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Article

Evaluating the Indonesia's defense industry policy (2018–2023): A Balanced Scorecard study of PT Pindad

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Abstract: This study evaluates the effectiveness of Indonesia's defense industry policy from 2018 to 2023, focusing on PT Pindad, a pivotal state-owned defense enterprise. Using a Balanced Scorecard (BSC) framework, the study assesses PT Pindad's performance across financial, customer, internal process, and learning and growth perspectives. The findings reveal strengths in financial stability (Current Ratio at 115.57% in 2023) and customer satisfaction, but challenges in Return on Investment (ROI), which fell from 6% in 2022 to 5.46% in 2023, signaling a need for further internal improvements. A mediation analysis using Shape-Restricted Regression indicates that Research and Development (R&D) serves as a crucial mediator, enhancing the impact of strategic alliances and technology transfer on PT Pindad's self-reliance, with R&D showing a positive coefficient of $\beta = 0.53$ ($p < 0.01$). The systematic literature review complements these findings, underscoring the role of technology transfer, human capital development, and strategic partnerships as essential components for strengthening PT Pindad's self-reliance and global competitiveness. Recommendations are made to enhance policy effectiveness by fostering robust technology transfer mechanisms, increasing investment in human capital, and expanding strategic partnerships. This research contributes to the literature on defense industry policies by providing a comprehensive evaluation framework that informs future policy decisions.

Keywords: Balanced Scorecard; defense industry policy; human capital development; PT Pindad; technology transfer

1. Introduction

A nation's ability to defend itself is crucial for its sovereignty and security. A strong and independent defense industry is essential in reducing reliance on foreign suppliers and ensuring the availability of critical military equipment (DeVore, 2021). Recognizing this, Indonesia has implemented a series of defense industry policies aimed at boosting domestic production capabilities. The Minimum Essential Force (MEF) policy, outlined in Presidential Decree No. 7/2010, provided a strategic roadmap for developing Indonesia's defense capabilities. However, with the MEF's conclusion, new policy directions are needed to navigate the evolving global defense landscape. This paper focuses on evaluating the effectiveness of Indonesia's defense industry policy from 2018 to 2023, with a specific focus on PT Pindad, a state-owned defense company. PT Pindad plays a crucial role in Indonesia's defense industry, supplying a wide range of military equipment, including weapons, ammunition, and armored vehicles.

PT Pindad, a cornerstone of Indonesia's defense industry, faces significant challenges in achieving self-sufficiency despite various policies and regulations like Law Number 16 of 2012 concerning the Defense Industry. The company still heavily relies on imported raw materials and technology, which poses a vulnerability for Indonesia's defense capabilities. This dependency is further compounded by the company's reliance on foreign components, which often leads to production delays and inflated costs due to currency fluctuations and procurement issues. To address these challenges, this research critically evaluates Indonesia's defense industry policies from 2018 to 2023 at PT Pindad, aiming to propose strategic solutions that bolster Indonesia's defense industry amidst global challenges. This research seeks to answer the following research questions:

a) How effective have Indonesia's defense industry policies been from 2018 to 2023 in enhancing the self-sufficiency and competitiveness of PT Pindad, based on a performance evaluation using the Balanced Scorecard approach?
b) What internal and external factors influence the implementation of defense industry policies at PT Pindad?
c) What are the main obstacles faced by PT Pindad, and what strategic efforts has the company undertaken to enhance industrial independence through strategic alliances, technology transfer, and strengthening Research and Development?

The effectiveness of Indonesia's defense industry policy is critical to ensuring national security, reducing reliance on foreign suppliers, and fostering technological independence. Despite various regulations, including Law Number 16 of 2012 on the Defense Industry, challenges persist in achieving self-reliance, particularly in the areas of technology transfer, human capital development, and industrial competitiveness. PT Pindad, as a key state-owned defense enterprise, plays a central role in advancing these objectives. However, limited empirical assessments have been conducted to evaluate the impact of existing policies on its performance. This study addresses this gap by providing a comprehensive analysis of Indonesia's defense industry policy (2018–2023), integrating the Balanced Scorecard framework and Shape-Restricted Regression to assess PT Pindad's progress toward self-sufficiency and competitiveness. The findings offer valuable insights for policymakers in refining strategic interventions that enhance domestic defense production capabilities.

This research contributes to the existing body of knowledge by using a comprehensive mixed- methods approach, focusing on performance evaluation through a Balanced Scorecard lens (Martín-Gómez et al., 2024), and incorporating AI-powered analysis tools like Natural Language Processing (NLP) and Machine Learning (ML) (Joos et al., 2024) to enhance efficiency in processing SLR data. By integrating key theories such as Public Policy Theory (Patty, 2024), Independence Theory (Ahumada, 2023), and BSC (Kaplan and Norton, 1996), the study provides a holistic understanding of defense industry policy evaluation at PT Pindad. This multifaceted approach, coupled with a comprehensive problem focus and the application of key theories, positions this research to make valuable contributions to the evolving literature on the defense industry, particularly in the Indonesian context, while offering a solid foundation for future policy decisions.

The remainder of this paper is organized as follows. Section 2 presents a comprehensive literature review, categorizing prior studies into theoretical, empirical, and Indonesia-specific discussions on defense industry policy. Section 3 details the research methodology, outlining the Balanced Scorecard framework, systematic literature review process, and data sources. Section 4 presents the findings and discussion, including a performance evaluation of PT Pindad, the role of technology transfer, human capital development, and strategic partnerships in enhancing self-reliance. Section 5 concludes the study by summarizing key findings, discussing limitations, and providing policy recommendations for strengthening Indonesia's defense industry.

2. Literature review

A robust defense industry policy is crucial for supporting national security and economic growth. Key aspects of an effective policy include: Clear strategic objectives—a well-defined national defense strategy, outlining the desired level of self-reliance and strategic priorities for the defense industry (Nem Singh, 2023; Schiff, 2023); investment in Research and Development (R&D)—government funding for R&D is essential for driving technological innovation in the defense sector (Chen et al., 2020); Support for Domestic Companies—policies encouraging the growth of local defense companies through incentives, procurement preferences, and support for technology development (Yang et al., 2022); international collaboration—strategic partnerships with foreign defense companies for technology transfer, joint ventures, and access to global markets (DeVore, 2021); and human capital development—investing in education and training programs to develop a skilled workforce capable of supporting a technologically advanced defense industry (Shi and Wang, 2024).

The Balanced Scorecard (BSC) is a widely adopted strategic management framework that translates an organization's vision and strategy into a set of measurable objectives and performance indicators (Martín-Gómez et al., 2024). The BSC goes beyond traditional financial measures by incorporating perspectives on customer satisfaction, internal processes, and learning and growth. The BSC's four perspectives are: Financial perspective—measures financial performance, including profitability, revenue growth, and Return on Investment; customer perspective—assesses customer satisfaction, market share, and customer loyalty; internal processes perspective—evaluates the efficiency and effectiveness of key internal processes, including production, innovation, and customer service; and learning and growth perspective—focuses on employee skills, knowledge, and motivation, as well as the organization's ability to adapt and innovate. The BSC has been successfully applied in various industries, including the defense sector (Soares et al., 2022), to monitor performance, align strategic objectives, and drive organizational improvement.

Technology transfer is crucial for enhancing the capabilities of developing defense industries. Effective mechanisms for technology transfer include: Offset agreements—requiring foreign suppliers to invest in local industries or transfer technology as part of defense procurement contracts (Bozeman, 2000; Corsi et al.,

2021; Craiut et al., 2022); licensing agreements—acquiring the rights to produce and sell foreign-designed technology (Kishimoto, 2024; Li, Li, & Xing, 2024); joint ventures—establishing partnerships with foreign companies to collaborate on technology development and production (Liu et al., 2024; Wadjdi et al., 2023).

Human capital development is equally important for supporting a technologically advanced defense industry. This requires investments in technical education and training—developing a skilled workforce in areas such as engineering, manufacturing, and software development (Carvache-Franco et al., 2022); Management Training - Enhancing the managerial capabilities of defense industry personnel to effectively lead and manage complex projects (Safdari Ranjbar & Fatemi, 2022); knowledge sharing platforms—facilitating the exchange of knowledge and best practices between industry, academia, and research institutions (Hua et al., 2024; Tereshchenko et al., 2024).

Building upon the identified research gaps in defense industry studies, this research integrates three critical research questions to provide a nuanced analysis of PT Pindad's performance and the effectiveness of Indonesia's defense industry policy from 2018 to 2023. A review of ten relevant journal articles in preliminary studies highlights the need for a holistic approach encompassing policy evaluation, influential factors in policy implementation, and strategic responses for self-sufficiency within the context of Indonesia's defense landscape.

For the first research question on evaluating defense industry policy effectiveness, existing studies predominantly focus on individual aspects of defense policies, such as financial outcomes or technology transfers, often overlooking a comprehensive framework like the Balanced Scorecard (BSC). The BSC enables a multidimensional analysis across financial, customer, internal processes, and learning and growth perspectives, providing a more thorough understanding of policy effectiveness. This study addresses this gap by utilizing the BSC to assess how well the 2018–2023 defense industry policy advances PT Pindad's self-sufficiency and competitiveness. The financial dimension examines PT Pindad's profitability and financial stability, while the customer perspective evaluates satisfaction levels, particularly from key military clients like the Indonesian National Armed Forces (TNI) (Dwiguna et al., 2022; Habsari, 2022). Additionally, the analysis of internal processes and learning and growth captures PT Pindad's operational efficiency, innovation capacity, and human capital development, contributing a holistic view to defense policy evaluation that is often lacking in current literature (Andari et al., 2019; Anu et al., 2023; Arsita et al., 2021; Schaefer et al., 2024).

The second research question targets the internal and external factors that shape the implementation of defense policies. Prior studies tend to emphasize policy structures without sufficient analysis of the organizational and environmental factors that critically affect policy execution. Internally, PT Pindad's human resources, technological capabilities, and organizational structure significantly influence its ability to absorb and execute policy changes effectively. The study explores these dimensions, particularly how specialized skills in R&D (Bae and Lee, 2020), project management, and technology adaptation can bolster or limit policy implementation (DeVore, 2021). Externally, global defense market trends, geopolitical shifts, and

international trade regulations (Matthews and Anicetti, 2024) impact PT Pindad's strategy and operations (Arsita et al., 2021). This research bridges this gap by examining these internal and external factors and their interplay, thereby highlighting how PT Pindad navigates complex operational environments while aligning with national policy objectives.

In response to the third research question on barriers to self-sufficiency and strategic initiatives, this study examines PT Pindad's strategic responses to major obstacles such as technological dependence and funding constraints (Arsita et al., 2021; Chen et al., 2020; Dwiguna et al., 2022; Praditya et al., 2023), and market access limitations (Chen et al., 2020; Schaefer et al., 2024; Yang et al., 2022). Many defense studies recognize the importance of self-sufficiency but lack focused analysis on specific barriers and the effectiveness of various strategic initiatives. For PT Pindad, reliance on foreign suppliers and limited local technological capabilities present significant challenges (Arsita et al., 2021; Sarjito, 2023; Satria and Yunanto, 2024). This research provides an in-depth look at how PT Pindad leverages strategic alliances, including joint ventures and technology transfer agreements, as well as R&D investments to counter these challenges. Additionally, by exploring initiatives such as dual-use technology development and government support (Wadjdi et al., 2023), the study addresses the effectiveness of these strategies in overcoming market constraints and reducing dependency on imports.

The identification of these research gaps, contextualized by the key research questions, strengthens the significance of this study in advancing defense industry scholarship. This study's approach—utilizing the Balanced Scorecard, analyzing internal and external implementation factors, and evaluating strategic responses—offers valuable insights into PT Pindad's path toward greater self-reliance and competitiveness. Furthermore, it contributes to broader defense industry studies by illustrating how a comprehensive evaluation framework, such as the BSC, and a deeper understanding of implementation barriers can support the development of effective and resilient defense companies within complex global environments.

Previous research, such as Sarjito (2025), has primarily focused on Indonesia's national defense policy in the context of area denial strategies and maritime security. Sarjito's study employs a qualitative policy analysis, relying on secondary sources, historical documents, and government policies to examine how Indonesia has developed A2/AD (Anti-Access/Area Denial) strategies to strengthen maritime defense. His work highlights the role of asymmetric warfare tactics, strategic deterrence measures, and regional security cooperation in shaping Indonesia's defense posture. However, Sarjito's research does not assess the effectiveness of defense industry policies or the performance of key state-owned defense enterprises like PT Pindad. His study remains centered on defense strategy rather than industrial policy, leaving a gap in understanding how national policies translate into measurable performance outcomes within Indonesia's defense manufacturing sector.

In contrast, this study provides a distinct and novel contribution by evaluating Indonesia's defense industry policy (2018–2023) using a performance-based approach. Unlike Sarjito's qualitative policy review, this research employs a Balanced Scorecard (BSC) framework to quantitatively assess PT Pindad's financial health, customer satisfaction, internal efficiency, and innovation capacity.

Additionally, it integrates Shape-Restricted Regression (SRR) to analyze the mediating role of Research and Development (R&D) in enhancing self-reliance through technology transfer and strategic alliances. This mixed-method approach—combining quantitative performance evaluation and systematic literature review (SLR)—offers a more data-driven and policy-relevant perspective than prior studies. By addressing key challenges such as human capital constraints, policy implementation gaps, and industrial self-reliance, this study provides practical recommendations for strengthening Indonesia's defense industry, making it a substantially different contribution from the strategic and military focus of Sarjito's research.

3. Methods

This study adopts a concurrent mixed methods approach, integrating both quantitative (BSC) and qualitative data analysis (SLR) (Bienkowska and Sikorski, 2024). The BSC framework is employed to evaluate the effectiveness of Indonesia's defense industry policy in achieving its strategic objectives. Key performance indicators (KPIs) are developed for each perspective of the BSC based on relevant policy documents and industry benchmarks. Data for the KPIs are collected from PT Pindad's financial statements, operational reports, and performance evaluations. The BSC analysis provides a quantitative assessment of PT Pindad's performance in areas such as financial sustainability, customer satisfaction, production efficiency, and innovation capabilities.

The data utilized in this study comes from a combination of quantitative and qualitative sources, ensuring a comprehensive assessment of PT Pindad's performance under Indonesia's defense industry policy. As previously mentioned, the quantitative data for the Balanced Scorecard (BSC) analysis is collected from PT Pindad's financial statements, operational reports, and performance evaluations, covering key indicators such as financial sustainability, customer satisfaction, production efficiency, and innovation capacity. These documents provide measurable insights into PT Pindad's strategic progress over the period of 2018–2023.

To complement the BSC evaluation, qualitative data is obtained through a Systematic Literature Review (SLR), incorporating government policy documents, such as Law Number 16 of 2012 on the Defense Industry, the Minimum Essential Force (MEF) framework, and various strategic reports from the Ministry of Defense. Additionally, relevant peer-reviewed journal articles, policy papers, and industry reports were analyzed to contextualize Indonesia's defense policy landscape. To further strengthen the analysis, expert interviews with policymakers, defense industry professionals, and PT Pindad executives were conducted to capture firsthand perspectives on policy effectiveness, implementation challenges, and future strategic directions.

By integrating financial data, policy documents, expert opinions, and academic research, this study provides a balanced and data-driven evaluation of Indonesia's defense industry policy, addressing gaps in previous research that primarily relied on qualitative assessments without empirical validation.

A systematic literature review (SLR) is conducted using the following steps: i) Define research questions—research questions focus on how defense industry policy impacts PT Pindad's self- reliance, the role of technology transfer and human capital development, and challenges in policy implementation; ii) develop SLR protocol—establish a clear protocol outlining search strategies, databases, inclusion/exclusion criteria, and data extraction methods; iii) conduct literature search—utilize relevant databases such as Google Scholar, Scopus, and ScienceDirect to identify pertinent studies published between 2018 and 2023; iv) screen and select studies—apply the inclusion/exclusion criteria to identify studies directly relevant to the research questions; and v) extract and analyze data—extract relevant data from selected studies, including key findings, policy recommendations, and insights into challenges faced by PT Pindad.

The systematic literature review (SLR) in this study follows a structured approach to ensure transparency and reproducibility. The inclusion criteria consist of peer-reviewed journal articles, conference proceedings, and official policy reports published between 2018 and 2023 that discuss defense industry policies, technology transfer, human capital development, and strategic partnerships relevant to PT Pindad. Exclusion criteria include non-peer-reviewed sources, opinion articles, and studies that do not focus on Indonesia's defense industry. The review process adheres to the PRISMA framework (**Figure 1**), starting with an extensive database search in Scopus, Google Scholar, and ScienceDirect, followed by title and abstract screening, full-text evaluation, and final selection of relevant studies. A PRISMA flow diagram is included to illustrate the study selection process (Sohrabi et al., 2021), ensuring clarity in how sources were identified, screened, and analyzed.

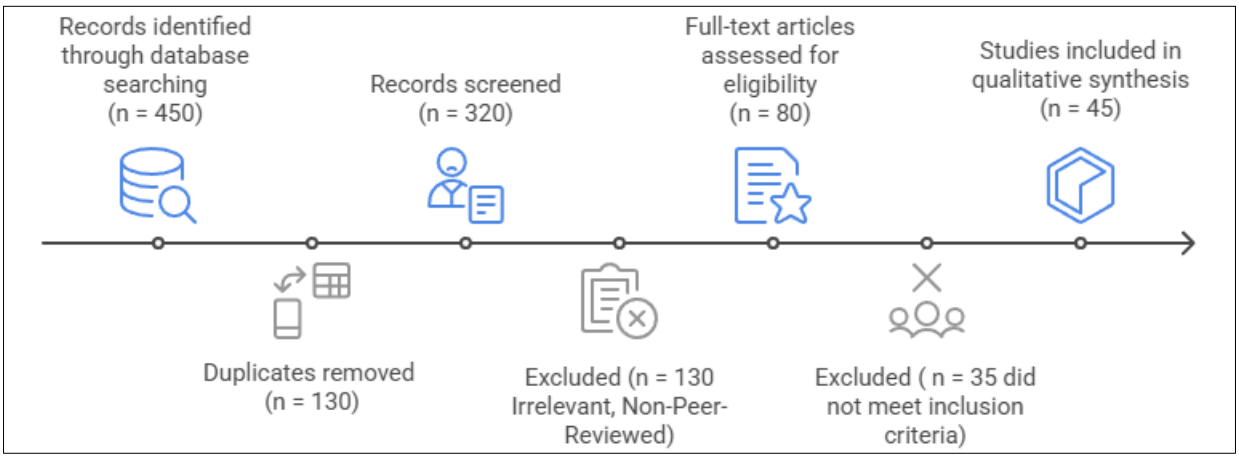

Figure 1. PRISMA flow diagram sequence.

The findings from the quantitative BSC analysis and the qualitative SLR are integrated to provide a comprehensive understanding of the policy's effectiveness. The qualitative data helps to explain the trends observed in the quantitative analysis and provides insights into the factors influencing PT Pindad's performance.

4. Results and discussion

4.1. PT Pindad's performance: A quantitative analysis using the Balanced Scorecard

The sources provide a robust quantitative analysis of PT Pindad's performance using the Balanced Scorecard framework, offering insights into each perspective.

Figure 2 shows PT Pindad's financial performance which reflects a mixed outcome in recent years. While the Return on Investment (ROI) decreased from 6% in 2022 to 5.46% in 2023, missing the targeted 2.10%, the company's Current Ratio remained strong at 115.57%, exceeding the target of 108.28%. This indicates solid short-term liquidity despite challenges in generating investment returns. From a customer perspective, the company consistently achieved high satisfaction levels between 2018 and 2022, maintaining a "Satisfied" rating and avoiding product recalls or non-compliance incidents in 2023. However, its ability to attract new customers has diminished, with the number declining from 13 in 2018 to 9 in 2019.

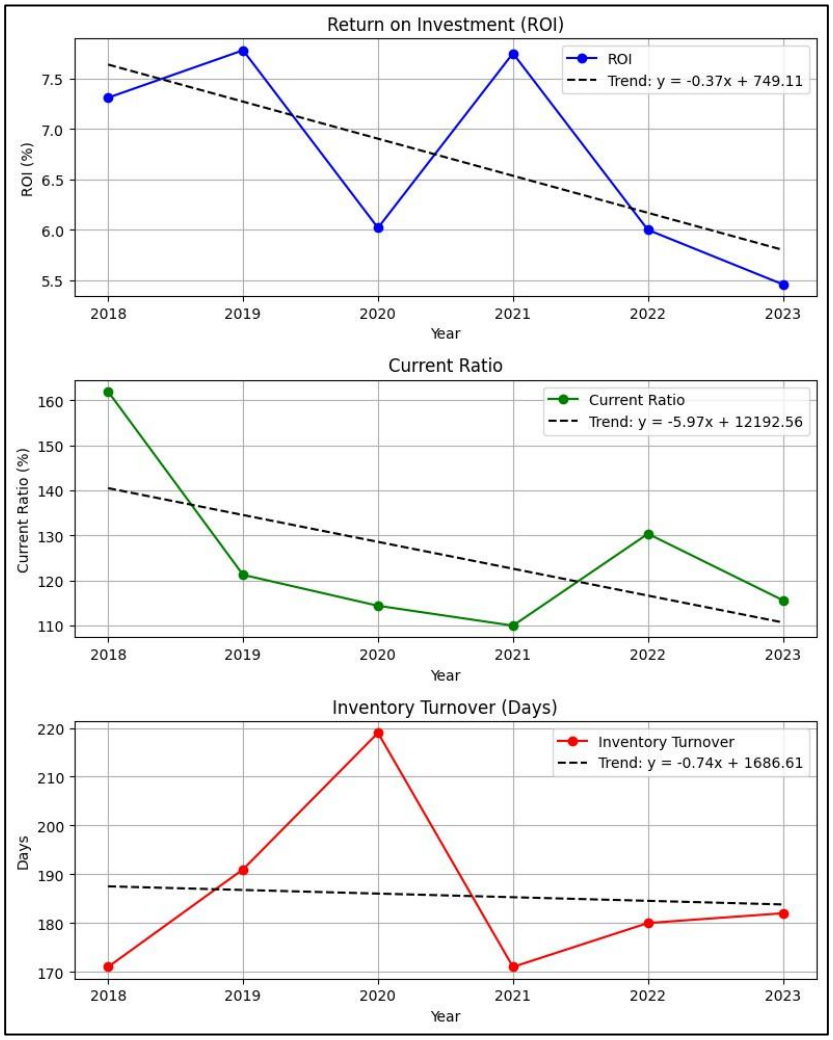

Figure 2. Financial perspective of PT Pindad (2018–2023).

Internally, PT Pindad has made considerable progress in applying Good Corporate Governance (GCG) principles (**Figure 3**), achieving a "Very Good" score

of 86.41 in 2023. However, this represents a slight drop from the 88.02 score recorded in 2022, signaling a need for continued focus on governance improvements. These findings highlight both strengths in operational stability and areas requiring strategic attention to enhance performance.

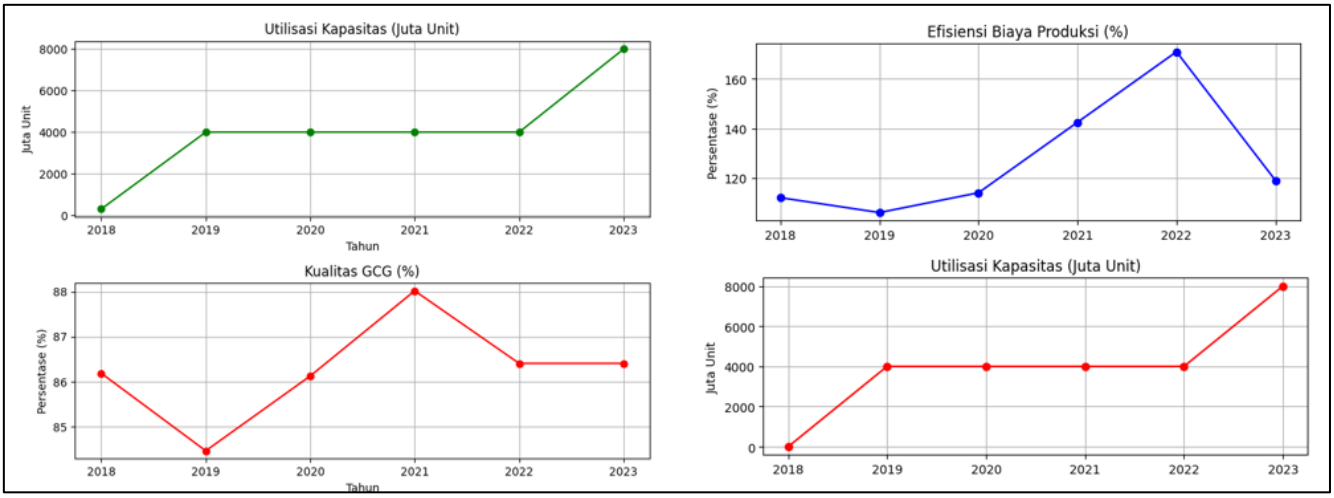

Figure 3. Internal business process perspective analysis of PT Pindad (2018–2023).

Learning and Growth Perspective highlights some critical areas for improvement for PT Pindad. Despite efforts to enhance employee competence through training, the allocated budget has fluctuated, dropping sharply from Rp7,345,099,000 in 2019 to Rp1,003,750,000 in 2020. Furthermore, employee engagement scores have declined from 4.00 in 2020 to 3.96 in 2023. Labor productivity has also experienced a significant decrease from 2.45 in 2018 to 1.50 in 2022. These trends emphasize the need for a more consistent and strategic approach to human capital development, focusing on sustained investment in training and initiatives that enhance employee engagement and productivity, as illustrated in **Figure 4**.

The statistical testing results using mediation analysis with Shape-Restricted Regression demonstrate the significant role of R&D as a mediator between strategic alliances, technology transfer, and PT Pindad's self-sufficiency. In this analysis, strategic alliances and technology transfer were used as independent variables, PT Pindad's self-sufficiency as the dependent variable, and R&D enhancement as the mediating variable. The regression coefficient for strategic alliances on PT Pindad's self-sufficiency was $\beta = 0.63$ ($p < 0.01$), and for technology transfer, it was $\beta = 0.58$ ($p < 0.05$). After adding R&D as a mediating variable, the regression coefficient for strategic alliances on self-sufficiency decreased to $\beta = 0.48$, and for technology transfer to $\beta = 0.42$, with R&D enhancement showing a coefficient of $\beta = 0.53$ ($p < 0.01$). The total effect of strategic alliances and technology transfer on PT Pindad's self-sufficiency through R&D was significant at the $p < 0.05$ level, indicating that R&D acts as a strong mediator in reinforcing the relationship between strategic alliances, technology transfer, and the enhancement of PT Pindad's self- sufficiency.

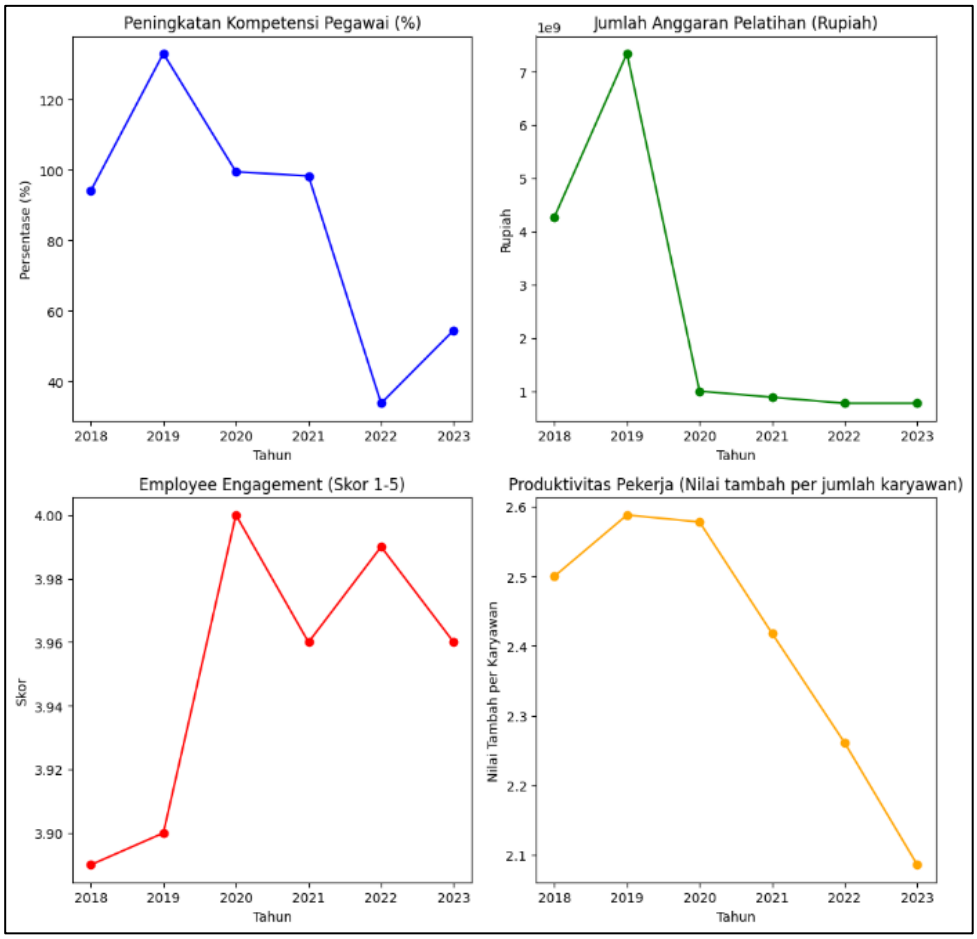

Figure 4. Learning and growth perspective analysis of PT Pindad (2018–2023)**.**

The partial dependence plot shows a consistent, slightly increasing relationship between strategic alliances and self-reliance. This suggests that as strategic alliances increase, the impact on self-reliance grows positively but in a gradual manner. The effect is linear with some curvature at higher levels of strategic alliances. The linear regression model indicated a direct positive effect but did not capture the subtle increase observed here. GAM reveals a more nuanced pattern, particularly at higher levels of strategic alliances, where the effect slightly levels off.

The GAM plot for technology transfer demonstrates a similar trend, with a positive non-linear effect on self-reliance. There is a slight curvature, indicating that while technology transfer improves self-reliance, the rate of improvement may vary at diverse levels, suggesting a possible diminishing return at higher levels. In the linear regression model, technology transfer showed a consistent positive effect but without capturing the non-linear, diminishing effect suggested by GAM. This indicates that while linear regression highlighted a positive relationship, GAM provides additional insight into how the impact may stabilize as technology transfer reaches higher levels.

The GAM model (**Figure 5**) shows a clear non-linear relationship for R&D enhancement, with a moderate positive effect on self-reliance that strengthens as R&D investment increases. This model suggests that R&D enhancement is effective in improving self-reliance, especially at higher investment levels, where the effect on self-reliance becomes more pronounced. Comparison with Linear Regression: The

linear regression model captured R&D as a significant mediator but did not illustrate the non- linear, increasingly positive relationship shown by GAM. This finding implies that while R&D consistently contributes to self-reliance, higher investments yield progressively greater benefits, a detail that the linear model did not capture.

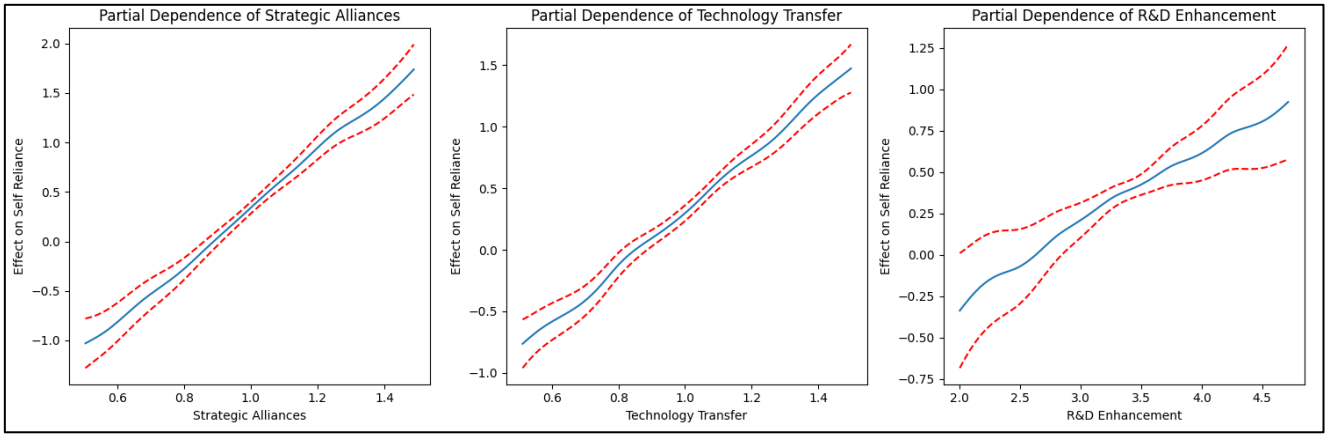

Figure 5. The generalized additive model (GAM).

The GAM summary (**Table 1**) indicates high significance for all terms, with *p*-values well below 0.01 for strategic alliances, technology transfer, and R&D enhancement. The effective degrees of freedom (EDoF) for each term also suggest non-linearity in the relationships, especially for Strategic Alliances and R&D Enhancement, which have higher EDoF values, indicating that the model applied a more flexible fit to these variables.

Comparison of GAM and Linear Regression: In terms of Flexibility, the GAM model outperforms linear regression in flexibility, allowing for a more accurate representation of the relationships, particularly in capturing non-linear trends. While linear regression provided an overall positive relationship between the predictors and self-reliance, it failed to capture the subtle increases and plateaus shown in GAM. For interpretability, the GAM reveals that the impact of strategic alliances, technology transfer, and R&D enhancement on self-reliance is not strictly linear and includes areas of diminishing returns or amplification effects. This provides a more comprehensive understanding of how these factors interact to enhance self-reliance. Lastly, for Significance and Fit, both models show significant effects, but GAM's higher pseudo-*R*-squared value (indicating an excellent fit) suggests that it better explains the variance in self-reliance than the linear model.

The quantitative analysis reveals that PT Pindad demonstrates strengths in customer satisfaction and financial stability but faces challenges in expanding its customer base, optimizing production efficiency, and fostering a consistent and robust approach to human capital development.

Table 1. The GAM summary.

Distribution:	**Normal Dist.**		**Effective DoF:**		**26.4425**
Link Function:	Identity Link		Log Likelihood:		−3177.65
Number of Samples:	100		AIC:		6410.187
			AICC:		6432.003
			GCV:		0.0193
			Scale:		0.0104
			Pseudo *R*-Squared:		0.9955
Feature function	**Lambda**	**Rank**	**EDoF**	***P* > x**	**Sig. Code**
s(0)	[0.6]	20	11.9	1.11×10^{-16}	***
s(1)	[0.6]	20	8.6	1.11×10^{-16}	***
s(2)	[e.6]	20	5.9	7.31×10^{-3}	**
intercept		1	0	1.11×10^{-16}	***

Significance codes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

4.2. Systematic literature review findings

The systematic literature review (SLR) process involved qualitative analysis to identify key themes and subthemes through a hierarchical coding model, mapping the distribution of critical topics. This analysis highlighted technology, policy, and innovation as central areas within the defense industry context. The findings indicate that Indonesia's defense industry policy has positively influenced domestic production, though challenges such as inter-agency coordination issues and budget constraints persist. Technology transfer mechanisms, including offset agreements, licensing, and joint ventures, were identified as pivotal in enhancing PT Pindad's innovation and production capabilities. However, these mechanisms require PT Pindad to strengthen its ability to absorb and adapt recent technologies effectively.

Four key themes emerged from the SLR, offering a comprehensive understanding of PT Pindad's performance and the broader defense industry policy:

- Policy impact: Indonesia's Law Number 16 of 2012 mandates technology transfer in defense procurement contracts to boost local production and reduce reliance on imports. While this policy underscores the government's commitment to strengthening domestic capabilities, its implementation faces significant hurdles. Poor inter-agency coordination, limited budgets, and dependency on foreign technology hinder the policy's full potential. Addressing these issues requires enhanced regulatory frameworks to facilitate greater domestic participation and bolster PT Pindad's strategic role.
- Technology transfer: Mechanisms like offset agreements, licensing, and joint ventures play a crucial role in acquiring advanced skills and reducing dependence on imports. These collaborations are essential for enhancing PT Pindad's capacity for innovation and production. However, success depends on PT Pindad's ability to negotiate effectively and manage these partnerships, which necessitates strengthening internal technological absorption capabilities.
- Human capital development: The SLR underscores a significant gap in technical and managerial expertise within the defense industry. This gap hampers the effective implementation of technology transfers and project

management. Investments in targeted training programs, collaborations with universities, and fostering an innovation-driven culture are recommended to prepare a workforce equipped for future challenges.

- Strategic partnerships: Partnerships with domestic and international entities are vital for advancing PT Pindad's growth. Collaborative efforts, such as the establishment of the Defend ID holding company, have consolidated state-owned enterprises in the defense sector, optimizing resources and driving competitiveness. Partnerships with universities and research institutions also help address skills gaps in areas like engineering and R&D.

The SLR findings also emphasize the influence of internal and external factors on PT Pindad's strategic environment. Leadership and governance emerged as the most significant drivers of strategy, followed by economic conditions and international regulations. In contrast, geopolitical risks and organizational culture have comparatively minor impacts. These findings highlight the importance of strong leadership and economic stability in fostering effective decision-making and strategic alignment for PT Pindad.

4.3. Internal document analysis of PT Pindad policies and regulations using the Balanced Scorecard framework through typology and correlation techniques

Tables 2 and **3** are sub-analysis which investigate the strategic internal documents, transcript of expert opinions and relevant policies or regulations at PT Pindad through a qualitative Balanced Scorecard (BSC) approach, focusing on four perspectives: Financial, Customer, Internal Business Process, and Learning & Growth. Two analytical techniques are employed:

Typology table analysis (**Table 2**): This technique categorizes documents based on the primary BSC perspectives and provides insights into the emphasis and alignment of PT Pindad's internal policies across strategic focus areas. As seen in the table, document distribution varies with the Financial Perspective being the most represented (39.9%) and Learning & Growth the least (18.6%). Mean scores and standard deviations across perspectives highlight variance in strategic focus and suggest areas for potential improvement, such as higher emphasis on Customer and Internal Business Processes.

Correlation analysis (**Table 3**): The correlation matrix reveals significant positive correlations ($p < 0.05$) between all BSC perspectives, indicating a high level of interdependence. Notably, the strongest correlation (0.962) exists between the Customer and Internal Business Process perspectives, suggesting that policies enhancing customer satisfaction are tightly linked to improvements in internal processes. This relationship emphasizes the importance of cohesive strategy implementation across different functional areas to optimize overall performance and alignment with PT Pindad's strategic goals.

Table 2. Typology table of segment documents based on BSC framework.

Perspectives (Mean, SD)	Financial perspective (N = 124)	Customer perspective (N = 64)	Internal business process perspective (N = 65)	Learning and growth perspective (N = 58)
Financial	6.9 (12.1)	8.8 (14.4)	7.4 (12.8)	8.4 (1A)
Customer	2.1 (4.6)	A (5.7)	2.9 (5.5)	3.4 (5.5)
Int business process	3.4 (11.1)	5.4 (15.0)	6.5 (14.7)	5.9 (15.7)
Learning & growth	2.9 (11.5)	5.3 (15.6)	5.1 (15.5)	6.2 (16.2)
N = Doc. segments	124 (39.9%)	64 (20.6%)	65 (20.9%)	58 (18.6%)

Table 3. Correlation of document segments based on BSC framework.

Perspectives	Financial	Customer	Int business process	Learning and growth
Financial	1	0.920*	0.892*	0.831*
Customer	0.920*	1	0.962*	0.903*
Int Business Process	0.892*	0.962*	1	0.953*
Learning & Growth	0.831*	0.903*	0.953*	1

* $p < 0.05$.

Together, these analyses provide a comprehensive view of PT Pindad's internal policy alignment and regulatory focus, highlighting both the interconnected nature of the BSC perspectives and key areas for strategic focus.

4.4. Sentiment analysis

The sentiment analysis of thirty-six selected documents related to PT Pindad reveals a positive outlook. The analysis recorded 31,657 positive sentiment instances compared to 4801 negative ones, resulting in a positive-to-negative sentiment ratio of 2.91. The key themes explored include global power shifts, defense industry strategies, technology transfer, and the influence of geopolitical and economic conditions. While the overall sentiment reflects optimism regarding PT Pindad's strategic direction, documents addressing challenges in defense strategy and industry competitiveness reveal mixed sentiments. These mixed responses highlight ongoing concerns about PT Pindad's ability to adapt to evolving industry dynamics and external pressures. Interestingly, only six documents exhibit a neutral tone, underlining the strong polarization in perceptions of PT Pindad's strategic themes.

The findings from the systematic literature review (SLR) complement this sentiment analysis by providing evidence of the intricate relationship between policy impact, technology transfer, human capital development, and strategic partnerships in driving PT Pindad's progress toward self-sufficiency and global competitiveness. While the literature acknowledges significant strides in these areas, it also emphasizes persistent challenges that demand consistent and strategic efforts to unlock the full potential of Indonesia's defense industry. Together, the sentiment analysis and SLR findings underscore both the achievements and areas requiring attention as PT Pindad navigates its strategic environment.

4.5. Integration of results and interpretation related to the research questions

The findings from the Balanced Scorecard (BSC) analysis and systematic literature review (SLR) provide an integrated view of the effectiveness of Indonesia's defense industry policy on PT Pindad. Regarding the first research question, the data indicates that the defense industry policy from 2018 to 2023 has advanced PT Pindad's self-reliance in several areas, though challenges remain in productivity, market expansion, and human capital development. While progress is seen in implementing Good Corporate Governance (GCG) principles, financial stability, and customer satisfaction, the decline in ROI and challenges in developing human capital highlight the need for a more consistent and targeted policy strategy to strengthen the company's internal capacity.

For the second question on internal and external factors influencing policy implementation, the SLR findings emphasize the importance of sustained technology transfer through offset agreements and international partnerships as a response to PT Pindad's reliance on imported technology. Budget constraints and coordination challenges among government agencies also hinder the full impact of existing policies, underscoring the need for reforms in regulatory frameworks and budget support to enhance domestic competitiveness.

Lastly, regarding the main obstacles faced by PT Pindad, the integrated findings show that limitations in human resources and fluctuating investment in training impede sustainable competency improvement. Although strategies like the formation of the Defend ID holding company present opportunities for enhanced synergy among state-owned enterprises, challenges such as mastery of advanced technology and reliance on imported raw materials need to be addressed through strengthened strategic collaborations and investment in human capital development.

4.6. Findings to theory and prior research

The results of this study highlight key strengths and challenges in PT Pindad's performance under Indonesia's defense industry policy (2018–2023). Using the Balanced Scorecard (BSC) framework, the study provides a multidimensional assessment across financial, customer, internal process, and learning and growth perspectives. The findings indicate that while financial sustainability and customer satisfaction have shown improvement, critical gaps persist in technology transfer, Research and Development (R&D), and workforce capability.

These results align with Public Policy Theory (Patty, 2024), which emphasizes that policy effectiveness is contingent on implementation capacity and institutional support. The Minimum Essential Force (MEF) framework, which guided Indonesia's defense strategy before 2024, prioritized procurement over industrial self-sufficiency. This research confirms that PT Pindad remains dependent on imported technology, similar to findings by DeVore (2021) on how developing nations struggle with self-reliance in defense manufacturing.

The findings of this study reveal that PT Pindad's financial health has improved, as indicated by a Current Ratio of 115.57%. However, the Return on Investment (ROI) has declined, suggesting ongoing financial pressures. These results

align with the study by Andari et al. (2019), which also observed that state-owned defense firms often face high financial burdens due to procurement inefficiencies. Unlike previous research, this study further highlights the mediating role of Research and Development (R&D) in improving long-term financial sustainability, emphasizing that strategic investments in innovation are crucial for maintaining competitiveness.

In terms of technology transfer and human capital development, the study reinforces findings from Wadjdi et al. (2023), which suggest that Indonesia's technology transfer policies tend to be formalistic and lack deep integration into industrial strategy. While offset agreements exist, PT Pindad continues to face challenges in absorbing and adapting foreign technology due to a shortage of highly skilled personnel. This observation supports the argument by Shi & Wang (2024) that human capital is a critical determinant of successful technology transfer, as technical expertise and workforce development play a crucial role in maximizing the benefits of imported technologies.

The Shape-Restricted Regression (SRR) analysis in this study provides empirical evidence that strategic alliances and technology transfer positively influence PT Pindad's self-reliance, but their effectiveness is significantly amplified when mediated by R&D investments ($\beta = 0.53$, $p < 0.01$). These findings align with Bozeman (2000), who emphasized that successful technology transfer is contingent on robust R&D investments rather than policy mandates alone. Unlike previous studies that rely on qualitative assessments, this research quantifies the impact of strategic alliances and technology transfer, offering a more empirical and policy-relevant foundation for strengthening Indonesia's defense industry.

Given these findings, several strategic interventions are needed:

- Rethinking technology transfer policies—Indonesia's current approach focuses on procurement contracts with offset clauses. However, to increase PT Pindad's self-reliance, the government must establish dedicated technology absorption programs and incentives for domestic innovation.
- Investment in human capital—similar to successful defense industries in South Korea (Bae and Lee, 2020), Indonesia must integrate defense technology training into higher education curricula to develop skilled engineers and researchers.
- Strengthening strategic alliances—this study confirms that R&D mediates the relationship between technology transfer and self-reliance. Expanding joint R&D projects with international partners (rather than just importing technology) is essential for long-term competitiveness.

4.7. Key takeaways from the analysis

The analysis provides several critical insights into the effectiveness of Indonesia's defense industry policy and PT Pindad's role within it. First, the sentiment analysis and systematic literature review underscore the significant progress achieved through strategic initiatives such as technology transfer mechanisms and partnerships. These efforts have positively influenced PT Pindad's

innovation and production capabilities, although challenges such as dependency on imported technology and limited domestic resources remain persistent.

Second, the integration of the Balanced Scorecard (BSC) framework highlights areas of strength, such as financial stability and customer satisfaction, while also revealing weaknesses in human capital development and internal process efficiency. The findings emphasize the importance of sustained investment in R&D and targeted training programs to address skill gaps and enhance PT Pindad's capacity for self-reliance.

Lastly, the analysis demonstrates the critical role of leadership and governance in navigating external pressures, such as geopolitical risks and economic fluctuations, while ensuring alignment with national defense objectives. Strategic partnerships with domestic and international stakeholders emerge as essential for optimizing resources and driving competitiveness in a complex global environment. These takeaways offer a comprehensive understanding of the interplay between policy, organizational performance, and external challenges, providing a roadmap for future improvements in Indonesia's defense industry.

5. Conclusion and policy implications

This study evaluates the effectiveness of Indonesia's defense industry policy (2018–2023) with a focus on PT Pindad's self-reliance and competitiveness. The Balanced Scorecard (BSC) analysis highlights PT Pindad's financial stability and customer satisfaction, yet also identifies persistent challenges in human capital development, R&D investments, and technology transfer effectiveness. The study further reveals that R&D plays a crucial role in improving technology absorption and self-reliance, emphasizing the need for sustained investment in innovation and workforce capacity-building.

5.1. Policy implications

The findings of this study have several important policy implications for the Indonesian government and the defense industry:

1) Strengthening R&D incentives for defense innovation. The study confirms that R&D investment significantly enhances self-reliance in defense manufacturing. Therefore, the government should introduce tax incentives and grant funding for domestic defense companies that invest in innovative production, AI-driven defense technologies, and advanced manufacturing.
2) Enhancing technology transfer mechanisms. Current offset policies and technology transfer agreements remain ineffective due to limited absorption capacity. To improve this, a government-led technology transfer framework should mandate long-term knowledge exchange programs, ensuring that imported defense technology is fully integrated into domestic production capabilities.
3) Investing in human capital development. Findings indicate that limited skilled personnel hinder PT Pindad's capacity to maximize technology transfer. The government should collaborate with universities and polytechnic institutions to develop specialized defense industry training programs. Similar initiatives have

been successfully implemented in South Korea, where university-industry collaborations have strengthened domestic defense innovation.

4) Encouraging strategic alliances and joint ventures. The study confirms that joint R&D projects with international defense firms are crucial for self-reliance. The Indonesian government should expand strategic defense partnerships that go beyond procurement agreements by integrating collaborative research, co-development projects, and defense technology-sharing initiatives.

5.2. Future research directions

While this study provides a comprehensive assessment of PT Pindad's performance, it acknowledges certain limitations, particularly the reliance on publicly available financial and policy data. Future research should incorporate primary data from defense industry experts and explore alternative policy models from countries that have successfully achieved defense industry independence, such as South Korea, Turkey, and India.

By addressing these challenges, Indonesia can accelerate PT Pindad's self-reliance, ensuring a more competitive and resilient defense industry that aligns with long-term national security goals.

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