

## Research Article

## **Optimization of National Downstream Synergy in Realizing Defense Industry Independence to Support the Mission of the Indonesian Air Force**

**Dedi<sup>1</sup>, Munawir Sahabuddin<sup>2</sup>, Tri Budianto<sup>3</sup>, Ery Harahap<sup>4</sup>, Asep Kurnia<sup>5</sup>, Yusa<sup>6</sup>**

<sup>1,2</sup> Air Force Staff and Command college, Bandung Regency, Indonesia

<sup>3,4,5,6</sup> Department of Science and Technology, Air Force Staff and Command College, Bandung Regency, Indonesia

Corresponding Author, Email: [dediumar85@gmail.com](mailto:dediumar85@gmail.com)

### **Abstract**

This study analyzes the optimization of national downstream synergy as a strategic pathway to achieving defense industry independence in Indonesia, particularly in supporting the operational readiness of the Indonesian Air Force (TNI AU). Using a qualitative descriptive approach, it integrates data from interviews, policy documents, and official reports from the Defense Industry Policy Committee (KKIP), the Ministry of Defense, and PT Dirgantara Indonesia (PTDI). The findings reveal that Indonesia's defense industry still faces major barriers, including dependence on imported raw materials and technology, low economies of scale, and limited coordination among stakeholders. The study identifies that the success of downstream synergy depends on institutional integration, long-term investment assurance, and technological capability enhancement. Strengthening the roles of KKIP as a policy integrator, the Ministry of Defense as a regulatory and funding enabler, and PTDI as a production executor is essential to align industrial capacity with Air Force requirements. Key strategies include implementing Long-Term Offtake Agreements (LTOA) to stabilize market demand, reforming the Offset and Local Content (IDKLO) mechanism for genuine technology transfer, and integrating upstream industries (PT Inalum, PT Krakatau Steel) to close the material sovereignty gap. The development of MIL-STD-certified testing facilities, local MRO capabilities, and a national defense digital innovation ecosystem will accelerate the transition toward self-reliant production. Ultimately, optimizing national downstream synergy will establish a resilient, competitive, and technologically



advanced defense ecosystem capable of independently supporting the Air Force and enhancing Indonesia's strategic autonomy.

**Keywords:** Defense Industry, Downstream Synergy, Air Force, Industrial Independence, Technology Transfer.

## INTRODUCTION

The optimization of national downstream synergy in the defense industry is a strategic step for Indonesia to strengthen competitiveness and achieve self-reliance in its defense sector. Industrial downstreaming is not limited to mass production but also includes research and technology development, raw material integration, and the enhancement of domestic supply chains. In this context, downstreaming serves as a key mechanism to reduce dependence on costly imported defense products while maximizing the utilization of national resources. Therefore, it is crucial to identify and optimize the roles of all stakeholders—government, defense industries, and the military—in realizing effective and sustainable downstream integration. Synergy among the Defense Industry Policy Committee (KKIP), the Ministry of Defense, and the national aerospace industry is essential to create an independent and innovative defense industrial ecosystem (Ministry of Defense of the Republic of Indonesia, 2022).

Defense industry independence is a key variable in ensuring that Indonesia can meet the needs of its Main Weapon System Equipment (Alpalhankam) in accordance with the operational standards of the Indonesian Air Force (TNI AU). Despite Indonesia's vast potential, dependence on imported technologies and components still hinders true self-reliance. The domestic defense industry faces several obstacles, including low local content, limited production capacity, and challenges in mastering advanced technologies required by the Air Force. According to the Ministry of Defense, only a small portion of defense equipment needs can be met by local industries, while the rest are still fulfilled through imports. Data from the Ministry of Trade shows that Indonesia's defense imports fluctuated significantly between 2018–2023, peaking in 2020 at USD 835.18 million (around 3,450 tons). From January to May 2023, imports were dominated by tanks and combat vehicles, representing 60.53% of total defense imports or USD 77.59 million. This indicates Indonesia's continued heavy reliance on foreign supplies for strategic defense needs, particularly for the Air Force. Hence, strengthening downstream processes and defense industrial self-reliance is crucial to reduce import

dependence while improving competitiveness and national resilience in the defense sector. This reveals a significant gap between existing potential and the realization of defense industry independence that must be addressed urgently.

Supporting the Air Force's missions is the ultimate goal of defense industry independence, particularly in procuring the main defense systems required to safeguard Indonesia's air sovereignty. However, despite efforts to expand domestic production capacity, the procurement of fighter aircraft, helicopters, radars, and other air defense systems still relies heavily on foreign technology. This dependency prevents the Air Force from fully relying on domestically produced equipment for daily operations. Limited technology mastery and production capacity have resulted in dependence on advanced technology-producing countries such as the United States and Russia. Although downstreaming policies have been introduced, the main challenge remains how to produce defense equipment that meets international standards while fulfilling the specific needs of the TNI AU (Agustin & Yani, 2020).

To address these gaps, a comprehensive and synergistic approach involving the government, defense industries, and the Air Force is required. Optimization of national downstreaming can be achieved through stronger collaboration among stakeholders in technology development, research, and production capacity. The government must ensure clear and consistent policy support, while domestic defense industries should increase investment in infrastructure, human resources, and research and development. In this regard, the application of offset technology and the enhancement of local content in defense products are essential for achieving true independence. Strengthened synergy among KKIP, the Ministry of Defense, and the national aerospace industry must be optimized so that downstreaming is not merely a production process but a strategic step toward building a resilient defense industry capable of fulfilling the needs of the Indonesian Air Force (Ministry of Defense of the Republic of Indonesia, 2022).

The purpose of this paper is to present an overview and analysis of how optimizing national downstream synergy can strengthen Indonesia's defense industry independence in support of the Air Force's operational needs. It aims to identify and analyze the main factors hindering self-reliance in meeting the Air Force's defense equipment requirements, examine the contributions of the Defense Industry Policy Committee (KKIP), the Ministry of Defense, and the national aerospace industry in accelerating downstream processes, and propose strategic policies to enhance

collaboration among stakeholders toward achieving sustainable and high-quality defense production.

## LITERATURE REVIEW

### Legal Framework

Several key regulations form the legal foundation for optimizing downstream synergy and achieving self-reliance in Indonesia's defense industry:

1. Law No. 3 of 2002 on State Defense

This law emphasizes that national defense must rely on domestic capabilities across land, sea, and air forces. It mandates the development of local defense industries to produce defense and security equipment in accordance with national standards, supporting industrial downstreaming and self-reliance.

2. Law No. 16 of 2012 on the Defense Industry

It establishes the goal of developing a national defense industry capable of supplying Main Weapon System Equipment (Alpalhankam) while maximizing the use of domestic resources. The law also requires the implementation of offset mechanisms in foreign procurement to promote technology transfer and local content growth.

3. Government Regulation No. 29 of 2019 on Empowerment of the Defense Industry

This regulation mandates government support through facilities, research, and policies that encourage downstream development and local content enhancement to strengthen domestic production capacity.

4. Minister of Defense Regulation No. 39 of 2016

It states that defense technology development aims to accelerate industrial self-reliance and competitiveness by fostering research and innovation in domestic defense industries.

5. Law No. 11 of 2020 on Job Creation

This law provides incentives and simplified licensing for strategic industries, including defense, to boost production capacity, promote the use of local products, and support technology transfer for industrial growth.

6. Government Regulation No. 76 of 2014 on Offset Mechanisms in Defense Procurement

It defines offset or countertrade as reciprocal trade that ensures part of

foreign procurement contracts contribute to domestic industry through technology transfer, human resource training, and local capacity building.

7. Minister of Defense Regulation No. 18 of 2018 on Independent Defense Industry Development

This regulation reinforces the obligation for domestic industries to prioritize local products, strengthen R&D, and build synergy among stakeholders—such as KKIP, the Ministry of Defense, and related industries—to achieve defense industry independence.

### **Theoretical Framework**

This study draws upon several key theories to analyze and support the discussion on optimizing downstream synergy and achieving self-reliance in Indonesia's defense industry:

1. Industrial Downstreaming Theory (Rosenstein-Rodan, 1943)

This theory emphasizes that effective industrial development requires simultaneous large-scale investments across interconnected sectors to create a “big push” in national growth. In the context of the defense industry, downstreaming adds value to raw materials through research, technological innovation, and domestic supply chain integration, strengthening production capacity and technological mastery for defense self-reliance.

2. Stakeholder Collaboration Theory (Austin, 2000)

Austin's Collaboration Continuum Model highlights that cross-sector collaboration evolves from philanthropic to integrative partnerships that create shared value. In defense downstreaming, synergy among the Defense Industry Policy Committee (KKIP), the Ministry of Defense, and PT Dirgantara Indonesia is essential for aligning policy and production, enabling technology transfer, and enhancing human resource capabilities.

3. Industrial Ecosystem Theory (Moore, 1993)

Moore views industries as dynamic ecosystems where government, industry, research institutions, suppliers, and end users co-evolve through collaborative value creation. Applied to defense downstreaming, this theory underscores that self-reliance can only be achieved through vertical and horizontal supply chain integration, joint R&D, and synchronized production policies among all ecosystem

actors.

4. Technological and Human Capability Development Theory (Nelson & Winter, 1982)

This theory explains that long-term competitiveness arises from continuous learning, innovation routines, and capability building. In the defense industry context, it supports the enhancement of Technology Readiness Levels (TRL) and Manufacturing Readiness Levels (MRL) through technology transfer, technical training, and sustained applied research—forming the basis of competence-based industrialization toward defense self-reliance.

### **Strategic Environment**

Indonesia's defense industry downstreaming is influenced by global, regional, and national dynamics.

1. Globally, competition in defense technology and shifting geopolitics push Indonesia to strengthen domestic R&D and reduce import dependence. While reliance on foreign technology poses risks, international cooperation and offset agreements offer opportunities for technology transfer and capacity building.
2. Regionally, rising tensions in the Asia-Pacific demand stronger defense capabilities. Indonesia must accelerate downstreaming to keep pace with regional competitors like Singapore and Malaysia, while leveraging ASEAN cooperation for joint production and innovation.
3. Nationally, Indonesia's vast geography, large productive population, supportive policies, and growing public awareness favor industrial self-reliance. However, challenges remain in technology mastery, funding, and policy consistency. Strengthened collaboration, innovation, and stable governance are key to achieving defense industry independence.

### **Data and Facts**

The optimization of national industrial synergy for defense independence is supported by data from key stakeholders—KKIP, the Ministry of Defense, and PT Dirgantara Indonesia (PTDI).

1. KKIP reports that Indonesia has 124 registered defense industries, mostly in West Java and Banten. Despite progress, about 40% of defense equipment (Alpalhankam)

procurement still relies on imports. The implementation of the IDKLO (Countertrade, Local Content, and Offset) policy aims to boost local production and technology transfer. However, the defense ecosystem remains fragmented, requiring stronger integration among R&D, manufacturing, and maintenance sectors.

2. PT Dirgantara Indonesia (PTDI) has achieved record-high contracts exceeding USD 1 billion in 2023, with growing production capacity for N219 and CN235 aircraft. The N219 supports inter-island connectivity, while CN235 exports continue to expand. PTDI focuses on downstream integration through R&D, human resource development, and flight simulation innovation. It also promotes ecosystem collaboration with global aerospace partners and empowers local talent for maintenance and operations.
3. The Ministry of Defense emphasizes five main development areas: technology, ecosystem strengthening, industrial cooperation, R&D, and local product utilization. Current policies mandate a minimum of 55% local content and 85% offset value in defense contracts. Programs like Bangtekindhan (2016–2024) invested over IDR 238 billion to enhance domestic R&D capacity. International collaborations through Defence Industry Cooperation Meetings (DICM) with partners such as China, Korea, Turkey, and Russia aim to accelerate technology transfer and industrial growth.

## METHOD

This study employs a qualitative descriptive method combining primary and secondary data. Primary data were collected through semi-structured interviews with key informants, including representatives from the Defense Industry Policy Committee (KKIP), the Ministry of Defense, PT Dirgantara Indonesia, and users from the Indonesian Air Force (TNI AU), selected purposively for their direct involvement in defense industry downstream policies and implementation. Secondary data were obtained from regulations, official government reports, statistical data (from the Ministry of Trade, KKIP, and PTDI), and academic literature to support field findings. Data validation was conducted through source triangulation (comparing information among informants and documents), method triangulation (interviews, FGDs, observations, and document analysis), and member checking to ensure interpretive accuracy. Reliability was strengthened through audit trails, expert peer reviews, and cross-checks with official quantitative data, ensuring both academic validity and

practical relevance for enhancing defense industry self-reliance in support of the Indonesian Air Force.

## RESULT AND DISCUSSION

### Challenges in Defense Industry Downstreaming

Efforts to optimize Indonesia's defense industry downstreaming face major structural, institutional, and human resource challenges. These issues must be addressed to shift from a "defense spending" mindset to "defense investment."

#### 1. Main Challenges

Indonesia's downstreaming process is hindered by dependence on foreign technology, fragmented supply chains, and weak institutional coordination. Despite the IDKLO (Countertrade, Local Content, and Offset) policy, 40% of defense equipment is still imported, especially in high-tech sectors like aircraft and radar systems. Limited mastery of advanced technology, funding shortages, and unskilled labor further constrain domestic production capacity.

In addition, supply chain disintegration—particularly for key raw materials like steel and aluminum—forces dependence on imports. Domestic materials often fail to meet military standards (MIL-STD), and local production capacity operates below 60% efficiency. Institutional misalignment among the Ministry of Defense, KKIP, and industries such as PT Dirgantara Indonesia leads to unsynchronized planning between users (TNI AU) and producers, causing project delays and market uncertainty.

#### 2. Human Resource Barriers

The gap between current skills and required Technology Readiness Level (TRL) and Manufacturing Readiness Level (MRL) remains wide. Limited testing facilities, weak certification systems, and ineffective Transfer of Technology (ToT) agreements restrict local talent from mastering critical defense technologies.

#### 3. Proposed Solutions

Key solutions include:

- a. Institutional Synergy – Strengthening coordination among government, military, and industry to align operational requirements with production capabilities.
- b. Strategic Investment – Building critical infrastructure, such as military-grade

testing facilities and upstream material industries (steel, aluminum), through targeted funding and public-private partnerships.

- c. Regulatory Optimization & HR Development – Offering fiscal incentives, simplifying licensing, and establishing structured talent programs through universities, R&D institutions, and defense industries.

By integrating these measures, Indonesia can enhance technological independence, improve coordination, and accelerate the realization of a self-reliant and competitive national defense industry.

### **Roles and Synergy of Stakeholders in Defense Industry Downstreaming**

Optimizing the downstream synergy of Indonesia's defense industry—especially in the aerospace sector—requires strong coordination among the Defense Industry Policy Committee (KKIP), the Ministry of Defense (Kemhan), and PT Dirgantara Indonesia (PTDI). This collaboration aims to shift the paradigm from “defense spending” to “defense investment”, focusing on long-term technological mastery, increased local content, and reduced dependence on foreign systems.

1. Strategic Synergy Context

KKIP coordinates national defense industry policy, Kemhan formulates and funds defense programs (including Imbal Dagang, Kandungan Lokal, Offset – IDKLO), and PTDI executes production, innovation, and technology transfer. Their cooperation ensures that every defense investment strengthens domestic capabilities and supports the Air Force's operational independence.

2. Trilateral Collaboration: KKIP – Kemhan – PTDI

KKIP aligns user requirements (TNI AU) with industrial capacity through the National Defense Industry Master Plan (RIIP), but institutional friction often causes mismatches between operational needs and production capacity. To address this, long-term procurement guarantees are essential to provide PTDI with market certainty.

Kemhan implements IDKLO to ensure at least 85% offset and 55% local content, funding R&D through the Bangtekindhan Program. Meanwhile, PTDI integrates domestic supply chains and aims to raise TKDN (local content) from around 44% to above 50%, emphasizing local production, MRO services, and skilled labor development.

### 3. Roles of Key Stakeholders

- a. KKIP: Regulates policy alignment, issues the RIIP, ensures standardization, and facilitates strategic investment and financing for defense industrialization.
- b. Kemhan: Strengthens industrial capacity through consistent funding, R&D support, and collaboration with upstream industries for materials meeting military standards.
- c. PTDI: Acts as the main executor of technology transfer, local component integration, and after-sales maintenance ecosystem to ensure product sustainability.

### 4. Advanced Collaboration Strategies

Future strategies include:

- a. Establishing a Program Management Office (PMO) to synchronize plans between Kemhan, TNI AU, and PTDI, ensuring operational and technical specifications align.
- b. Developing MIL-STD-certified testing and certification facilities through state or PPP investment to ensure quality assurance and supply chain integration.
- c. Utilizing digital integration systems (SDIP) to unify data on defense needs, production capabilities, and local content, promoting evidence-based, real-time coordination.

In summary, effective synergy among KKIP, Kemhan, and PTDI—supported by digitalization, regulatory consistency, and long-term investment—will accelerate defense industry downstreaming and foster true technological and industrial independence.

## **Strategic Policies and Measures to Accelerate Downstreaming for the Independence of the Air Force's Defense Industry**

Accelerating downstreaming in Indonesia's defense aerospace sector requires shifting from "defense spending" to "defense investment"—a paradigm that prioritizes sustainable industrial capability and independence in defense equipment production (*Alpalhankam*) for the Air Force. Key strategies include procurement reform, upstream material sovereignty, technological advancement, and human capital development.

### 1. Procurement Reform and Long-Term Investment

The government must guarantee market certainty for domestic defense

industries through Long-Term Offtake Agreements (LTOA), ensuring stable demand and enabling PT Dirgantara Indonesia (PTDI) to achieve economies of scale and invest in R&D. KKIP should synchronize user requirements (Opsreq) with production plans (Renprod), while Kemhan enforces stricter Offset and Local Content (IDKLO) policies to ensure genuine technology transfer, especially in critical systems such as avionics and radar.

## 2. Strengthening Upstream Material Sovereignty

To reduce dependency on imported materials, the state must promote investment in MIL-STD-certified smelters for high-grade aluminum and special alloys, with targeted energy subsidies and fiscal incentives. The development of testing and certification facilities is vital to guarantee global-standard product quality. Incentives for small and medium industries (IKM) and private firms will expand domestic component production and build a robust supply ecosystem.

## 3. Advancing Technology and Industrial Readiness

Achieving TRL 9 and MRL 10 for national defense programs (e.g., aircraft, UAVs, radar, missiles) requires consistent funding for the Bangtekindhan Program, integrated R&D collaboration among PTDI, PT Len Industri, and research institutions, and regular capability assessments. Utilizing dual-use technologies—AI, automation, and big data—will accelerate innovation and defense modernization.

## 4. Strengthening the Aerospace Ecosystem and Human Resources

Developing a national aerospace ecosystem based on four pillars—aircraft manufacturing, component supply chains, MRO, and after-sales services—is essential. PTDI should leverage long-term contracts (e.g., CN235) to boost local content and empower SMEs. Human resource development must focus on technical training and ToT absorption, while the MRO sector should be optimized to localize maintenance operations and ensure operational independence.

## 5. Policy Recommendations for Air Force Support

- a. **Standardization and Interoperability:** KKIP should establish defense industry standards (SIP) to integrate PTDI's platforms and PT Len's systems.
- b. **First Buyer Policy and Export Promotion:** TNI AU should serve as the first buyer for certified local products (e.g., N219), while defense diplomacy expands export markets to boost competitiveness.

- c. Technology Security and Cyber Protection: Kemhan must strengthen IP rights, safeguard sensitive technologies, and enhance cybersecurity across the defense supply chain.

In summary, accelerating defense downstreaming requires coherent policy alignment, investment assurance, material sovereignty, technological mastery, and human capital strengthening—all driving Indonesia toward sustainable defense industry independence in support of the Air Force's mission.

### **Indicators of Success in Implementing National Defense Industry Downstream Synergy**

The success of Indonesia's defense downstreaming synergy lies not only in production volume but in achieving technological mastery, structural transformation, and operational independence—particularly for the Air Force. It reflects a national shift from import dependency to full value-chain control through effective coordination among KKIP, the Ministry of Defense (Kemhan), and industry (PTDI).

#### **1. Structural and Policy Indicators**

Success is marked by a shift from defense spending to defense investment, measured through consistent funding, clear procurement planning, and implementation of Long-Term Offtake Agreements (LTOA) to ensure market stability. Continuous funding for Bangtekindhan programs and synchronization between user needs (Opsreq) and production plans (Renprod) signify policy maturity.

#### **2. Institutional Synergy Indicators**

Collaboration among KKIP, Kemhan, and PTDI is assessed through alignment of regulations, R&D, and production readiness.

- a. KKIP ensures operational-production synchronization.
- b. Kemhan boosts technology readiness (target TRL 9/MRL 10).
- c. Industry develops certified domestic supply chains for key materials (e.g., aircraft-grade alloys).

Effective coordination minimizes institutional friction and builds a sustainable defense ecosystem.

#### **3. Quantitative Indicators**

Key measures include:

- a. Local Content (TKDN): Rising from 44.7% (2025) to 52.5% (2029) in aircraft like N219, shifting focus toward high-tech components (avionics, radar).
- b. Import Substitution: Reducing imported defense procurement from 40% to below 20% by 2029, ensuring 80% domestic absorption.
- c. Technology Transfer (ToT): Deep ToT under IDKLO agreements, focusing on engineering design and testing infrastructure development.

#### 4. Qualitative and Capability Indicators

Indicators include certification of domestic materials to MIL-STD, the development of local upstream industries, and national achievement of TRL 9/MRL 10 in air defense programs such as UAVs and radar systems. These mark true autonomy in design and production.

#### 5. Production Capacity and Operational Independence

Increased capacity utilization ( $\geq 75\%$  annually for CN235 and N219), localization of MRO (77%), and strengthened human capital—through simulator-based pilot training and AI-driven defense systems—show improved readiness and reduced foreign dependence.

#### 6. Final and Global Competitiveness Indicators

Success culminates in:

- a. Certification and adoption of domestic prototypes as official Air Force systems.
- b. Integration into the global defense supply chain, positioning Indonesia as a key MRO hub in Southeast Asia.
- c. Financial independence of defense SOEs, contributing  $\geq 2\%$  to GDP.

In essence, downstream synergy success is reflected in policy consistency, industrial integration, technological self-reliance, and sustainable defense autonomy, positioning Indonesia as a regional defense industrial power by 2045.

### **SWOT Analysis of Optimizing National Downstream Synergy in Realizing Defense Industry Independence**

The SWOT analysis of optimizing national downstream synergy in Indonesia's defense industry highlights the strategic interaction among government institutions (KKIP/Kemhan), industry (PTDI/BUMN/BUMS), and users (TNI AU) to build a self-reliant defense ecosystem.

Strengths include strong legal and political mandates (Law No. 16/2012), proven

design and production capabilities (e.g., N219, CN235), clear long-term technological goals (Prognas TRL 9/MRL 10), and mandatory offset and local content mechanisms (IDKLO/TKDN). PTDI's experience and MRO potential also strengthen local operational independence.

Weaknesses involve dependence on imported raw materials (material sovereignty gap), limited economies of scale, low technological maturity in critical subsystems, and institutional misalignment between operational needs (Opsreq) and production planning (Renprod).

Opportunities arise from the national agenda on resource downstreaming, a shift toward "defense investment" with long-term procurement (LTOA), adoption of dual-use technologies (AI, Big Data), and prospects to expand regional MRO markets and join the global defense supply chain.

Threats include persistent import dependency, asymmetric technology transfer (ToT) failures, geopolitical risks such as embargoes, and intense global price competition driven by foreign subsidies and dumping practices.

Strategic directions are:

1. Aggressive (S-O): institutionalize LTOA to stabilize demand and scale production while investing in dual-use technologies for higher TRL levels.
2. Improvement (W-O): develop national MIL-STD testing and certification facilities to close material gaps and strengthen local supply chains.
3. Conservative (S-T): tighten IDKLO enforcement for substantive ToT, diversify suppliers, and enhance self-reliant MRO capabilities.
4. Defensive (W-T): digitalize coordination (Opsreq-Renprod), provide fiscal incentives for local industries, and restructure the supply chain to mitigate foreign dependency and market pressure.

Overall, the strategy aims to build a resilient, adaptive, and technology-driven defense ecosystem that ensures Indonesia's long-term strategic autonomy.

## CONCLUSION

Indonesia's defense industry still faces major barriers to achieving self-reliance, including dependence on imported materials and components, limited MIL-STD testing facilities, inconsistent R&D funding, and weak implementation of offset and local content (IDKLO) policies.

Effective synergy among key stakeholders—KKIP, the Ministry of Defense, PT Dirgantara Indonesia, and the Air Force—is crucial. KKIP must act as a policy integrator aligning operational needs (Opsreq) with industrial production (Renprod), while the Ministry of Defense enables capacity and research funding, and the Air Force ensures demand continuity as the main user.

To strengthen independence, strategies should institutionalize Long-Term Offtake Agreements (LTOA) to guarantee market stability, integrate upstream–downstream industries through MIL-STD standardization, and reform IDKLO to ensure substantive technology transfer and human resource development. Implementing a unified defense industry database (SDIP) and enhancing domestic Maintenance, Repair, and Overhaul (MRO) capabilities will support operational autonomy.

In the long term, developing a dual-use technology talent ecosystem will ensure sustainable innovation and competitiveness, enabling Indonesia’s defense industry to meet Air Force operational needs independently and effectively on a global scale.

## **Recommendations**

To strengthen the implementation of national downstream synergy and achieve defense industry self-reliance, several strategic actions are recommended:

1. **Institutional and Regulatory Aspects:** Strengthen KKIP’s role as a cross-sector coordinating body with implementation authority to align policies between the Ministry of Defense, industry, and the Air Force. Establish multi-year budgeting for defense R&D and accelerate the adoption of Defense Industry Standards (SIP) to ensure system interoperability.
2. **Industrial and Technological Aspects:** Provide fiscal incentives, such as super tax deductions, for companies investing in strategic defense R&D. Integrate upstream industries (PT Inalum, PT Krakatau Steel) into the defense supply chain to close the material sovereignty gap. Reform the IDKLO mechanism to ensure real technology transfer and higher Technology Readiness Levels (TRL).
3. **Human Resources and Digital Innovation Ecosystem:** Develop a National Defense Talent Ecosystem connecting the Ministry of Defense, BRIN, universities, and military institutions to produce MIL-STD–certified experts in dual-use technologies. Establish a Defense Digital Innovation Hub to foster collaboration, digital integration, and data-driven decision-making, enabling an adaptive and efficient

Industry 4.0-based defense ecosystem that supports Air Force operational readiness.

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