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Managing the 'Triple Helix' Model of Cooperation between Government, Industry, and Academia in Indonesian Defense Technology Innovation

Franceline Adella[1]*, Aris Sarjito[2], Agus Sudarya[3]
Republic Indonesia Defence University, Indonesia
Corresponding Author: Franceline Adella francelineadella@gmail.com

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A B S T R A C T

This study examines how the Triple Helix model of government, industry, and academia can be managed to accelerate defense technology innovation in Indonesia. Using a qualitative systematic literature review, the research analyzes policy frameworks, institutional alignment, and cultural dynamics affecting collaboration in the defense sector. The findings reveal persistent challenges, including fragmented governance, financial precarity that widens the "Valley of Death," and weak intermediary structures to bridge academia-industry-government divides. The study contributes by proposing strategic measures such as establishing intermediary institutions, ensuring stable procurement-driven funding, and fostering mission-oriented research consortia. These recommendations aim to strengthen innovation ecosystems, reduce dependency on foreign technology, and advance Indonesia's pursuit of defense self-reliance.

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INTRODUCTION

National security and technological sovereignty are paramount for any nation's stability and strategic autonomy. In the 21st century, the capacity for domestic defense technology innovation is a critical component of this sovereignty. Globally, the paradigm for fostering such innovation has shifted from a state-led, top-down approach to a more dynamic ecosystem model. The 'Triple Helix' model, conceptualized by Etzkowitz and Leydesdorff, provides a robust framework for understanding this ecosystem, emphasizing the interactive and overlapping roles of Government, Industry, and Academia in driving innovation (Dudin et al., 2014).

Indonesia, with its strategic geopolitical position and ambition to modernize its armed forces, has placed a strong emphasis on achieving defense self-reliance. This ambition is primarily driven by the Minimum Essential Force (MEF) program, a multi-phase initiative designed to build a credible defense capability sufficient to secure the nation's vast maritime and territorial sovereignty. To provide a legal foundation for this goal, policies such as Law No. 16/2012 on the Defense Industry were established. This key legislation mandates the prioritization of domestic production, facilitates technology transfer from foreign acquisitions, and formally encourages collaboration between government users, industrial producers, and academic researchers. Despite these clear strategic and legal directives, the actual implementation of a synergistic relationship between these three critical actors remains a significant challenge.

Despite the existence of a formal policy framework, the collaboration among the three helices in Indonesia's defense sector is often fragmented, inefficient, and lacks a coherent management strategy. Academia produces research that is usually not aligned with the needs or requirements of the Ministry of Defense and industry users. The industry faces challenges in commercializing research due to high risks and inconsistent government procurement practices. The government, in turn, struggles with bureaucratic hurdles, budgetary constraints, and a lack of clear long-term roadmaps for technology acquisition and development. This results in a persistent "valley of death" where promising research fails to translate into deployable defense technology, hindering Indonesia's goal of defense self-reliance.

Therefore, this study addresses the central research question: *How can the Triple Helix model of cooperation between government, industry, and academia be effectively managed to accelerate and sustain defense technology innovation in Indonesia?* To answer this, the study aims to analyze the managerial challenges within this trilateral relationship and propose a strategic framework for its improvement. Specifically, it will identify the critical institutional and cultural barriers, evaluate existing policies, and develop actionable recommendations to enhance synergy among the three sectors.

This research is expected to have significant contributions on multiple levels. On a practical and policy level, it will provide evidence-based recommendations enabling the formulation of more coherent and effective innovation policies. For industry and academic stakeholders, this study will offer valuable insights into navigating government partnerships and aligning research efforts with tangible national security needs, thereby increasing the real-world

impact of their work. Theoretically, this research will add to the academic literature by applying the Triple Helix model to the unique and often understudied context of a developing nation's strategic defense sector.

LITERATURE REVIEW

The Triple Helix Model as a Framework for National Innovation

In the modern knowledge economy, innovation is the fundamental engine of national progress. The outdated view of innovation as a simple, linear process directed by the state has been replaced with a more sophisticated understanding. Today, innovation is recognized as a complex, interactive system involving a diverse set of actors, a concept known as the National Innovation System (NIS). A core component of this system is the Triple Helix model. This model highlights explicitly the synergistic and often overlapping interactions between three crucial pillars: academia, industry, and government. The dynamic collaboration among these institutions is a key mechanism for creating a fertile environment for innovation, ultimately driving economic development.

The National Innovation System (NIS) is a conceptual framework used to understand the complex processes of technological innovation and economic development within a country. An NIS is broadly defined as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies (Feinson, 2003). This network includes firms, universities, and government agencies, but its performance is determined less by the individual actors and more by the complex interactions and knowledge flows between them (Feinson, 2003).

The NIS concept arose from the failure of the post-WWII linear "technology push" model, which posited a simple chain reaction from basic research to commercial application (Feinson, 2003). This linear perspective could not explain the different rates of economic growth among industrialized nations. Evidence showed that development depended more on the efficient diffusion and absorption of technology than on being the first to invent it (Feinson, 2003).

For developing countries, the NIS approach is particularly critical for catching up to technological leaders. The focus shifts from pure innovation to learning, the process of acquiring, absorbing, and disseminating existing modern technologies. A nation's absorptive capacity depends heavily on its base of human capital, highlighting the essential role of education and training systems (Karasev et al., 2018).

Emerging from the broader NIS concept, the Triple Helix model, introduced by Henry Etzkowitz and Loet Leydesdorff, offers a more specific framework for analyzing the interactive relationships among universities, industry, and government (Dudin et al., 2014). The central thesis is that the potential for innovation in a Knowledge Society is found in a more prominent role for the university and the hybridization of elements from all three spheres to generate new institutional and social formats for knowledge production and transfer (Ranga & Etzkowitz, 2013).

The model identifies three primary configurations of these university-industry-government (UIG) relationships (Ranga & Etzkowitz, 2013):

1. Statist model, where the government plays the dominant role in driving academia and industry, is standard in former socialist countries and parts of Latin America.
2. Laissez-faire model, where industry is the primary driver and the state and university play limited, ancillary roles. This has been characteristic of the United States and some Western European nations.
3. Balanced model, where the university acts as a co-equal partner with industry and government, creating a more favorable environment for innovation through tri-lateral networks and hybrid organizations at the intersections of the spheres.

The Triple Helix is not a static structure but an endless transition where relationships are continuously reshaped (Ranga & Etzkowitz, 2013). A key dynamic is substitution, where one institutional sphere can take on the traditional role of another to fill a gap in the system. For instance, a university may create a venture capital fund (an industry role), or the government may create a public venture fund when the private sector is insufficient (Ranga & Etzkowitz, 2013). This dynamic leads to the emergence of hybrid institutions, such as university technology transfer offices, science parks, and public-private venture funds, that operate at the intersection of the three spheres

The Triple Helix acts as an operational model within the broader NIS, providing a more detailed view of the core UIG interactions that drive innovation (Afzal et al., 2018). Thus, it can be said that the Triple Helix system is a distinct type of innovation system, characterized by its components, relationships, and functions. The primary function of a Triple Helix system, the generation, diffusion, and use of knowledge and innovation, is realized through the articulation of three spaces (Ranga & Etzkowitz, 2013):

1. The Knowledge Space: Encompasses the generation of new knowledge, primarily through R&D in universities and public research institutes, and aims to strengthen the regional and national knowledge base.
2. The Innovation Space: Consists of hybrid organizations and entrepreneurial individuals that translate knowledge into commercial value through firm formation, technology transfer, and incubation.
3. The Consensus Space: Represents the governance function where actors from all three spheres come together for strategic dialogue, planning, and conflict moderation to guide the region toward a knowledge-based future.

The interaction between these spaces is non-linear. For example, a consensus space can catalyze the development of knowledge and innovation spaces where they are weak, highlighting the importance of collaborative governance in fostering a thriving innovation ecosystem (Ranga & Etzkowitz, 2013). This integrated approach provides a robust analytical framework for understanding and shaping national innovation policy and practice.

The "Valley of Death" in Defense Technology Transfer and Commercialization

Transitioning promising scientific research into viable, fielded technology is one of the most persistent challenges in innovation management, particularly in high-risk, high-cost sectors such as national defense. Many promising technologies fail not because they are scientifically unsound, but because they

cannot navigate the perilous gap between initial discovery and successful productization. This gap is known as the "Valley of Death." Understanding this challenge requires examining the Technology Readiness Level (TRL) scale, which is used to measure technological maturity, as well as the specific difficulties associated with transferring technology from universities to the defense industry.

The "Valley of Death" is a widely used metaphor to describe the critical phase in early-stage innovation where a lack of funding and support hinders a technology's continued development (Ellwood et al., 2022). It represents the gap between academic-based innovations or government-funded research and their successful commercial application in the marketplace. This phase occurs at the transition between invention and innovation, a point where foundational scientific research is not yet fully complete and the path to commercialization is not yet fully underway (Ellwood et al., 2022). Two overlapping phenomena characterize this valley:

1. A funding gap, where public sector funding for basic research ends before private sector investment for applied development begins. Promising technologies are often abandoned in this gap because they cannot attract the necessary funding to advance their development (Townes, 2023).
2. A process gap, where technologies that are proven in a lab environment struggle to be developed into complete, scalable products. In the defense context, this is described as the divide between non-recurring defense R&D funding and recurring defense revenue from formal programs of record (Townes, 2023).

This transition presents a challenging management issue due to high uncertainty in both the technology and potential markets, rendering investment decisions uncertain (Ellwood et al., 2022). For startups attempting to work with the government, this valley is a formidable barrier, where initial R&D contracts rarely lead to recurring revenue at scale. To better measure and understand the journey across the Valley of Death, organizations use the Technology Readiness Level (TRL) scale. The TRL is a systems engineering tool created to perform a methodical evaluation of a technology's maturity. Initially developed by NASA in the 1970s, the TRL scale was intended to provide an objective framework for decision-making and to communicate the readiness of new technologies for mission planning (Bhattacharya et al., 2022). The scale consists of nine distinct levels (Bhattacharya et al., 2022):

1. TRL 1–3: Covers basic research, from observing principles (TRL 1) to formulating a technology concept (TRL 2) and achieving analytical and experimental proof-of-concept (TRL 3) (Bhattacharya et al., 2022).
2. TRL 4–6: Represents the heart of the Valley of Death. This stage involves validating components in a lab environment (TRL 4), validating them in a relevant environment (TRL 5), and demonstrating a system or prototype in a relevant environment (TRL 6) (Bhattacharya et al., 2022). A TRL-6 is often considered the point where a technology is a form-and-function prototype, significantly de-risked for further investment (Townes, 2023).
3. TRL 7–9: Involves demonstrating a system prototype in an operational environment (TRL 7), completing and qualifying the actual system (TRL

8), and proving the system through successful mission operations (TRL 9) (Bhattacharya et al., 2022).

Many large government and defense organizations have adopted the TRL scale to assess and manage technical risk in their technology acquisition programs. The scale is crucial because research from academic institutions often results in technologies with a maturity level of TRL-5 or lower, placing them directly within the Valley of Death. Consequently, private sector organizations, wary of the costs and uncertainty of early-stage development, are often unwilling to license these technologies until they reach a higher maturity level, typically a TRL-6 or greater (Townes, 2023).

Now, transferring technology from universities and startups to industry is difficult in any sector, but the challenges are magnified in the defense domain. The process is rarely a simple transaction; it is a complex, labor-intensive effort that requires a strong commitment from both the developer and the receiver (Bellais & Guichard, 2006). A foundational challenge stems from the divergent institutional logics between academia and industry. Academic culture values open science and the dissemination of findings through publication, while industrial research relies on confidentiality and secrecy to protect competitive advantage and profits (Adams et al., 2001). This creates a fundamental conflict over the disclosure of inventions and the management of intellectual property (IP).

These differences are even more pronounced in the defense sector, creating a wall of separation due to its unique customer requirements and cost structures. Furthermore, the defense industry has historically protected innovations through secrecy rather than patents, which strongly inhibits the potential for commercial spin-offs and licensing (Bellais & Guichard, 2006). This lack of an Intellectual Property Rights (IPR) culture is a major barrier to technology transfer.

Beyond these cultural divides, startups and universities face immense bureaucratic and procedural barriers when engaging with the government. Innovators report that solicitations often seem wired for insiders, communication is poor, and timelines are unreliable or non-existent. The government often lacks a transparent decision-making process, turning what should be a swift “yes” or “no” into a slow “maybe,” a pace that is untenable for a growing company (TERRAFORMING THE VALLEY OF DEATH: Making the Defense Market Navigable for Startups, 2023).

This is symptomatic of a deeper, systemic issue: the lack of product-market fit between government R&D investments and its formal procurement programs. Early-stage R&D funding is often spent on a customer-less R&D island, with no clear path to recurring revenue, making it difficult for private investors to judge a technology’s value (Adams et al., 2001). This problem is compounded by the fact that government program managers often lack the resources or motivation to conduct proper market research for available commercial solutions.

METHODOLOGY

This study employs a qualitative approach using the systematic literature review method. This method was chosen to deeply and comprehensively identify, evaluate, and synthesize findings from various relevant studies. The focus of this review is to build a coherent understanding of the challenges and dynamics of Triple Helix collaboration within the context of Indonesia's defense industry. The research process began with the formulation of specific research questions, followed by a systematic literature search to gather relevant data.

The research population comprises all relevant academic and professional literature, including peer-reviewed journal articles, government reports, conference proceedings, and books discussing innovation systems, Triple Helix collaboration, and defense industry policy, with a specific focus on Indonesia. The sample was selected using strict inclusion and exclusion criteria to ensure the relevance and quality of the sources. The selected sources were analyzed using thematic content analysis, where data were extracted, coded, and categorized to identify recurring themes, patterns, and relationships. Tools such as reference management software were used to organize the literature, while the analysis was conducted manually to ensure a deep interpretation of the narratives and arguments presented in each source.

RESEARCH RESULT

Indonesia's Pursuit of Defense Self-Reliance through Collaboration

As an archipelagic nation in a strategic global position, Indonesia's national security is intrinsically linked to its maritime and defense capabilities. A central theme in its national strategy is the pursuit of defense self-reliance to reduce dependence on foreign suppliers and bolster state sovereignty. This goal is contingent upon effective collaboration among the government, the domestic defense industry, and the academic/research communities.

Indonesia's pursuit of a self-reliant defense industry is a long-standing policy, with foundational efforts dating back to the 1970s (Irfan et al., 2023). This ambition is legally codified in several key regulations and national plans. The primary legal framework is Law No. 16 of 2012 concerning the Defense Industry. This law defines the defense industry as a national enterprise, comprising both state-owned enterprises and private companies, tasked with producing defense and security equipment to meet strategic national interests (Kennedy, 2023). The law's stated aim is to increase national economic growth and achieve self-sufficiency in meeting the needs of the Main Weapons System by maximizing national resources and technological expertise.

This legal framework is operationalized through national development plans, most notably the Minimum Essential Force (MEF) program. Established in the 2010-2014 Medium Term Development Plan, the MEF is Indonesia's core mandate for military modernization. It is a phased program (Phase I: 2010-2014, Phase II: 2015-2019, Phase III: 2020-2024) designed to build a baseline defense capability to handle real threats within the constraints of a limited budget (Kennedy, 2023). A crucial component of the MEF policy is the stipulation that the procurement of defense equipment from foreign industries must be

accompanied by technology transfer and knowledge sharing to ensure proper use and maintenance of the equipment (Nugroho, 2022).

Despite these foundational policies, studies consistently find that the legal framework remains insufficient. Research suggests that Law No. 16/2012 remains largely ad hoc and partial, lacking precise and detailed regulations necessary to effectively guide the industry's growth (Irfan et al., 2023). This lack of a clear legal umbrella creates uncertainty and is not conducive to the long-term development of a robust and competitive domestic defense industry.

While national policy sets the goal of self-reliance, there is also an indication that achieving it is hindered by deep-seated challenges in funding, institutional alignment, and inter-sectoral collaboration. A primary inhibitor is the inadequate and inconsistent funding for the domestic defense industry. A heavy dependence on the state budget, which is subject to political cycles, often leads to prioritizing the procurement of foreign equipment over long-term domestic research and development (R&D) (Kennedy, 2023).

This financial precarity is exacerbated by institutional and policy misalignment, as policies are often created in silos, resulting in uncoordinated implementation and a failure to align the long-term strategic goals of the Ministry of Defense with the research priorities of academia and the commercial focus of industry. Furthermore, the Indonesian government's triple role as owner, regulator, and enforcer of rules for its state-owned enterprises can undermine the competitiveness and efficiency of the defense industry (Irfan et al., 2023).

Finally, there are also significant cultural and communication gaps between the key collaborators. A cultural divide exists between academia, which is driven by the pursuit of novelty and the need to publish research, and the military, which, as the end-user, requires proven, scalable, and commercially viable technology. The military's rigid requirements are often not effectively communicated to researchers early in the development process (Nugroho, 2022). This communication gap highlights the need for translator or broker institutions, such as well-funded and professionally managed Technology Transfer Offices (TTOs) at universities, to bridge the cultural and operational divide.

The Challenge of an Integrated System vs Separate Entities

Indonesia's National Innovation System (NIS) operates as a collection of separate entities with weak linkages, rather than as a synergistic, integrated ecosystem. The existing framework aligns with the "statist model" of the Triple Helix theory, in which the government is the dominant institutional sphere, directing and controlling the other actors, academia and industry (Sugiono et al., 2018). This configuration stands in stark contrast to the "balanced model," which envisions a dynamic, interactive partnership considered more effective for fostering a knowledge-based economy (Irawan et al., 2025). For Indonesia, which remains in the nascent stages of industrial development, this results in a premature Triple Helix configuration characterized by tenuous and underdeveloped triadic relationships (Irawan et al., 2025). This structural reality is a primary cause of institutional misalignment, preventing the emergence of a truly innovative ecosystem.

The government's dominance is evident in its overwhelming control of research and development (R&D) funding and activities. The state provides the vast majority of R&D expenditure, with some estimates showing government funding accounts for over 84% of the total (Zhengqi, 2016). However, this financial control has not translated into effective coordination. Legally, the Ministry of Research and Technology (MoRT) has a clear mandate to formulate national R&D policy and coordinate all research institutions; however, this authority is not accompanied by financial authority, rendering it challenging to implement consistently (Lakitan, 2014). R&D activities are fragmented across numerous ministries, non-ministerial government institutions (NMGIs), and universities, with communication flowing vertically within hierarchical silos rather than horizontally between collaborators. This leads to inefficient use of the already limited R&D budget and a lack of mutualistic symbiosis among the nation's research institutions (Lakitan, 2013).

This fragmentation is particularly acute at the interfaces between the three helices. The linkage between academia and industry is notably weak. Universities and public R&D institutions often operate as an Ivory Tower, pursuing research agendas based on academic interests rather than the tangible technological needs of domestic industries (Yudhoyono et al., 2025). This creates a significant mismatch between the technology being developed and the market's demands, resulting in a low adoption rate of indigenous technologies. From the industry perspective, this gap is exacerbated by a lack of transparency, unrealistic research goals, and poor knowledge-sharing mechanisms from academic partners. Concurrently, a lack of trust from the private sector towards government institutions further impedes collaboration (Taufik, 2007). Businesses perceive government policies as fragmented and lacking a coherent, long-term framework that would incentivize investment in domestic innovation.

The consequence of this state-led, fragmented system is a significant hindrance to Indonesia's innovative capacity. The lack of synergy means that the core actors often work at cross-purposes, duplicating efforts and failing to capitalize on potential opportunities for collaboration (Nugroho, 2022). Horizontal and substantive communication between actors is almost non-existent. This systemic failure directly impacts innovation outputs, such as the number of patents, high-quality publications, and the export value of high-technology products. The top-down, government-centric approach has not successfully stimulated a demand-driven innovation culture (Dading Gunadi et al., 2018). Instead, it perpetuates a system where individual entities remain isolated, preventing the development of the dynamic, interactive, and collaborative ecosystem necessary for sustained innovation and national economic competitiveness.

DISCUSSION

The Financial Precarity Widens the "Valley of Death"

The ambition for a self-reliant Indonesian defense industry is fundamentally undermined by a state of financial precarity that widens the "Valley of Death," the critical gap between initial research and a viable, marketable product. This chasm is not merely a lack of funds, but a systemic issue rooted in

the nature of government budgeting, the absence of robust financial incentives, and a critical disconnect between research funding and procurement commitment (Marzah & Setiawan, 2015). The result is a risk-averse environment where both industry and academia are hesitant to invest in high-risk, long-term Research and Development (R&D), ultimately reinforcing a dependency on foreign technology imports. This discussion interprets how Indonesia's underlying state-dominated innovation model is the root cause of this financial uncertainty, which in turn creates a vicious cycle that actively prevents the nation from achieving its strategic defense goals.

The financial instability faced by Indonesia's domestic defense innovators is a direct symptom of its statist innovation model. In this structure, the government dictates terms rather than facilitating a balanced, interactive partnership. In this top-down system, the government's role as the primary funder and director of R&D inadvertently stifles the very collaboration it seeks to promote (Sumantha et al., 2024). State funding, which accounts for the vast majority of R&D expenditure, is fragmented across numerous ministries and government agencies that operate in silos with poor horizontal communication.

This institutional misalignment means there is no coherent, integrated strategy linking the nation's technological priorities with its human resource development or industrial capacity (Savitri, 2016). Instead of fostering a dynamic partnership, this top-down control creates a dependency culture where academia and industry become passive recipients of state direction. Universities, driven by academic incentives, remain in an Ivory Tower disconnected from market needs, while industries, lacking trust and clear policy signals, are hesitant to engage (Suadnyana & Aritonang, 2025). This statist structure is therefore not just a phase of development but a critical impediment that creates the systemic uncertainty at the heart of the industry's financial precarity.

This underlying structural issue manifests as a severe funding gap known as the Valley of Death, where promising technologies fail after initial R&D grants are exhausted but before they are mature enough to attract private investment or procurement contracts. The industry's overwhelming dependence on the annual state budget (APBN) is ill-suited for the long-term, capital-intensive nature of defense R&D (Savitri, 2016). The unpredictability of this funding makes it nearly impossible for companies to commit to multi-year development projects, creating a critical barrier where prototypes cannot be scaled into full production.

However, a more profound issue than the scarcity of R&D funds is the lack of a credible procurement commitment from the government as the sole domestic customer (monopsony) (Gbadegeshin et al., 2022). There is a significant disconnect between the agencies funding R&D and the end-users (the Indonesian Armed Forces, or TNI) responsible for procurement. A company may successfully develop a prototype with a government grant, but there is no institutionalized pathway or guarantee that this will translate into a sales contract (Handayani Pedah et al., 2025). This absence of a clear demand pull creates an untenable level of market uncertainty for any domestic firm. For a company to invest its own significant resources to mature a technology from a prototype (e.g., TRL 4-6) to a production-ready system (TRL 7-9) is an immense financial risk if the only potential buyer has

not signaled a clear and reliable intent to purchase the final product (Sugiono et al., 2018).

This environment of high financial risk and extreme market uncertainty forces a rational, albeit detrimental, response from all actors in the ecosystem. Both industry and academia become intensely risk-averse, making them unwilling to invest their own limited capital in ambitious, high-risk domestic R&D projects that have no clear path to market. This directly reinforces the vicious cycle of importing technology. When the TNI faces an urgent operational need, such as fulfilling the targets of the Minimum Essential Force (MEF) program, acquiring a proven, off-the-shelf system from a foreign supplier is the faster, cheaper, and less risky option (Yudhoyono et al., 2025).

This reliance on imports consumes a large portion of the defense budget, leaving insufficient funds for domestic R&D. The subsequent lack of domestic R&D ensures that local capabilities do not mature, meaning that the next time a defense need arises, importing is once again the only viable option (Matthews et al., 2025). Consequently, despite national policies prioritizing the domestic industry, the lack of consistent financial commitment and procurement follow-through perpetuates a state of technological dependency. The Valley of Death in Indonesia is therefore not a naturally occurring phenomenon but is actively deepened by a systemic lack of financial commitment, forcing the nation's defense industry into a cycle of dependency that makes the national goal of self-reliance an ever-distant ambition (Zhengqi, 2016).

The Need for Intermediary Structures to Bridge the Cultural Divide

While financial precarity and the lack of procurement commitment create the treacherous terrain of the Valley of Death, it is the deep-seated cultural and communication divides between academia, industry, and government that prevent innovators from building the bridges needed to cross it. The research findings highlight a critical disconnect in objectives, incentives, and operational languages among the Triple Helix actors, leading to a silo effect that stifles collaboration and perpetuates inefficiency (Siegel et al., 2003). By recognizing that cultural gaps are a fundamental barrier to innovation, we can argue that overcoming them requires more than just policy mandates or increased funding. It necessitates the deliberate creation of robust intermediary structures, specialized translator and broker institutions, that can actively manage the complex interfaces between these disparate worlds and foster a truly integrated innovation ecosystem.

The cultural chasm between the helices is profound and multifaceted. At its core, it is a clash of institutional logics. Universities and public research institutes (PRIs) operate within an academic culture that prioritizes the creation of new knowledge, scientific discovery, and dissemination through peer-reviewed publications. Their incentive structures reward contributions to scholarly literature, and their timelines are often dictated by the long-term, exploratory nature of basic research (Sutopo et al., 2022). In stark contrast, the defense industry, as a commercial entity, is driven by the need to develop proven, reliable, and scalable technologies that meet the specific, often rigid, requirements of the military end-user. Their focus is on market application, profitability, and shorter

development cycles. The government, particularly the Ministry of Defense, adds another layer of complexity with its focus on national security objectives, bureaucratic procedures, and a risk-averse procurement culture.

These differing goals, timelines, and reward systems create what is effectively a communication breakdown, where actors may be speaking, but not understanding one another. Industry perceives academic research as too abstract and far from market-ready, while academia often views industry as lacking an appreciation for the foundational science that underpins technological breakthroughs (Jupriyanto et al., 2024).

This is where the critical need for innovation intermediaries emerges. These are organizations or individuals that act as knowledge brokers or boundary spanners, actively working to bridge the structural holes in the innovation network. Their primary function is to translate the needs and capabilities of one helix into the language and context of another. An effective intermediary can de-risk collaboration by facilitating communication, managing expectations, aligning objectives, and building the mutual trust that is essential for any successful partnership (Jupriyanto et al., 2024). They can transform the abstract goals of a research project into a concrete value proposition for an industrial partner and, conversely, translate the technical requirements of an end-user into a viable research question for academics. In the defense sector, these intermediaries are crucial for navigating the complex web of security regulations, intellectual property (IP) negotiations, and bureaucratic hurdles that often derail collaborative projects. Without such dedicated translators, the cultural and communication gaps remain, and potential synergies are lost.

In many innovation systems, the Technology Transfer Office (TTO) at a university is intended to serve this intermediary function. However, the literature reveals that TTOs in Indonesia, and often globally, are ill-equipped to fulfill this role effectively. A common finding is that TTOs are severely underfunded, understaffed, and lack the deep industry expertise and commercial acumen required to successfully broker technology deals (Haryadi et al., 2025).

Many TTOs in Indonesia operate on a passive dissemination model, where they make research available rather than actively engaging in the complex, relationship-intensive work of matchmaking, negotiation, and project management. They often lack the capacity to conduct market analysis, develop compelling business cases, or navigate the intricacies of IP law, especially in a specialized field like defense (Haryadi et al., 2025). This institutional weakness means that the primary formal link between academia and industry is often the weakest point in the chain, leaving a critical gap in the ecosystem that informal or ad-hoc relationships cannot consistently fill.

Therefore, a successful management model for Indonesia's defense innovation system must go beyond simply reforming TTOs. It requires the establishment of a multi-layered network of formal mechanisms and collaborative platforms designed to force continuous dialogue and joint project definition between all three helices from the earliest stages of the R&D cycle. This could include government-facilitated research consortia that bring together university labs, state-owned defense enterprises, private SMEs, and military end-users to

work on specific, mission-oriented technological challenges. Such platforms provide a structured environment for the co-creation of knowledge and technology, ensuring that research is aligned with real-world needs from its inception (Hendrix et al., 2024).

Furthermore, these structures can serve as neutral ground for negotiating complex issues like IP ownership, cost-sharing, and benefit distribution, which are often major points of friction in bilateral collaborations. By building these formal bridges, the government can shift from a top-down, statist director to a strategic facilitator, creating a consensus space where the different cultures can meet, interact, and ultimately integrate. This deliberate, structured approach to fostering collaboration is essential to transform the current collection of separate entities into the cohesive, integrated, and truly innovative ecosystem that Indonesia needs to achieve its goal of defense self-reliance (Ariputro et al., 2024).

CONCLUSION AND RECOMMENDATION

The Triple Helix model of cooperation between the government, industry, and academia in Indonesia's defense sector is fundamentally broken. The current top-down, state-dominated approach stifles the innovation needed for defense self-reliance. This statist model has created a dysfunctional ecosystem where institutional misalignment, severe financial instability, and deep cultural divides between the three sectors prevent any meaningful collaboration. As a result, the system fails to bridge the Valley of Death, where promising research dies before becoming viable technology, ultimately perpetuating Indonesia's dependence on foreign defense imports.

To fix this, a strategic shift is required to create a truly integrated and demand-driven innovation ecosystem:

1. Redefine the Government's Role: Transition from a director to a strategic facilitator by establishing a National Defense Innovation Council to align strategy and streamlining bureaucracy to encourage participation.
2. Establish Intermediary Institutions: Create and empower knowledge brokers, such as professionalizing university Technology Transfer Offices (TTOs) and establishing a central Defense Innovation Hub to bridge the gap between researchers and industry.
3. Ensure Stable Funding and Procurement: Create a multi-year defense R&D fund to provide financial stability and implement a procurement pull mechanism that guarantees consideration for successful domestic projects.
4. Foster a Collaborative Culture: Launch mission-oriented research consortia focused on specific defense challenges and implement personnel exchange programs between academia, industry, and the military to build trust and mutual understanding.

ADVANCED RESEARCH

This research provides a qualitative, high-level analysis of the structural and systemic impediments within Indonesia's defense innovation ecosystem. A primary limitation is its focus on the overarching framework of the Triple Helix model, which, while revealing critical systemic flaws, does not deeply analyze quantitative metrics of innovation such as patent-to-product conversion rates or

specific project-level return on investment. Consequently, the study offers a broad critique of the state-dominated model. However, it may not fully capture the nuanced operational dynamics or isolated pockets of success that could exist within specific defense technology programs.

Building on this foundational analysis, future research should pursue a quantitative approach to rigorously measure the performance of the existing collaborative framework. Such a study could establish key performance indicators (KPIs) to track the efficiency of R&D funding, the velocity of technology maturation through Technology Readiness Levels (TRLs), and the success rate of technologies transitioning across the Valley of Death into procurement. This would provide the empirical data necessary to validate this paper's qualitative findings and precisely identify the most critical bottlenecks in the innovation pipeline.

Furthermore, valuable insights could be gained from in-depth, comparative case studies. Future investigations could contrast successful and unsuccessful defense technology projects within Indonesia to isolate the specific managerial practices and contextual factors that determine project outcomes. A comparative analysis with other nations like South Korea or Turkey, which have cultivated robust defense innovation ecosystems, could also yield actionable models and best practices adaptable to the Indonesian context, moving beyond critique to offer proven, practical solutions.

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REFERENCES

Adams, J. D., Chiang, E. P., & Starkey, K. (2001). Industry-University Cooperative Research Centers. *Journal of Technology Transfer*, *26*(1–2), 73–86. https://doi.org/10.1023/A:1007836328722/METRICS

Afzal, M. N. I., Sulong, R. S., Dutta, S., & Mansur, K. (2018). An Investigation on Triple Helix Model and National Innovation Systems: The Case of Malaysia. *Asian Journal of Innovation and Entrepreneurship*, *03*(03), 299–313. https://journal.uii.ac.id/ajie/article/view/10305

Ariputro, A. B., Syahtaria, M. I., Trismadi, T., Suwarno, P., Widodo, P., & Purwanto, D. A. (2024). Collaboration and Technology Transfer in the Defense Industry as Drivers of Innovation and Global Security Enhancement. *Physical Sciences, Life Science and Engineering*, *1*(3), 12–12. https://doi.org/10.47134/PSLSE.V1I3.247

Bellais, R., & Guichard, R. (2006). Defense innovation, technology transfers, and public policy. *Defence and Peace Economics*, *17*(3), 273–286. https://doi.org/10.1080/10242690600645274;SUBPAGE:STRING:ACCESS

Bhattacharya, S., Kumar, V., & Nishad, S. N. (2022). Technology Readiness Level: An Assessment of the Usefulness of this Scale for Translational Research. *Productivity*, *62*(2), 106–118. https://doi.org/10.32381/PROD.2021.62.02.2

Dading Gunadi, A., Arkeman, Y., Nazli, R. S. S., Rahardjo, T., & Wachjudiningsih, A. (2018). Designing Simulation of Indonesia National Innovation Capability Model Using the Dynamic System. *IOSR Journal of Business and Management (IOSR-JBM)*, *20*(7), 40–48. https://doi.org/10.9790/487X-2007074048

Dudin, M. N., Frolova, E. E. evna, Gryzunova, N. V., & Shuvalova, E. B. (2014). The Triple Helix Model as a Mechanism for Partnership between the State, Business, and the Scientific-Educational Community in the Area of Organizing National Innovation Development. *Asian Social Science*, *11*(1), p230. https://doi.org/10.5539/ASS.V11N1P230

Ellwood, P., Williams, C., & Egan, J. (2022). Crossing the valley of death: Five underlying innovation processes. *Technovation*, *109*, 102162. https://doi.org/10.1016/J.TECHNOVATION.2020.102162

Feinson, S. (2003). *National Innovation Systems Overview and Country Cases*.

Gbadegeshin, S. A., Natsheh, A. Al, Ghafel, K., Mohammed, O., Koskela, A., Rimpiläinen, A., Tikkanen, J., & Kuoppala, A. (2022). Overcoming the Valley of Death: A New Model for High Technology Startups. *Sustainable Futures*, *4*, 100077. https://doi.org/10.1016/J.SFTR.2022.100077

Handayani Pedah, F., Royke Deksino, G., Nengah Putra, I. A., Yanto, S., & Luntungan, A. H. O. (2025). The Important Role of the Defense Industry in Supporting National Defense. *East Asian Journal of Multidisciplinary Research*, *4*(3), 1401-1416–1401 – 1416. https://doi.org/10.55927/EAJMR.V4I3.89

Haryadi, A., Sulistyadi, E., & Asmoro, N. (2025). Driving Innovation in the Defense Sector: Unlocking the Power of Industry, Academia, and Government Collaboration. *Formosa Journal of Multidisciplinary Research*, *4*(2), 991–1002. https://doi.org/10.55927/FJMR.V4I2.48

Hendrix, T., Nasution, S. Y., Ariyani, L., Maulana, S., Wicaksono, A., & Ferianto, F. (2024). Conceptualizing a Seamless Model of Technology Transfer: Evidence from Public Research Institutes and Universities in Indonesia. *Foresight and STI Governance*, *18*(1), 46–57. https://doi.org/10.17323/2500-2597.2024.1.46.57

Irawan, B., Anggraini, E., & Purwono, J. (2025). Analisis Faktor Keberhasilan Kolaborasi Triple Helix: Perspektif Industri. *Owner: Riset Dan Jurnal Akuntansi*, *9*(3), 1596–1608. https://doi.org/10.33395/OWNER.V9I3.2736

Irfan, M., Nidar, S. R., Azis, Y., & Widianto, S. (2023). Self-reliant in defense industries: Case study Indonesia. *Cogent Business & Management*, *10*(3). https://doi.org/10.1080/23311975.2023.2262715

Jupriyanto, J., Roslinawati, A. M., Sulistyadi, E., & Djunaidi, M. (2024). Critical Challenges and Opportunity Factors in Stakeholder Collaboration for Indonesian Defense Technology Innovation. *Jurnal Ilmiah Teknik Industri*, 1–9. https://doi.org/10.23917/JITI.V23I1.4383

Karasev, O., Beloshitsky, A. V., Trostyansky, S. S., & Krivtsova, A. O. (2018). National Innovation Systems: A Case Study of the Leading Developing Countries. *European Research Studies Journal*, *XXI*(2), 713–723. https://doi.org/10.35808/ersj/1297

Kennedy, P. S. J. (2023). Indonesian Defense Industry and Minimum Essential Force. *International Research Journal of Economics and Management Studies IRJEMS*, *2*(2). https://doi.org/10.56472/25835238/IRJEMS-V2I2P116

Lakitan, B. (2013). Connecting all the dots: Identifying the "actor level" challenges in establishing effective innovation system in Indonesia. *Technology in Society*, *35*(1), 41–54. https://doi.org/10.1016/J.TECHSOC.2013.03.002

Lakitan, B. (2014). *National Innovation System in Indonesia: Present Status and Challenges*. https://www.academia.edu/7534337/National_Innovation_System_in_Indonesia_Present_Status_and_Challenges

Marzah, R., & Setiawan, B. (2015). *Calhoun: The NPS Institutional Archive DSpace Repository Analysis of government policies to support sustainable domestic defense industries* [Naval Postgraduate School]. https://hdl.handle.net/10945/45896

Matthews, R., Maharani, C., Jupriyanto, & Wu, S. S. (2025). Indonesia's defense acquisition strategy. *Asian Security*, 1–24. https://doi.org/10.1080/14799855.2025.2527088

Nugroho, S. S. (2022). Utilization of the Defense Industry in Supporting the Duties of the Navy to Enforce the Law and Maintain Security in Indonesian Waters. *Journal of Industrial Engineering & Management Research*, *3*(6), 97–102. https://doi.org/10.7777/JIEMAR.V3I6.340

Ranga, M., & Etzkowitz, H. (2013). Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society. *Industry and Higher Education*, *27*(4), 237–262. https://doi.org/10.5367/IHE.2013.0165;WEBSITE:WEBSITE:SAGE;WGROUP:STRING:PUBLICATION

Savitri, C. M. (2016). *Contribution of Offset to Defence Industrialisation in Indonesia* [Cranfield University].

https://dspace.lib.cranfield.ac.uk/server/api/core/bitstreams/14d3d8a2-00b6-4060-a747-ffb4f7e57674/content

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research*, *14*(1), 111–133. https://doi.org/10.1016/S1047-8310(03)00007-5

Suadnyana, I. N., & Aritonang, S. (2025). Defense industry policy strategy in developing the national defense system to strengthen national security | Jurnal Praksis dan Dedikasi Sosial. *Jurnal Praksis Dan Dedikasi Sosial*, *8*(1). https://doi.org/10.17977/um022v8i12025p231-236

Sugiono, A., Akim, & Ramadhan, R. A. (2018). The Implementation of the Triple Helix Model in the Indonesian Aerospace Defense Industry. *Central European Journal of International and Security Studies*, *12*(4), 196–213. https://cejiss.org/the-implementation-of-the-triple-helix-model-in-the-indonesian-aerospace-defense-industry

Sumantha, E. A., Hardjono, R. K., & Nugroho, B. Y. (2024). Alliance Strategy Model Design on Defend ID in Creating Competitive Advantage in Indonesian Defence Industry. *Journal of Human Security*, *20*(2), 16–22. https://doi.org/10.12924/johs2024.20203

Sutopo, W., Khofiyah, N. A., Hisjam, M., & Ma'aram, A. (2022). Performance Efficiency Measurement Model Development of a Technology Transfer Office (TTO) to Accelerate Technology Commercialization in Universities. *Applied System Innovation 2022, Vol. 5, Page 21*, *5*(1), 21. https://doi.org/10.3390/ASI5010021

Taufik, T. A. (2007, April). Indonesia's Sub-national Innovation System Policy and Programmes. *National Workshop on Subnational Innovation Systems and Technology Capacity Building Policies to Enhance Competitiveness of SME*. https://www.researchgate.net/profile/Tatang-Taufik/publication/341371682_Indonesia's_Sub-national_Innovation_System_Policy_and_Programmes/links/5ebd1b67299bf1c09abbe192/Indonesias-Sub-national-Innovation-System-Policy-and-Programmes.pdf

TERRAFORMING THE VALLEY OF DEATH Making the Defense Market Navigable for Startups. (2023). https://innovation.defense.gov/Portals/63/DIB_Terraforming%20the%20Valley%20of%20Death_230717_1.pdf

Townes, M. (2023). *The Role of Technology Maturity Level in the Occurrence of University Technology Transfer*. https://doi.org/10.20944/PREPRINTS202301.0504.V1

Yudhoyono, A. H., Sukoco, B. M., Maharani, I. A. K., Putra, I. K., & Suhariadi, F. (2025). Bridging the gap: Indonesia's research trajectory and national development through a scientometric analysis using SciVal. *Journal of Open Innovation: Technology, Market, and Complexity*, *11*(1), 100505. https://doi.org/10.1016/J.JOITMC.2025.100505

Zhengqi, P. (2016). State-Led Innovation Partnerships: Asian Developmental States within the Triple Helix Paradigm. *European Journal of East Asian Studies*, *15*(1), 108–143. https://doi.org/10.1163/15700615-01501005