The Future of Underwater Technology: Challenges and Opportunities for Indonesia in the Global Ocean Economy

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Abstrak

Sebagai negara kepulauan terbesar di dunia, Indonesia memiliki potensi yang sangat besar dalam ekonomi kelautan global. Namun, penguasaan teknologi bawah air hingga saat ini masih didominasi oleh negara-negara maju. Artikel perspektif ini membahas urgensi pengembangan teknologi bawah air di Indonesia, khususnya pada sektor energi, komunikasi, dan keamanan maritim. Selain itu, artikel ini menyoroti tantangan ketergantungan terhadap teknologi impor, pentingnya penguatan sumber daya manusia (SDM), serta arah strategis kebijakan riset dan inovasi kelautan. Penulis berpendapat bahwa tanpa strategi nasional yang terintegrasi, Indonesia berisiko hanya menjadi pasar teknologi. Sebaliknya, melalui investasi riset, kolaborasi antara industri dan akademisi, serta penerapan kebijakan ekonomi biru, Indonesia memiliki peluang untuk menjadi pemain signifikan dalam industri teknologi subsea global.

Kata Kunci: *Teknologi Bawah Air, Ekonomi Biru, Kemandirian Teknologi, Keamanan Maritim, Inovasi Kelautan.*

Abstract

As the world's largest archipelagic nation, Indonesia possesses immense potencial within the global ocean economy. However, mastery of underwater technology is still dominated by developed nations. This perspective article discusses the urgency of developing underwater technology in Indonesia, particularly in the energy, communications, and maritime security sectors. Furthermore, it highlights the challenges of dependency on imported technology, the importance of strengthening human resources (HR), and strategic directions for marine research and innovation policies. The author argues that without an integrated national strategy, Indonesia risks becoming merely a technology market. Conversely, through research investment, industry-academic collaboraon, and blue economy policies, Indonesia has the opportunity to become a significant player in the global subsea technology industry.

Keywords: *Underwater Technology, Blue Economy, Technological Independence, Maritime Security, Marine Innovation.*

INTRODUCTION

The ocean plays a central role in Indonesia's development. With a marime territory covering approximately two-thirds of the total naonal area, Indonesia holds vast potenal in energy, fisheries, transportation, and communications. The concept of the Blue Economy emphasizes the sustainable use of marine resources to drive economic growth and community welfare [3], [4].

In this context, underwater technology serves as a vital foundation. This technology includes Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV), sensor and sonar systems, submarine cable infrastructure, and deep-sea energy exploration technology [5], [6], [13]. However, to date, Indonesia remains reliant on imported technology. This arcle offers the perspecve that underwater technological independence must become a national strategic agenda to strengthen Indonesia's posion in the global ocean economy.

UNDERWATER TECHNOLOGY AS STRATEGIC INFRASTRUCTURE

Energy and Deep-Sea Exploration

Offshore oil and gas exploration relies heavily on subsea technology, parcularly for inspection, maintenance, and seabed mapping [5], [6]. Beyond fossil fuels, the potential for marine renewable energy such as ocean currents, waves, and Ocean Thermal Energy Conversion (OTEC) requires sophiscated underwater installation and monitoring systems [9], [12].

Indonesia possesses significant ocean current energy potenal, especially in its eastern regions. However, domestic technological limitations have hindered optimal utilizaon. From the author's perspecve, investing in marine energy technology research impacts not only energy security but also national technological sovereignty.

Global Communication and Digital Resilience

More than 95% of international data traffic is transmitted via submarine fiber optic cables [2], [20]. This infrastructure is the backbone of the global digital economy. As an archipelagic nation, Indonesia is highly dependent on submarine cable networks for both domestic and internaonal connectivity.

Disruptions to submarine cables can jeopardize economic stability and national security. Therefore, technology for the detection, monitoring, and protection of submarine cables must be priorized as strategic infrastructure [2], [20].

Marime Security and Territorial Surveillance

Given its vast sea area and high marime activity, underwater surveillance poses a major challenge. Sonar technology, acoustic sensors, and autonomous underwater vehicles can enhance early detection capabilities against security threats [1], [14].

In the geopolitical context of the Indo-Pacific region, mastery of underwater technology is closely linked to maritime stability and sovereignty.

CHALLENGES: DEPENDENCY AND LIMITED NATIONAL CAPACITY

Despite its great marine resource potential, Indonesia faces several key obstacles, including dependency on imported technology, where the procurement of ROVs, AUVs, and sonar systems is still dominated by foreign products [5], [6]. In addition, limited technology transfer means that international cooperation is often not followed by an increase in domestic production capacity. Another challenge is the low investment in Research and Development (R&D), as Indonesia's research spending remains relatively small compared to developed nations [3]. In the author's view, this dependency is not just an economic issue but also a strategic one. Without mastering core technologies, Indonesia will find it difficult to compete in the global value chain of the maritime sector.

STRATEGIC OPPORTUNITIES: TOWARD TECHNOLOGICAL INDEPENDENCE

Strengthening Human Resources and the Research Ecosystem

Developing underwater technology requires multidisciplinary collaboration: ocean engineering, robotics, oceanography, artificial intelligence, and materials science [1], [5], [12]. Universities and national research institutions must strengthen their focus on applied maritime technology. The Triple Helix collaboration model (government–industry–academia) can be an effecve approach to accelerating innovation.

Industrialization of Marime Technology

Indonesia has the opportunity to develop a domesc industry for mid-scale ROV components, oceanographic sensors, and underwater survey services [6], [17]. An import substitution strategy based on local innovation could be the first step toward global competitiveness.

Technology-Based Blue Economy Policy

The blue economy is not just about resource exploitation; it is about technological innovation and sustainability [3], [4]. Therefore, national maritime policies need to include a roadmap for underwater technology development as a long-term strategic priority.

CONCLUSION AND PERSPECTIVE RECOMMENDATIONS

Underwater technology is a strategic infrastructure that supports national energy, communications, and security [1], [2], [5]. In the era of the global ocean economy, mastering this technology is an indicator of a nation's maritime sovereignty. From the author's perspective, Indonesia needs to establish underwater technology as a national priority in research policy, significantly increase marine R&D investment, encourage technology transfer through strategic partnerships based on domestic production, and integrate the underwater technology agenda into the National Blue Economy Strategy [3], [4]. With these steps, Indonesia will not only be a user of technology but also an innovator in the global maritime industry.

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