JURNAL MULTIDISIPLIN MADANI (MUDIMA)

Homepage: https://mryformosapublisher.org/index.php/mudima
ISSN: 2808-5639 (Online)
Research Article

Volume 5, No 8, August (2025)	DOI: https://doi.org/10.55927/mudima.v5i8.523	Page: 837-845

Optimizing Transfer of Technology for Sustainable Competitiveness in Submarine Projects

Muhammad Khalil Fikri[1*], Khaerudin[2], I Nengah Putra A[3]
Universitas Pertahanan Republik Indonesia
Corresponding Author: Muhammad Khalil Fikri mhd.khalilfikri30@gmail.com

ARTICLEINFO

Keywords: Absorptive Capacity, SWOT, Transfer of Technology, Submarine Development

Received : 2 June
Revised : 22 July
Accepted : 22 August

©2025 Fikri, Khaerudin, Putra: This is an open-access article distributed under the terms of the Creative Commons Atribusi 4.0 Internasional.

ABSTRACT

This study evaluates the strategic partnership between PT PAL Indonesia and Naval Group in developing the Scorpène Evolved submarine, applying the Absorptive Capacity framework combined with SWOT analysis. A qualitative approach based on systematic literature review was employed to assess four ACAP dimensions acquisition, assimilation, transformation, and exploitation and to map internal and external strategic factors. The findings indicate that, compared to the previous collaboration with DSME, the Naval Group project offers higher ACAP potential, particularly in knowledge acquisition and assimilation, supported by full involvement in design and construction as well as the establishment of a joint R&D center. Integration of domestic suppliers and adaptation of designs for tropical conditions strengthen the transformation dimension, while export prospects and technology spin-offs enhance exploitation opportunities. The SWOT analysis positions PT PAL in a relatively strong strategic stance, with its main strengths, local production from the first unit, joint R&D capability, and domestic supply chain integration enabling the acceleration of co-design, local manufacturing, and market expansion. Key recommendations include reinforcing dual-sourcing strategies to enhance supply chain resilience, developing critical components through co-development initiatives, and implementing capacity-building programs for specialized human resources. This integrated approach provides a comprehensive framework for evaluating technology transfer effectiveness in defense projects, offering both academic insights and practical guidance for sustaining competitiveness in the maritime defense industry

INTRODUCTION

Indonesia faces a strategic imperative to enhance its maritime defense capabilities, particularly in response to evolving geopolitical dynamics and the need to safeguard national sovereignty. One of the primary strategies to achieve this objective is the mastery of submarine technology. Consequently, the acquisition and development of such technology have consistently been designated as a priority program within the Indonesian Navy's Minimum Essential Force (MEF) framework. Following its previous collaboration with South Korea's Daewoo Shipbuilding & Marine Engineering (DSME) on the Nagapasa-class submarine project, Indonesia signed a contract on April 2, 2024, with France's Naval Group for the construction of two Scorpène-class submarines. This agreement, which came into effect on July 23, 2025, designates PT PAL's shipyard in Surabaya as the primary production site (ANTARA, 2025).

While Law No. 16/2012 already outlines obligations regarding transfer of technology (ToT) and local content (TKDN), recent regulatory instruments have introduced more stringent requirements. The Ministry of Defense Regulation No. 6/2024 mandates that a minimum of 85% of the total contract value must be fulfilled through offset, local participation, or countertrade schemes (IDKLO) (Kementerian Pertahanan, 2024. Likewise, Ministry of Industry Regulation No. 4/2023 and Ministerial Decree No. 4058/2023 refine the procedures for calculating and verifying TKDN/BMP contributions (Kementerian Perindustrian, 2023). These legal developments underscore the government's determination to ensure that defense procurement activities generate tangible benefits for the domestic defense industry and foster long-term technological self-reliance.

Nevertheless, scholarly investigations assessing the extent to which foreign defense technologies are successfully internalized within Indonesia's industrial ecosystem remain limited. To address this gap, the present study employs the absorptive capacity (ACAP) framework as an analytical lens to evaluate organizational capability in acquiring, assimilating, transforming, and exploiting new external knowledge (Zahra & George, 2002). Recent empirical contributions further validate this approach. A meta-analysis by Pu and Liu (2023) highlighted the robust linkage between ACAP and innovation performance, while subsequent research in 2024–2025 has emphasized the distinction between potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP) in technologically intensive sectors (Hara et al., 2025). Complementarily, this study incorporates SWOT analysis to systematically examine the internal and external factors shaping PT PAL's strategic position in the Scorpène collaboration. This dual-method approach seeks to capture not only the organizational learning dimension of technology transfer but also its strategic sustainability implications for Indonesia's defense industry (Triantaphyllou & Kotsiopoulos, 2023).

METHODS

This study employs a qualitative approach based on a Systematic Literature Review (SLR) to evaluate the collaboration between PT PAL and the Naval Group in constructing the Scorpène Evolved-class submarines, and to compare it with the earlier PT PAL–DSME partnership on the Nagapasa-class submarine project. Two analytical frameworks are applied. First, the Absorptive Capacity) model is used to assess PT PAL's ability to acquire, assimilate, transform, and exploit transferred technology. Second, SWOT analysis is employed to identify the strengths, weaknesses, opportunities, and threats associated with the collaboration, thereby providing strategic insights that complement the ACAP assessment.

Data were collected through searches in academic databases, including Scopus, Web of Science, and Google Scholar, using predetermined keywords. Literature selection followed inclusion–exclusion criteria covering publication period, topic relevance, and direct connection to the maritime defense sector. The extracted data were analyzed using the ACAP framework to identify performance indicators across its four dimensions and were subsequently organized into a SWOT matrix to examine internal and external strategic factors.

The concept of absorptive capacity was first introduced by Cohen and Levinthal (1990) as an organization's ability to recognize the value of external knowledge, assimilate it, and apply it for commercial purposes. Zahra and George (2002) later expanded this framework into four dimensions: acquisition, assimilation, transformation, and exploitation. Building on this, Flatten et al. (2011) developed widely adopted measurement instruments applicable across various sectors, including the defense industry.

Table 1. Absorptive Capacity Dimention

Dimention	Defined
Acquisition	he ability to identify and obtain externally generated knowledge critical to the organization's operations.
Assimilation	the process of analyzing, interpreting, and understanding information obtained from external sources.
Transformation	the development and refinement of routines that integrate newly acquired and assimilated knowledge with existing knowledge.
Exploitation	the consistent application of newly acquired knowledge for long-term commercial or operational benefits.

Source: Zahra dan George, 2002

Absorptive Capacity serves as a framework for assessing the extent to which an organization not only adopts technology from foreign partners but also internalizes and utilizes it to develop independent innovation (Jansen et al., 2005). Research in the defense sector suggests that strong ACAP can accelerate the achievement of industrial self-reliance

SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a strategic evaluation tool that maps both internal and external factors influencing organizational performance (Gürel & Tat, 2017). Internal factors encompass strengths and weaknesses derived from an organization's capacities, resources, and internal processes. External factors include opportunities and threats arising from market conditions, government policies, technological advancements, and environmental changes.

The application of SWOT analysis can support the formulation of medium- and long-term strategies, particularly when organizations face shifts in technology and global market dynamics. A study by Syahtaria et al. (2019) demonstrated that applying SWOT in Indonesian shipyards can complement technical frameworks such as ACAP, offering a broader strategic perspective.

RESULTS AND DISCUSSION

Absorptive Capacity Analysis

This section presents the findings of the systematic literature review, categorized into the four key dimensions of absorptive capacity (ACAP): acquisition, assimilation, transformation, and exploitation. Two collaborative projects serve as points of comparison: the Nagapasa-class (PT PAL–DSME, South Korea) and the Scorpène-class (PT PAL–Naval Group, France).

Acquisition

In the DSME project, the first two submarines were constructed in South Korea, while domestic assembly occurred only with the third unit (KRI Alugoro). This arrangement limited early exposure to core engineering processes and main systems (Bila et al., 2023). By contrast, the Scorpène program was designed for local construction from the first unit in Surabaya (Naval Group, 2025), thereby enabling learning-by-doing and the absorption of technical knowledge from the outset of the project cycle.

Assimilation

The DSME collaboration encountered several assimilation barriers, including reliance on Korean technicians, inconsistent access to technical documentation, and the absence of a well-established knowledge management system (Asmoro et al., 2018). In the Scorpène project, a joint R&D center between PT PAL and Naval Group was established in 2022, providing a more continuous channel for cross-team engineering knowledge internalization (Waskito et al., 2023). This aligns with Flatten et al.'s (2011) ACAP model, which emphasizes the importance of cross-functional integration in the assimilation process.

Transformation

During the Nagapasa project, PT PAL successfully adapted the Jang Bogo-class design by integrating upgraded sonar and navigation systems. However, these adaptations were largely reactive and limited in scope (Bila et al., 2023). In contrast, the Scorpène collaboration involved Indonesian engineers from the early design phase, including the adaptation of lithium-ion batteries and combat systems for tropical conditions. This represents a shift towards co-design, which fosters realized ACAP (Naval Group, 2025) and demonstrates a more proactive and collaborative approach to transformation.

Exploitation

Following the completion of the Nagapasa project, few derivative innovations emerged, and the domestic supply chain saw limited growth, with most modules still imported (Waskito et al., 2023). Conversely, the Scorpène program has engaged two state-owned enterprises—PT Dirgantara Indonesia and PT Barata Indonesia—alongside five private companies as key component suppliers (Tabloid Maritim, 2025). This arrangement has the potential to strengthen domestic content requirements (TKDN) and promote cross-project learning opportunities.

Table 2. Summary of ACAP Evaluation Across Dimensions

Dimension	DSME	Naval Group	General Evaluation
Acquisition	Collaboration with DSME involved three units, with the first two submarines fully built in South Korea and only the third assembled domestically at PT PAL's Surabaya shipyard.	The Scorpène Evolved program is designed for local construction at PT PAL from the very first unit, with over 50% of components sourced domestically.	The French scheme is comparatively more assertive, granting PT PAL early exposure and broader opportunities for knowledge absorption.
Assimilation	A Local Design Office (LDO) was established in Surabaya, but knowledge	A joint research and development (R&D) center was established in 2022	The French model offers a more structured mechanism for sustained

	transfer faced challenges such as reliance on Korean experts, uneven documentation access, and incomplete system integration.	between PT PAL and Naval Group, facilitating continuous internalization of technical knowledge across engineering teams.	knowledge assimilation compared to the Korean partnership.
Transformation	The Jang Bogo-class design was modified with upgraded sonar and navigation systems; however, adaptations were reactive and limited in scope.	Indonesian engineers were directly involved in the early design phase of the Scorpène project, including the adaptation of lithium-ion batteries and tropicalized combat systems.	Transformation has shifted from reactive, project-based adjustments (DSME) to proactive, co-design collaboration (Naval Group).
Exploitation	Limited downstream innovation followed the Nagapasa project, with supply chains remaining weak and most modules still imported.	The Scorpène collaboration engaged two state-owned enterprises (PT Dirgantara Indonesia and PT Barata Indonesia) and five private firms as key suppliers of critical components.	Integration of broader domestic supply networks reflects progress toward sustainable exploitation and higher local content (TKDN).

Source: Data Processed by the Author (2025)

The comparative summary in Table 1 highlights key differences between the two submarine collaboration projects. The Nagapasa-class partnership with DSME demonstrates a more limited trajectory of knowledge transfer, particularly in the acquisition and exploitation phases, where domestic involvement remained constrained and supply-chain integration was minimal. In contrast, the Scorpène-class collaboration with Naval Group exhibits a more comprehensive approach, characterized by local construction from the outset, structured assimilation through joint R&D activities, proactive transformation via co-design, and wider exploitation involving state-owned and private enterprises. These findings suggest that the French model provides stronger opportunities for sustainable capability development within Indonesia's defense industry.

The findings across the four ACAP dimensions reveal that the success of technology collaboration is not solely determined by the availability of training programs or formal knowledge transfer activities, but also by the institutional design and the long-term commitment of the partners involved. Although both DSME and Naval Group engaged with PT PAL under technology transfer frameworks, the structures and approaches adopted reflect significantly different levels of preparedness and intensity in organizational learning.

The DSME project largely strengthened what is referred to as *potential absorptive capacity*, focusing on the acquisition and comprehension of new knowledge. In contrast, the Naval Group collaboration appears to have been deliberately structured to promote deeper organizational learning, thereby enabling the transformation and strategic exploitation of technology—indicative of *realized absorptive capacity*. This comparative analysis therefore aims to identify the key factors that differentiate the effectiveness of the two collaborations, while clarifying policy directions for the future development of Indonesia's defense industry.

The comparison between the two projects highlights a shift in technological cooperation from a build-under-license model toward co-development. In the DSME case, capacity building was concentrated in the acquisition–assimilation stages, while transformation–exploitation remained limited. Conversely, the Naval Group partnership introduced full local construction, joint R&D, and integration of domestic suppliers, creating a more complete cycle of organizational learning. These findings reinforce Hellberg's (2025) argument that the success of technology transfer in the defense sector is heavily influenced by the readiness of local organizations to absorb and continuously develop knowledge.

Table 3. SWOT Analysis of PT PAL - Naval Group Collaboration

Category	Key Factors	
Strengths (S)	S1.	Local construction initiated from the first unit, expanding learning-by-doing opportunities.
	S2.	Establishment of a joint R&D center between PT PAL and Naval Group enhances cross-functional knowledge flows.
	S3.	Integration of two state-owned enterprises and five private firms in subsystem production opens pathways for domestic content (TKDN) and broader exploitation.
Weaknesses (W)	W1.	Continued dependence on imported critical components.
	W2.	Limited availability of skilled personnel with design and certification expertise.
	W3.	Underdeveloped digital knowledge management systems and insufficient standardization of technical documentation.
Opportunities (O)	O1.	Rising regional demand for submarines creates potential for exports and joint marketing.
	O2.	Pro-TKDN and offset policies aligned with the Minimum Essential Force (MEF) framework.
	O3.	Access to Naval Group's global networks and advanced technical standards.
	O4.	Adaptable tropicalized designs provide opportunities for spin-offs into other platforms.
Threats (T)	T1.	Competition from regional producers (e.g., South Korea, Japan, Turkey).
	T2.	Geopolitical risks and supply chain disruptions.
	T3.	Fluctuations in defense budgets.
	T4.	Risk of technological lock-in if core design transfers remain incomplete.

Source: Data Processed by the Author (2025)

The next stage involves formulating strategies derived from the SWOT analysis. This process is operationalized through the Internal Strategic Factor Analysis Summary (IFAS), which evaluates the organization's internal conditions, and the External Strategic Factor Analysis Summary (EFAS), which examines the external environment. The results of IFAS and EFAS are then combined within a strategic matrix to generate four types of strategies: leveraging strengths to exploit opportunities (SO), addressing weaknesses to capture opportunities (WO), utilizing strengths to mitigate threats (ST), and minimizing weaknesses to reduce vulnerability to threats (WT).

Table 4. SWOT-Based Strategic Formulation

Strategy Type	Formulated Strategies
SO (Strengths-Opportunities)	Accelerate co-design and local production of export-oriented variants by leveraging pro-TKDN policies and rising regional demand. Develop modular priority components through Naval Group's global networks and adaptive design capabilities.
WO (Weaknesses–Opportunities)	Engage in co-development of critical components with global partners supported by government incentives. Implement certification programs and specialized workforce upskilling to fully capitalize on export opportunities.
ST (Strengths–Threats)	Establish dual-sourcing and domestic supplier development to address regional competition and supply chain risks. Formulate a roadmap for transfer of design authority to anticipate budget fluctuations and mitigate the risk of technological lock-in.
WT (Weaknesses–Threats)	Strengthen strategic stock management and digital knowledge management systems to counter supply disruptions. Gradually substitute imported components to ensure long-term sustainability of organizational learning.

Source: Data Processed by the Author (2025)

The SWOT matrix analysis demonstrates that PT PAL's strengths such as initiating local construction from the outset, establishing a joint R&D center, and integrating domestic suppliers can be leveraged to accelerate co-design, domestic production, and exports in line with TKDN policies and regional demand. The strategies emphasize the development of modular components through Naval Group's global networks, risk mitigation against competition and supply disruptions through dual-sourcing, and anticipation of budget fluctuations via a roadmap for the transfer of design authority. Weaknesses, including dependence on imports and limited specialized human resources, are addressed through co-development of critical components, certification programs, and workforce upskilling, while risks of supply chain disruptions and technological lock-in are mitigated through strategic stock management, digital knowledge management, and gradual import substitution to ensure the continuity of technological learning.

The findings indicate that the combined application of Absorptive Capacity (ACAP) and SWOT provides a comprehensive overview of PT PAL performance in its collaboration with the Naval Group on the Scorpène Evolved-class submarine project. From a practical standpoint, these results may serve as valuable inputs for:

- PT PAL and industrial partners, in prioritizing the reinforcement of acquisition and assimilation during the early stages of the project, while simultaneously designing long-term strategies for transformation and exploitation.
- Government and policymakers, in formulating regulations and incentives that support localization of critical components, development of specialized human resources, and consolidation of the domestic supply chain.
- The national defense industry, as a reference model for effective international cooperation, where technology transfer is assessed not only in technical terms but also in terms of strategic readiness to address market opportunities and threats.

From an academic perspective, this study extends the application of ACAP in the maritime defense sector and demonstrates that its integration with SWOT adds a strategic dimension that is rarely explored in similar studies.

CONCLUSION

The study reveals that, compared to the previous collaboration with DSME, the partnership with the Naval Group has provided PT PAL with greater absorptive capacity in the acquisition and assimilation dimensions, supported by full participation in design and construction processes as well as the establishment of a joint R&D center. The integration of domestic suppliers, adaptation of designs to tropical conditions, export potential, and technology spin-offs further strengthen the transformation and exploitation dimensions. The SWOT analysis positions PT PAL in a relatively strong strategic stance, although challenges remain in terms of dependence on imported components, limited specialized human resources, and risks of technological lock-in. The TOWS-based strategy formulation recommends leveraging internal strengths to maximize market opportunities, reinforcing supply chain resilience, and enhancing human capital capacity while gradually reducing import dependence.

Based on these findings, it is recommended that PT PAL prioritize co-development of critical components and structured transfer of design authority with measurable targets, implement international certification and continuous upskilling for specialized personnel, and establish dual domestic sourcing, strategic stock management, and digital knowledge management systems to mitigate supply chain risks. Furthermore, the enhancement of domestic content (TKDN) should be optimized through the expansion of local supplier integration while utilizing Naval Group's global networks to strengthen export opportunities. Periodic evaluations using ACAP and SWOT are also necessary to ensure that the implemented strategies remain aligned with market dynamics, government policies, and technological advancements in the maritime defense sector.

REFERENCES

Antara (2025). Indonesia-France Scorpene submarine project underway: Ministry. https://en.antaranews.com/news/369021/indonesia-france-scorpene-submarine-project-underway-ministry

Antara. (2025). *PT PAL dan Naval Group bangun kapal selam modern libatkan anak bangsa*. https://www.antaranews.com/berita/5004737/pt-pal-dan-naval-group-bangun-kapal-selam-modern-libatkan-anak-bangsa

Asmoro, T., et al. (2018). The Role of TNI AL in Naval Technology Transfer. JOURNAL ASRO, 9(1), 74–82. https://doi.org/10.37875/asro.v9i1.61

Bila, T. M., Halim, R., & Yudha, T. A. (2023). Evaluasi Roadmap Penguasaan Teknologi Pembuatan Kapal Selam. Jurnal Pertahanan, 9(3), 467–478. https://doi.org/10.33172/jp.v9i3.15134

Flatten, T. C., et al. (2011). Absorptive Capacity and Firm Performance. European Management Journal, 29(2), 98–116. https://doi.org/10.1016/j.emj.2010.11.002

Gürel, E., & Tat, M. (2017). SWOT analysis: A theoretical review. *The Journal of International Social Research*, 10, 994–1006. https://doi.org/10.17719/jisr.2017.1832

Hara, Y., Ito, T., & Nakamura, M. (2025). The roles of relational diversity and embeddedness in interfirm learning: An absorptive capacity perspective. Industrial Marketing Management, 122, 87–99.

Hellberg, R. (2025). Performance Constraints in Defence Supply Chains. Defence and Peace Economics. https://doi.org/10.1080/10242694.2025.2500362

Jansen, J. J. P., et al. (2005). Managing Potential and Realized Absorptive Capacity. Academy of Management Journal, 48(6), 999–1015. https://doi.org/10.5465/amj.2005.19573106

Naval Group. (2025). Indonesia and France Launch Submarine Construction Program with PT

PAL. https://www.naval-group.com/en/newsroom

Naval Group. (2025). Indonesia and France Launch Submarine Construction Program. https://www.naval-group.com

Pu, K., & Liu, W. (2023). Is absorptive capacity the "panacea" for organizations? A meta-analysis of absorptive capacity and innovation. *PLOS ONE, 18*(2)

Reuters. (2024). Indonesia signs deal with France's Naval Group to build submarines. https://www.reuters.com/world/asia-pacific/indonesia-signs-deal-with-frances-naval-group-build-submarines-2024-04-02/

Syahtaria, I., et al. (2019). SWOT application on determining ship yard development strategies: A case study. *International Journal of ASRO*, 10(3), 37–41. https://doi.org/10.37875/asro.v10i3.148

Tabloid Maritim. (2025). Langkah Strategis Naval Group Gandeng BUMN dan BUMS. https://tabloidmaritim.com

Tabloid Maritim. (2025, June 13). *Langkah strategis, Naval Group gandeng 2 BUMN dan 5 BUMS pasok komponen Scorpene dibangun di PAL Indonesia*. https://tabloidmaritim.com/2025/06/13/langkah-strategis-naval-group-gandeng-2-bumn-dan-5-bums-pasok-komponen-kapal-selam-canggih-scorpene-dibangun-di-pal-indonesia/

Triantaphyllou, E., & Kotsiopoulos, X. (2023). The European defence industry at a crossroads: A SWOT analysis of future prospects. *Defence Studies, 23*(4), 455–472.

Waskito, D., Ahmad, R., & Prakoso, D. (2023). Transfer Teknologi Pembuatan Kapal Selam Indonesia-Prancis. International Journal of Social Science and Religion Research, 6(1), 312–319. https://doi.org/10.47814/ijssrr.v6i1.918

Waskito, D., Ahmad, R., & Prakoso, D. (2023). Transfer Teknologi Pembuatan Kapal Selam Indonesia-Prancis. IJSSRR, 6(1), 312–319. https://doi.org/10.47814/ijssrr.v6i1.918

Zahra, S. A., & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension. Academy of Management Review, 27(2), 185–203. https://doi.org/10.5465/amr.2002.6587995