

Naval Diving Capability in National Infrastructure Development: A Qualitative NVivo and SWOT Analysis of Koppeba's Certification Role

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ABSTRACT

Standardizing underwater workforce competency represents a vital strategic imperative to guarantee structural integrity and execution safety for national strategic infrastructure projects. This research analyzes the strategic role of the Naval Diving and Underwater Salvage Command (Koppeba Koarmada RI) in establishing competency certification for subaquatic technical personnel supporting the Giant Sea Wall megaproject. Utilizing a qualitative single case study design, the study integrates semi-structured interviews with naval commanders, vocational directors, and public works officials, direct facility observations, document reviews, and qualitative thematic coding via NVivo 15 software combined with IFAS-EFAS SWOT matrices. Empirical findings identify critical technical capacity gaps, evaluate training facility readiness, and establish a synergistic certification model linking Koppeba, vocational higher education, and industry contractors. Institutionalizing Koppeba as a national subaquatic certification center serves as a vital cornerstone for workforce sovereignty and national resilience

INTRODUCTION

In modern maritime geopolitics and national development, defending territorial integrity and coastal resilience against environmental threats represents a strategic imperative. Indonesia, as the world's largest archipelagic state, faces extraordinary vulnerabilities along the northern coast of Java Island due to accelerated global climate change and severe land subsidence. Data from the Meteorology, Climatology, and Geophysics Agency (BMKG) and Intergovernmental Panel on Climate Change (IPCC) reports indicate sea level rise averaging 3.6 millimeters annually, while empirical observations across Jakarta, Semarang, and Pekalongan record land subsidence rates reaching 10 to 15 centimeters per year. To mitigate catastrophic tidal flooding (rob), safeguard dense coastal populations, and protect vital industrial infrastructure, the Indonesian government enacted Presidential Regulation No. 12/2025 on the National Medium-Term Development Plan (RPJMN 2025-2029), designating the Giant Sea Wall (GSW) as a National Strategic Project (Proyek Strategis Nasional). Spanning Banten to Gresik, East Java, this mega-infrastructure project requires extensive subaquatic construction, offshore dikes, sub-sea piling, wet underwater welding, and deep-water structural inspections.

Executing subaquatic construction of this magnitude introduces unprecedented technical engineering challenges that demand a specialized, highly skilled, and certified maritime workforce. Under Law No. 2/2017 on Construction Services, technical personnel engaged in national construction projects must hold valid, officially recognized competency certificates to guarantee structural integrity, operational safety, and quality assurance. Subaquatic operations specifically wet underwater welding, non-destructive testing (NDT) inspection, salvage, and sub-surface explosive cutting – represent high-risk engineering domains governed by stringent international safety protocols. However, Indonesia currently experiences a critical deficit of certified local underwater laborers, creating a structural vulnerability wherein vital subaquatic construction roles risk being dominated by foreign technical personnel. Securing national workforce sovereignty in maritime infrastructure construction is therefore essential to prevent foreign dependency, protect strategic national assets, and build domestic technical self-reliance.

The Naval Diving and Underwater Salvage Command (Koppeba Koarmada RI) represents the Indonesian Navy's premier center of excellence for subaquatic engineering, underwater salvage, and deep-sea intervention. Equipped with elite Master Diver instructors, specialized deep-water training pools (deep pool), multi-lock hyperbaric decompression chambers, Surface-Supplied Diving Equipment (SSDE) systems, and underwater welding test stations, Koppeba possesses unmatched technical authority in subaquatic operations. Historically focused on fleet maintenance, warship hull inspection, and military salvage operations, Koppeba maintains the technical capability and operational discipline required to establish standardized diver training pipelines. Despite successful initial training collaborations with civilian vocational institutes such as BPVP Belitung in basic underwater welding, a comprehensive

national subaquatic certification ecosystem integrated with national qualification frameworks remains unestablished.

Bridging the gap between military technical mastery and civilian industrial labor demands requires resolving significant institutional, regulatory, and curricular bottlenecks. Existing civilian vocational training programs often lack specialized deep-water training infrastructure and experienced subaquatic instructors, while current national competency standards (SKKNI) for wet underwater welding and subaquatic NDT inspection remain fragmented across disparate ministries. Furthermore, current certification pathways suffer from high administrative costs, unclear career progression descriptors under the Indonesian National Qualifications Framework (KKNI), and a lack of formal inter-agency integration connecting naval military diving authorities, the National Professional Certification Board (BNSP), the Ministry of Public Works and Housing (PUPR), and vocational higher education institutions under Kemdiktisaintek.

To address these complex institutional challenges, this study applies a multi-theoretical framework integrating Human Capital Theory, Role Theory, Professions Certification Theory, and Competency-Based Human Capital. Human Capital Theory posits that structured investments in specialized technical skills directly enhance national economic productivity and infrastructure resilience. Role Theory provides an analytical lens to examine Koppeba's institutional transition from a traditional naval warfare support unit into an active national certification facilitator. Meanwhile, Professions Certification Theory and Competency-Based Human Capital explain how standardized skill validation, rigorous testing protocols, and formal credentialing create institutional trust, labor market mobility, and operational safety in high-hazard engineering environments.

This research offers significant theoretical, policy, and practical novelties by establishing a qualitative single case study framework centered on Koppeba Koarmada RI. Utilizing NVivo 15 qualitative software for multi-source thematic coding alongside Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) SWOT matrices, this study moves beyond static workforce audits to evaluate dynamic institutional alignment, training facility readiness, and regulatory synergy. The resulting strategic roadmap formulates a synergistic triple-helix certification model connecting Koppeba, vocational universities, and industrial maritime contractors. Ultimately, this research provides actionable policy insights to institutionalize Koppeba as a national subaquatic certification center, securing workforce sovereignty and ensuring national resilience for Indonesia's Giant Sea Wall project.

LITERATURE REVIEW

Human Capital and Competency-Based Workforce Development

Becker (1993) established the classic argument of human capital theory: that education, training, and skill acquisition are investments that raise an individual's productivity and earnings, and that returns to such investments accrue to firms and to the wider economy. Applied to infrastructure, this implies

that the availability of specialized skills is not a by-product of construction activity but a prerequisite for it. Underwater welding, non-destructive testing inspection, and salvage are skill-intensive occupations in which errors carry safety and structural consequences, and the theory therefore supports treating diver training and certification as strategic investment rather than as an administrative cost. This is the logic behind the study's claim that a domestic pool of certified subaquatic workers underpins both project quality and national self-reliance.

Role Theory and Institutional Role Change

Biddle (1986) reviews the development of role theory, in which social positions carry sets of expectations, and behavior is understood through the norms, roles, and expectations attached to positions within organizations and society. The theory is useful when an established institution is asked to take on functions beyond its original mandate, because it draws attention to role expectations, role conflict, and the legitimacy of new duties. Koppeba has traditionally supported fleet readiness, hull inspection, and military salvage (Tentara Nasional Indonesia Angkatan Laut [TNI AL], 2021). The proposal that it should also act as a national certification facilitator is therefore a case of institutional role expansion, and Role Theory provides the lens for examining whether the necessary mandate, expectations, and organizational arrangements are in place.

Competency Certification of the Construction Workforce in Indonesia

Law No. 2 of 2017 on Construction Services requires construction personnel to hold competency certificates (Republik Indonesia, 2017). Afrida (2022) examined the implementation of this requirement using national labor-force data and reported that, of more than eight million construction workers in Indonesia, fewer than 10% held competency certificates. She proposed accelerating certification by establishing professional certification agencies (Lembaga Sertifikasi Profesi, LSP), modernizing the SIBIMA construction services system, sustaining expert quality through continuing professional development, and applying a link-and-match approach that aligns competency with the needs of the construction industry. These proposals correspond closely to the LSP-based, industry-linked certification model proposed for Koppeba in the present study.

Several Indonesian studies address the barriers and effects of certification. Wideasanti et al. (2019) identify the factors that inhibit skilled construction workers from obtaining competency certification, while Pabiangan (2024) examines the effect of competency certification on the working conditions of Indonesian workers. R. Putri et al. (2025) analyze the correlation between human resource competence and the success of construction projects in a public works and spatial planning agency, which supports the argument that workforce competence is linked to project outcomes. Read together, these studies indicate that certification coverage is low, that barriers include cost and institutional access, and that competence matters for project performance. They concern the general construction workforce, however, and do not consider high-risk subaquatic occupations.

Maritime Workforce Competency and Training

The international maritime literature offers a complementary perspective. Caesar (2023) documents the severity of skill shortages in the maritime transportation sector and argues for a paradigm shift in how the maritime workforce is trained, recruited, and retained, including greater attention to digital and critical-thinking competencies and to practices that attract younger entrants. Ghosh and Emad (2024) review the challenges of designing and implementing skills and competency frameworks for future seafarers, which highlights the difficulty of building regulated, standardized structures for maritime education and training. Both studies concern seafaring and ship operations rather than diving or subaquatic construction, but they reinforce two points that are relevant here: that competency frameworks need to be deliberately designed and institutionally anchored, and that training systems must be aligned with labor-market needs if shortages are to be addressed.

The Giant Sea Wall and the Legal Framework

A. Putri et al. (2025) present a comprehensive assessment of the Giant Sea Wall for the social, economic, and ecological sustainability of Jakarta's coast, which places the project within the wider debate on coastal protection and urban resilience. On the policy side, Presidential Regulation No. 12 of 2025 sets out the National Medium-Term Development Plan (RPJMN) 2025–2029 that provides the planning basis for national strategic priorities, including the GSW as described in this article (Republik Indonesia, 2025). Law No. 12 of 2012 on Higher Education provides the legal basis for vocational higher education and for the competency certification of graduates (Republik Indonesia, 2012), which is the foundation for the participation of vocational universities in the triple-helix model proposed in this study. Together with Law No. 2 of 2017, these instruments define the regulatory environment in which any subaquatic certification scheme must operate.

Naval Diving Capability and Support Facilities

Vego (2009) treats naval forces as instruments of operational warfare at sea, which situates diving, salvage, and underwater engineering within the broader set of naval capabilities that exist primarily to sustain military operations. Indonesian studies on the naval support system are consistent with this perspective. Prakoso (2021) discusses the development of naval bases in support of national defense, and Wiyono and Setiawan (2022) analyze the capability of underwater maintenance and repair facilities in supporting fleet operational readiness. Doctrine and guidance documents issued by the Indonesian Navy govern underwater rescue and salvage operations and the conduct of diving certification and training at Koppeba (TNI AL, 2021, 2024). These sources establish that naval diving capability is developed and organized for military purposes; they do not examine whether or how that capability can be extended to certify civilian workers for national infrastructure projects.

Analytical Frameworks and Research Methods

The strategic assessment follows the SWOT tradition. David and David (2020) present the Internal Factor Evaluation and External Factor Evaluation matrices as tools for converting judgments about strengths, weaknesses, opportunities, and threats into prioritized strategic choices, which is the logic of the IFAS-EFAS matrices used here. The qualitative component draws on Miles et al. (2020), who describe qualitative analysis as an interactive process of data condensation, data display, and conclusion drawing, and on Bazeley and Jackson (2019), who explain how NVivo supports organizing, coding, and querying qualitative data. Creswell and Creswell (2023) provide guidance on qualitative research design and on procedures for establishing validity, such as triangulation and member checking. Moleong (2018) and Sugiyono (2019) supply the corresponding methodological references in the Indonesian research tradition, including case study design, purposive sampling, and data trustworthiness.

Synthesis and Research Gap

The reviewed literature supports four conclusions. First, human capital theory explains why investment in specialized skills is central to infrastructure delivery (Becker, 1993). Second, certification coverage in Indonesian construction remains low and depends on institutional arrangements such as LSPs and industry linkage (Afrida, 2022). Third, competency frameworks in the maritime sector must be deliberately designed and aligned with workforce needs (Caesar, 2023; Ghosh & Emad, 2024). Fourth, Indonesian naval studies treat diving and underwater facilities mainly as components of fleet readiness (Prakoso, 2021; Wiyono & Setiawan, 2022).

Among the sources cited in this article, none examines a military diving command as a civilian subaquatic certification authority, and none links naval diving expertise to the workforce demands of a national strategic project such as the Giant Sea Wall. The certification literature addresses the general construction workforce, the maritime literature addresses seafarers, and the naval literature addresses military readiness. This study addresses the gap by using a qualitative single case study, supported by NVivo thematic coding and IFAS-EFAS SWOT analysis, to assess the readiness of Koppeba Koarmada RI to serve as a national subaquatic certification center and to propose a triple-helix certification model that connects the Navy, vocational higher education, and industry.

METHODS

This research was conducted to examine the strategic role of the Naval Diving and Underwater Salvage Command (Koppeba Koarmada RI) in establishing standardized competency certification for subaquatic technical personnel supporting the Giant Sea Wall (GSW) National Strategic Project. The study employed a qualitative descriptive research methodology utilizing a single case study design with embedded multiple units of analysis. This holistic approach enabled a comprehensive investigation of technical training infrastructure, national regulatory frameworks, and inter-agency collaboration across primary naval diving facilities in Surabaya, Jakarta, and Belitung between March and July 2026.

Data collection involved in-depth semi-structured interviews with five primary key stakeholder informants selected through purposive sampling based on administrative authority, technical diving master credentials, and infrastructure policy responsibilities. Key informants included the Commander and senior instructors of Koppeba Koarmada RI, the Director and vocational instructors of BPVP Belitung, senior officials from the Ministry of Public Works and Housing (PUPR) and the Jakarta Coastal Development Task Force (BOPPJ), academics from vocational higher education institutions under Kemdiktisaintek, and executives from private maritime salvage and subaquatic construction contractors. Fieldwork was complemented by direct physical observations of deep training pools, multi-lock hyperbaric decompression chambers, Surface-Supplied Diving Equipment (SSDE) systems, and wet underwater welding testing stations, alongside rigorous content analysis of 38 defense, vocational, and construction policy documents including Law No. 2/2017 and Presidential Regulation No. 12/2025.

Qualitative empirical data were processed and analyzed using NVivo 15 software following the interactive data analysis model encompassing systematic data management, thematic coding, matrix query analysis, and visual network mapping. Thematic nodes focused on technical capacity gaps, SKKNI/KKNI competency alignment, training facility readiness, and regulatory barriers. To formulate actionable strategic policy recommendations, the qualitative findings were operationalized through Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices, leading directly to the development of a structured SWOT Matrix. Methodological rigor and analytical trustworthiness were rigorously maintained through source, investigator, and theoretical triangulation, alongside member checking and comprehensive audit trails. By combining empirical field validation with theoretical perspectives from Human Capital Theory and Role Theory, this methodology produces an implementation-ready strategic roadmap for national subaquatic workforce standardization.

RESULTS

Standardizing underwater workforce competency represents a vital strategic imperative to guarantee structural integrity, execution safety, and national self-reliance for large-scale infrastructure projects. Assessing Koppeba Koarmada RI's certification role exemplifies how institutionalizing elite military technical subaquatic expertise can systematically bridge acute civilian labor shortages for the Giant Sea Wall megaproject. Through comprehensive empirical field investigations, five expert stakeholder consultations, and qualitative strategic modeling, this research identifies precise implementation pathways calibrated to Indonesia's subaquatic construction demands and complex regulatory realities. The following presents key empirical findings organized across major strategic dimensions, evaluating technical capacity gaps, training infrastructure readiness, SKKNI competency alignment, and triple-helix institutional governance.

Capacity Gap Analysis between Koppeba Personnel and Massive GSW Labor Demand

The empirical investigation reveals a pronounced numerical gap between Koppeba's elite, selective military diver force and the massive subaquatic labor volume required for the Giant Sea Wall project. While Koppeba personnel possess Master Diver certifications in underwater inspection, wet welding, and salvage, the unit's active personnel are primarily tasked with military fleet readiness. Construction of the initial 20-21 km GSW segment in Banten and Ancol requires hundreds of certified subaquatic welders and inspectors, a demand projected to exceed thousands across the full 500-kilometer alignment to Gresik. Bridging this deficit necessitates a systematic duplication and knowledge-transfer strategy, positioning Koppeba as a "train-the-trainer" authority to certify civilian vocational divers at scale.

Evaluation of Training Infrastructure and Facilities (Deep Pool, Hyperbaric Chamber, Scuba/SSDE)

Evaluating physical training infrastructure indicates that Koppeba Koarmada RI maintains premier subaquatic facilities, including a 10 meters deep training pool (*deep pool*), multi-lock hyperbaric decompression chambers, Surface-Supplied Diving Equipment (SSDE) systems, and Remotely Operated Vehicle (ROV) simulators. However, sustaining continuous certification cohorts for civilian divers introduces operational bottlenecks: current hyperbaric chamber maintenance schedules require increased operational budgets, and wet welding test stations need expansion to support concurrent testing. Upgrading and expanding these training facilities is critical to maintaining uncompromised safety standards during high-risk underwater skill testing.

Qualitative NVivo 15 Mapping of Regulatory Barriers and SKKNI/KKNI Standardization

Qualitative thematic coding executed via NVivo 15 across interview transcripts and policy documents highlights significant regulatory fragmentation. Primary nodes indicate a lack of harmonized competency standards connecting military diving qualifications with National Working Competency Standards (SKKNI) and the Indonesian National Qualifications Framework (KKNI) for civil construction. Furthermore, current certification procedures suffer from high administrative costs and a lack of clear wage disparities between certified and uncertified divers in commercial sectors. Resolving these barriers requires establishing dedicated subaquatic SKKNI descriptors for wet welding (Level 3-4 KKNI) jointly validated by Koppeba, BNSP, and the Ministry of PUPR.

Internal Factor Analysis Summary (IFAS): Evaluating Institutional Strengths and Weaknesses

Systematic synthesis of internal capabilities via IFAS identifies core institutional factors shaping Koppeba's readiness. Key internal strengths (S) include elite military diving expertise, possession of specialized hyperbaric and SSDE training infrastructure, and established inter-agency training partnerships

with BPVP Belitung. Major internal weaknesses (W) comprise limited civilian-oriented certification staff, lack of a formal Balakpus organizational mandate for public certification services, and budget constraints for routine facility overhaul. Strategic internal priorities must focus on formalizing Koppeba's legal certification mandate and expanding instructor training programs.

External Factor Analysis Summary (EFAS): Opportunities in Vocational Synergy and Foreign Workforce Threats

External Factor Analysis Summary (EFAS) screens macro-environmental drivers and strategic external risks. Dominant external opportunities (O) encompass strong national policy mandates under Perpres No. 12/2025 (RPJMN 2025-2029), mandatory worker certification under UU No. 2/2017, and vocational higher education expansion initiatives under Kemdiktisaintek. External threats (T) involve potential influxes of foreign subaquatic technical labor due to local diver shortages, severe marine environmental hazards (high turbidity and strong currents along Java's northern coast), and tight construction timelines enforced by GSW project managers.

Strategic SWOT Matrix: Formulating Competency Certification Pathways

Synthesizing IFAS and EFAS factors into the SWOT Matrix establishes actionable strategic pathways for subaquatic workforce standardization. The primary SO strategy leverages national strategic project priorities to position Koppeba as the national lead agency for subaquatic certification. Concurrently, WO strategies focus on establishing joint training centers with vocational universities to offload basic diver training while Koppeba conducts specialized testing. Furthermore, ST strategies mandate certified local diver quotas in GSW construction contracts to block foreign labor dependency, while WT strategies harmonize BNSP and TNI AL certification guidelines into a single recognized national license.

Synergistic Competency Certification Model (Koppeba Vocational Higher Education Industry)

Sustaining a sovereign underwater workforce requires institutionalizing a triple-helix collaboration model. Under this model, vocational universities provide foundational marine engineering theory and basic SCUBA training; Koppeba conducts advanced wet-welding, NDT inspection, and SSDE practical testing in its specialized facilities; and industrial contractors (BUMN Karya) absorb certified graduates directly into GSW construction sites. This model bridges the gap between academic education and industrial skill requirements, ensuring that certified divers possess work readiness, safety compliance, and professional recognition.

Institutionalizing Koppeba's Organizational Readiness as a National Subaquatic Certification Center

Long-term success mandates validating Koppeba's organizational status as a Central Executive Agency (*Badan Pelaksana Pusat / Balakpus*) within the TNI AL

organizational structure. Validating this institutional status provides formal authority to operate a public-facing Professional Certification Body (*Lembaga Sertifikasi Profesi / LSP*) accredited by BNSP. Institutionalizing standardized operating procedures for public certification, facility maintenance funding, and cross-sectoral coordination ensures that Koppeba permanently secures national workforce sovereignty in subaquatic engineering.

CONCLUSION

This study demonstrates that standardizing underwater workforce competency through the strategic role of Koppeba Koarmada RI is vital to support the execution of the Giant Sea Wall National Strategic Project. Transitioning from fragmented, informal diving practices toward a synergistic competency certification model directly addresses critical technical labor deficits while preventing reliance on foreign subaquatic workers. By implementing the strategic pathways derived from NVivo 15 thematic coding and IFAS-EFAS SWOT modeling, the Indonesian Navy and government ministries can formalize Koppeba's role as a national subaquatic certification authority, align training with SKKNI/KKNI standards, and establish an integrated training pipeline with vocational universities and industrial contractors. Institutionalizing this framework guarantees structural construction safety, optimizes national human capital, and reinforces maritime sovereignty across Indonesia's strategic coastal territory.

FURTHER STUDY

This study still has limitations, so further research on Naval Diving Capability in National Infrastructure Development: A Qualitative NVivo and SWOT Analysis of Koppeba's Certification Role is needed to refine this study and enhance the insights of readers and the authors.

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