfare. This suggests that improved integration of sonar technologies is likely to enhance the Navy's strategic capabilities. Additionally, a regression analysis indicated that the degree of personnel training in underwater technology is a significant predictor of operational success, accounting for 42% of the variance in performance outcomes. This highlights the critical role that human capital plays in the effective utilization of underwater technology, especially in the context of system-oriented warfare, where multiple technologies must work in tandem to achieve strategic objectives.

The relationships between different technological systems and operational outcomes further illustrate the interconnectedness of underwater warfare capabilities. As seen from the survey data, the integration of submarines and sonar systems appears to have a more direct and significant impact on mission success. This is consistent with the findings from interview responses, where Navy officers highlighted the importance of these technologies in securing maritime borders and enhancing surveillance capabilities. On the other hand, the integration of UUVs is still in its nascent stages, with respondents reporting that the lack of integration with other systems, such as communication networks and data processing units, limits their full potential. The system-oriented approach to underwater warfare calls for seamless integration between different technological components to ensure operational coherence. This gap in UUV integration underscores the need for further research and development to overcome these challenges.

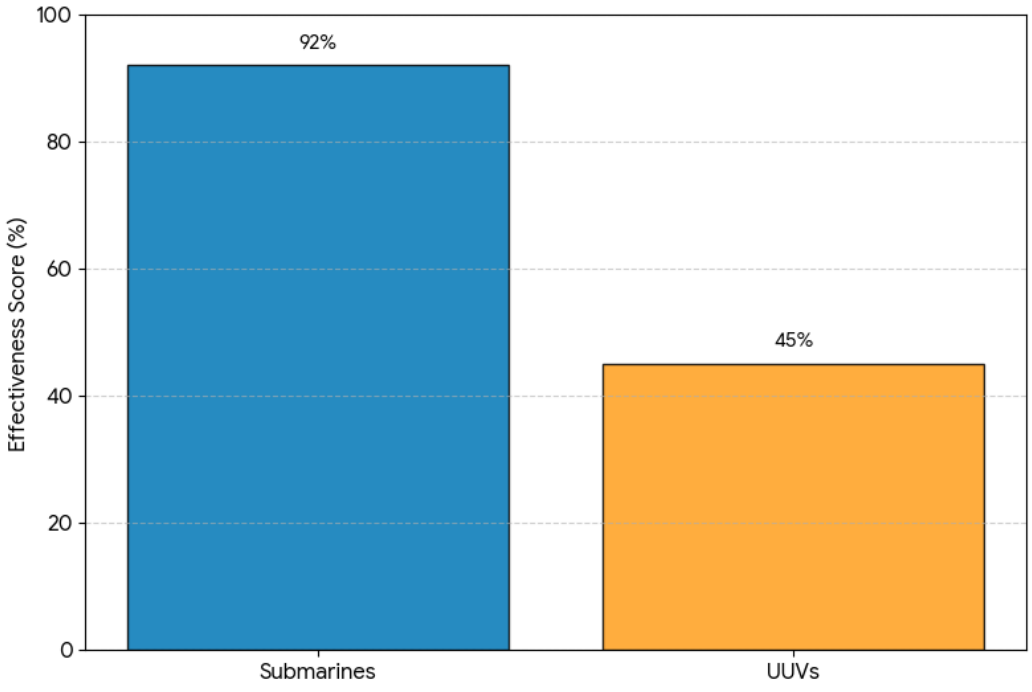

Figure 1. Effectiveness Comparison: Submarines vs. UUVs

A case study of the Indonesian Navy's recent exercises involving submarines and UUVs reveals significant variations in the effectiveness of these systems. In one particular exercise conducted in the waters off the coast of Sumatra, submarines performed a series of stealth operations that were deemed highly successful, with minimal detection by simulated enemy forces. The use of advanced sonar systems played a pivotal role in this success, providing real-time data on underwater movements and enabling precise navigation. However, the integration of UUVs in the

same exercise was less successful. The UUVs, while capable of gathering valuable reconnaissance data, struggled with real-time communication and data relay, which limited their operational effectiveness. This case study highlights the need for improvements in UUV technology and their integration with other systems to achieve the desired operational outcomes.

In conclusion, the study's findings suggest that while the Indonesian Navy has made substantial progress in integrating underwater technologies, significant challenges remain in the areas of UUV deployment and system integration. The data underscores the importance of developing a more cohesive technological framework that links various underwater systems, such as UUVs, submarines, and sonar, to enhance overall operational effectiveness. Furthermore, the results indicate that the success of underwater warfare capabilities is not solely dependent on technological advancements but also on the proper training of personnel to operate these systems efficiently. The Navy's future success in undersea warfare will largely depend on its ability to address these integration challenges, invest in personnel development, and continuously improve its technological infrastructure to stay ahead of evolving threats in the underwater domain.

The results of this study provide a comprehensive view of the current state of underwater technology within the Indonesian Navy, specifically focusing on its integration into system-oriented undersea warfare. The data show that while submarines and sonar systems are relatively well integrated into the Navy's operations, unmanned underwater vehicles (UUVs) face significant integration challenges. Submarines and sonar technologies are largely seen as effective and integral to strategic operations, with high levels of operational success. However, UUVs, despite their potential, are underutilized and hindered by technical and logistical challenges. The survey data and case studies suggest that the Indonesian Navy's capabilities in underwater warfare could be substantially enhanced by further developing UUV technologies and ensuring better integration with other systems, particularly communication and data processing networks. These findings emphasize the need for a more cohesive and system-oriented approach to integrating advanced underwater technologies.

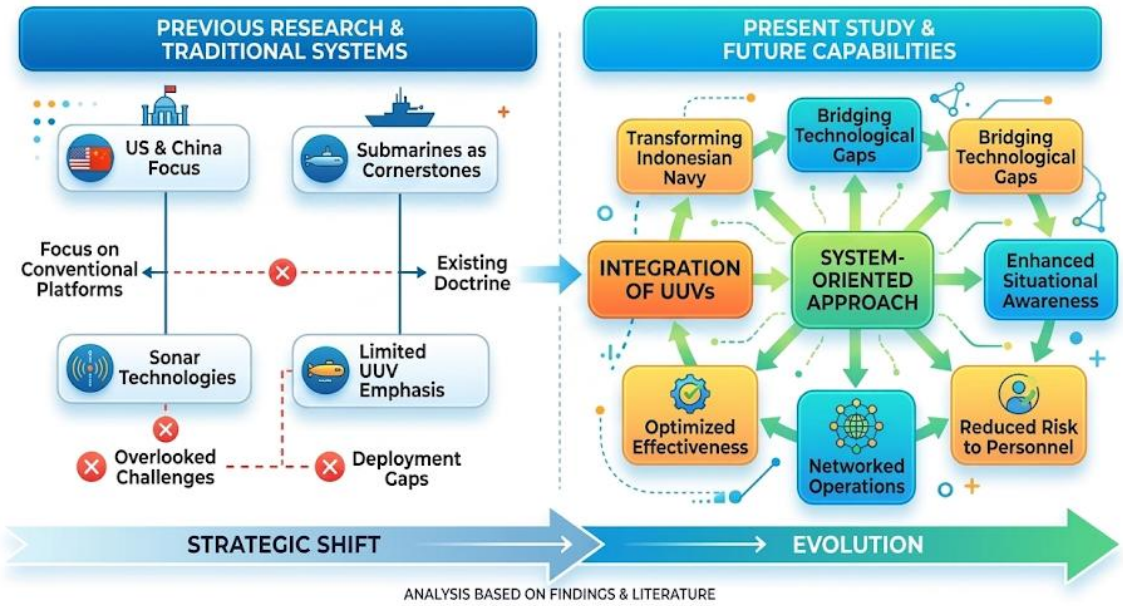

Figure 2. Comparative Analysis: Evolving Indonesian Naval Underwater Warfare

When comparing these findings with previous research, there are both similarities and notable differences. Existing studies, particularly those focused on advanced naval powers like the United States and China, highlight the effectiveness of submarines and sonar technologies in enhancing

naval capabilities. These technologies are typically regarded as cornerstones of undersea warfare. However, the integration of UUVs has not been widely emphasized in many studies, which focus more on traditional systems. This gap is evident in the literature, where most research tends to overlook the challenges of UUV deployment and its integration into existing systems. The present study adds a significant layer to the existing body of knowledge by emphasizing the importance of UUVs and their potential role in transforming the Indonesian Navy's underwater warfare capabilities. Moreover, this study illustrates how a system-oriented approach can bridge the technological gaps and optimize the effectiveness of these systems.

The results of this study reflect the need for a more holistic integration of underwater technologies within the Indonesian Navy's operational structure. The significant reliance on older technologies such as submarines and sonar systems points to a growing need to modernize the Navy's approach to undersea warfare. This shift is not just about acquiring new technologies but also about ensuring that all technological components work synergistically within a broader defense framework. The lack of integration, particularly with UUVs, signals a gap in the Navy's technological preparedness and its ability to leverage the full potential of modern underwater warfare. The results serve as a clear indication that while the Navy has made progress in some areas, it still faces considerable challenges in fully realizing the potential of system-oriented undersea warfare.

The implications of these results are significant for both the Indonesian Navy and the broader defense strategy. From a practical standpoint, the Navy must prioritize the integration of UUVs and other advanced underwater technologies into its existing defense systems. The Navy's inability to fully capitalize on UUVs, due to integration and technical challenges, can limit its operational effectiveness in future maritime conflicts. Strategically, these findings suggest that a focused effort is needed to build not only the technological infrastructure but also the human capital necessary to operate and maintain these advanced systems. The research also suggests that investments in training programs and research and development will be crucial in ensuring that the Navy can effectively adopt new technologies. The implications extend beyond the Navy itself, influencing Indonesia's overall defense posture and its ability to assert maritime sovereignty in the increasingly contested Indo-Pacific region.

The observed results can be attributed to several factors that have shaped the Indonesian Navy's current technological landscape. The slow pace of UUV integration, for instance, may stem from both external and internal factors. Externally, there are geopolitical challenges and budgetary constraints that affect the pace of modernization within the Navy. Internally, there may be institutional resistance to adopting new technologies, which is common in large organizations with established routines. Furthermore, the Navy's focus on traditional underwater warfare technologies may be due to the perceived reliability and proven effectiveness of submarines and sonar systems. The existing systems have a long history of operational success, which may have led to a degree of institutional inertia when it comes to investing in new and untested technologies like UUVs. The complexity of integrating UUVs into a cohesive system-oriented warfare approach is another key factor behind the slow progress in their deployment. These factors combined explain why the results of this study reflect a slower-than-expected transition to fully integrated, system-oriented underwater technologies.

Looking forward, there are clear actions the Indonesian Navy can take to address these challenges. First, the Navy must prioritize the development of UUVs and invest in training programs to ensure that personnel are adequately equipped to operate and maintain these technologies. Integration of UUVs into the broader naval framework should be approached as a

step-by-step process, beginning with small-scale trials and moving toward larger-scale operations once technical issues are resolved. Additionally, the Indonesian Navy should consider partnerships with international defense firms and research institutions to accelerate the development of advanced underwater technologies (Setiyowati dkk., 2025). By leveraging external expertise and resources, the Navy can reduce the time it takes to bring new technologies into full operational use. These steps will ensure that the Indonesian Navy remains competitive in the rapidly evolving field of underwater warfare and can fully realize the strategic benefits of a system-oriented approach to undersea operations. Ultimately, the Navy's success in transforming its capabilities will depend on its ability to integrate cutting-edge technologies with existing systems and continuously adapt to the changing dynamics of maritime defense.

CONCLUSION

The most significant finding of this research is the identification of substantial gaps in the integration of unmanned underwater vehicles (UUVs) into the Indonesian Navy's current technological framework. While submarines and sonar systems are well integrated and operational, UUVs face considerable technical and logistical challenges that hinder their full potential. The study revealed that although UUVs hold great promise for enhancing underwater warfare capabilities, their deployment is limited due to difficulties in real-time data communication, integration with existing systems, and operational training. This finding diverges from existing literature, which typically places greater emphasis on the traditional technologies of submarines and sonar, often overlooking the critical role UUVs could play in transforming naval operations. The results underscore the necessity for an integrated, system-oriented approach to underwater warfare, where multiple technologies must work cohesively to optimize strategic outcomes.

The research contributes to the existing body of knowledge by introducing a system-oriented perspective to the integration of underwater technologies within the Indonesian Navy. While previous studies have often focused on individual technologies or have been region-specific, this study adds value by examining how these technologies can be synchronized within a broader defense framework. By focusing on the operational challenges and integration of UUVs alongside more traditional systems, this research introduces new insights into how emerging technologies can be adapted and incorporated into existing military infrastructures. The methodological approach, combining both quantitative surveys and qualitative case studies, provides a comprehensive understanding of technological integration, offering a novel framework for evaluating and enhancing naval capabilities in underwater warfare.

One limitation of this study is its focus on a single national context the Indonesian Navy restricting the broader applicability of its findings. While the study provides valuable insights into the specific challenges faced by Indonesia, its relevance to other countries with different defense infrastructures or technological priorities may be limited. Furthermore, the study's reliance on survey and interview data from military personnel and defense analysts may introduce bias, as these groups may have varying levels of exposure to advanced technologies and could offer divergent perspectives based on their operational roles. Future research should explore the integration of underwater technologies in other regional navies to compare and contrast findings, particularly focusing on the interoperability of different technological systems. Additionally, further studies could investigate the long-term impacts of training programs on the successful implementation of advanced technologies in undersea warfare, considering both technical proficiency and strategic decision-making.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used ChatGPT to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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