

Driving Innovation in the Defense Sector: Unlocking the Power of Industry, Academia, and Government Collaboration

Airwan Haryadi^{1*}, Edy Sulistyadi², Novky Asmoro³

Universitas Pertahanan Indonesia

Corresponding Author: Airwan Haryadi airwanharyadi@gmail.com

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ABSTRACT

The defense industry plays a critical role in enhancing national security and sovereignty. This study examines the effectiveness of triple helix collaboration – academia, industry, and government – in fostering innovation, technology transfer, and sustainable defense industry development. Using a qualitative approach and secondary data analysis, this research highlights successful global and national collaboration models, identifies challenges in implementation, and explores solutions for overcoming these barriers. The findings demonstrate that effective collaboration drives technological independence, increases competitiveness, and strengthens national defense capabilities. Recommendations include enhancing regulatory frameworks, improving coordination among stakeholders, and fostering innovation ecosystems tailored to defense sector needs. This study contributes to understanding the dynamics of collaboration for advancing defense industry innovation and competitiveness.

INTRODUCTION

The collaboration between academia, industry, and government, known as the triple helix model, has emerged as a critical framework for fostering innovation across various sectors, including defense. This model underscores the importance of synergy among these three pillars in driving technological advancements and addressing complex challenges in national development (Azhar & Wibowo, 2020). The defense industry, as a high-stakes and technology-intensive field, provides an ideal context for the application of the triple helix model. Through effective collaboration, stakeholders can pool resources, share expertise, and create groundbreaking solutions that enhance national security while contributing to economic growth (Akimkina et al., 2021).

Indonesia, a nation with strategic geopolitical significance, recognizes the potential of this collaborative approach. However, the practical implementation of triple helix collaboration in the Indonesian defense sector faces persistent challenges. These include limited technological infrastructure, fragmented policies, and a lack of robust mechanisms to facilitate seamless interaction among academia, industry, and government (Kuswanto et al., 2022). Despite these hurdles, recent policy initiatives demonstrate Indonesia's commitment to advancing innovation in defense. Programs like "Defend ID" aim to enhance self-reliance by fostering local manufacturing capabilities and integrating domestic industries into the global defense supply chain (Hidayaturahmi & Farida, 2022).

Internationally, successful examples of triple helix collaboration in defense underscore its transformative potential. Projects such as the Eurofighter Typhoon and the Korean-Indonesian KFX/IFX fighter jet development exemplify how strategic partnerships among academia, industry, and government can result in technological breakthroughs while strengthening domestic industries (Armandha et al., 2016; Matthews & Al-Saadi, 2023). These initiatives highlight the necessity of clear governance structures, mutual trust, and aligned goals to ensure the success of such collaborations (Sezal & Giumelli, 2022).

For Indonesia, the imperative to foster innovation in the defense sector is particularly pressing. Reliance on imported defense technologies not only limits self-sufficiency but also poses risks to national security in times of geopolitical tension (Hidayaturahmi & Farida, 2022). Enhancing the local defense industry's capacity through research, innovation, and production has thus become a national priority. Universities contribute by providing critical research and development expertise, industries drive the practical application of technologies, and the government establishes supportive policies and funding mechanisms (Azhar & Wibowo, 2020).

Despite these efforts, several barriers continue to impede progress. A significant challenge is the misalignment between academic research outputs and industrial needs, which slows the pace of technology transfer. Additionally, fragmented coordination among stakeholders often hampers the effectiveness of collaborative initiatives (Da Silva et al., 2017). Addressing these issues requires a deeper understanding of the dynamics at play in triple helix partnerships and the identification of strategies to harmonize efforts across sectors.

This study aims to evaluate the effectiveness of the triple helix model in promoting innovation in Indonesia's defense sector. By examining existing collaborations and analyzing their outcomes, the research seeks to identify best practices and areas for improvement. The findings will provide actionable insights for policymakers, industry leaders, and academics, with the ultimate goal of enhancing Indonesia's defense capabilities and advancing its position in the global defense industry.

LITERATURE REVIEW

Triple Helix

The Triple Helix model, introduced by Etzkowitz and Leydesdorff, emphasizes the vital role of collaboration between three key sectors: academia (universities), industry, and government. This model proposes that the interaction among these three entities is crucial for driving innovation and technological advancement, fostering a knowledge-based economy. The basic premise is that universities contribute to research and development, industries focus on commercialization and practical application, and governments create favorable policies and provide resources for research and innovation (Etzkowitz & Leydesdorff, 2000). According to the Triple Helix theory, innovation is not solely the result of individual efforts but arises from the dynamic interplay between these three sectors, where each sector plays a complementary role.

Various models and approaches related to the Triple Helix have emerged, which emphasize the synergies between these sectors. For instance, the "open innovation" model, which highlights the importance of knowledge flows and partnerships between universities and industries, has been integrated into the Triple Helix framework (Chesbrough, 2003). Additionally, the Triple Helix has been adapted in different countries to address specific national challenges, such as in South Korea's collaboration with academia and industry in the defense sector, and the European Union's support for public-private partnerships in technological development. Azhar and Wibowo (2020) discuss how Triple Helix collaboration is a key factor in enhancing national competitiveness, as it facilitates the transfer of technology, improves the quality of human resources, and boosts industrial capacity. The application of the Triple Helix model, thus, is not static; rather, it adapts to the specific needs and structures of various countries and industries, especially in sectors like defense, where innovation and technology are critical for national security and global competitiveness. The Triple Helix model has shown significant potential in fostering a robust innovation ecosystem, with positive impacts on economic development and technological progress (Etzkowitz & Leydesdorff, 2000).

The Role of Academia in Innovation and Technology

Universities play a crucial role as centers of research and development (R&D), particularly in sectors like defense, where innovation and advanced technologies are pivotal. As research hubs, universities conduct fundamental and applied research that can lead to breakthroughs in military technology, such as new materials, communication systems, and defense mechanisms. Their role in advancing innovation extends beyond theoretical studies to the development of

prototypes and models, which are essential for practical applications in the defense industry. Furthermore, universities are often at the forefront of exploring emerging technologies, such as artificial intelligence, cybersecurity, and autonomous systems, all of which have significant implications for national defense strategies. By collaborating with industries and government agencies, universities help bridge the gap between research and real-world application, ensuring that cutting-edge innovations are effectively transferred and utilized (Akimkina et al., 2021).

The process of technology transfer, where knowledge and innovations from academia are adapted and commercialized by the private sector, is another critical function of universities. Through partnerships with defense companies, universities contribute to the development of technologies that enhance defense capabilities. These collaborations often lead to new products, services, or systems that directly impact national security. The role of academia in facilitating technology transfer is further strengthened through patenting, licensing, and spin-off ventures, which enable the commercialization of university-developed technologies. Additionally, academic research contributes to policy development by providing evidence-based insights that shape public policy, particularly in the defense sector. By offering expertise and conducting impact assessments, universities influence decisions related to defense strategies and technology adoption (Akimkina et al., 2021). Thus, universities not only drive technological innovation but also play an integral role in the application of these innovations within the defense industry and public policy.

The Role of Industry in Collaboration

The industrial sector, particularly in defense, plays a pivotal role in translating academic research into practical applications, which ultimately enhances production capacity and global competitiveness. By leveraging the results of research conducted in universities, industries can develop new technologies, refine existing products, and improve manufacturing processes. For example, academic research on materials science, robotics, or advanced electronics can directly inform the design and production of defense systems, such as aircraft, naval vessels, or cyber defense tools. These innovations often lead to the creation of high-tech products with superior performance, giving defense companies a competitive edge in the global market. Furthermore, industries can scale up prototypes and models developed in academic settings, transforming them into mass-produced solutions that meet both national security needs and market demands.

In the context of defense, collaboration between industry, government, and academia is crucial for developing domestic defense technologies. As governments often set the priorities and provide funding for defense projects, industries benefit from this support while universities provide the cutting-edge research and development necessary to fuel innovation. This synergy fosters the creation of new defense technologies that are tailored to the specific needs of a country's defense strategy. Kuswanto et al. (2022) highlight several examples where Indonesian defense companies have worked with universities and

government agencies to develop advanced technologies such as drones, missile systems, and military communication infrastructure. By engaging in these collaborations, industries can access knowledge and expertise that might otherwise be unavailable, leading to the creation of more sophisticated, cost-effective, and locally produced defense systems. These partnerships not only boost the industrial sector's capacity to produce high-quality products but also contribute to national security by ensuring that defense technologies are domestically developed and tailored to meet specific defense needs. Ultimately, the collaboration between industry, academia, and government in the defense sector enhances both technological innovation and strategic autonomy.

The Role of Government in Encouraging Collaboration

Governments play a crucial role in fostering collaboration between academia and industry, particularly in the defense sector, through supportive policies, regulations, and strategic programs. By establishing clear and favorable regulations, governments can create an environment that encourages innovation, technology transfer, and collaboration. For instance, policies that facilitate intellectual property (IP) rights protection, ease of licensing, and patenting are essential for ensuring that innovations developed through academic research can be effectively commercialized and applied in defense industries. Additionally, governments can offer financial incentives such as grants, subsidies, or tax breaks to companies that collaborate with universities on research and development (R&D) projects. These incentives can lower the financial risk for industries investing in new technologies, making them more likely to engage in joint ventures with academic institutions. Moreover, the government can establish strategic programs that align university research with defense priorities, ensuring that the outcomes of academic research are directly applicable to the nation's defense needs.

Hidayaturahmi and Farida (2022) explore the role of the government in creating an ecosystem conducive to collaboration between academia and industry. They argue that government involvement is critical in building infrastructure that facilitates such collaborations, such as technology parks, innovation hubs, and dedicated R&D facilities. Furthermore, governments can act as intermediaries, helping universities and industries identify mutual interests, streamline communication, and navigate bureaucratic obstacles. Through the establishment of defense innovation funds and technology incubators, governments can help accelerate the commercialization of research findings into deployable technologies. By coordinating these efforts and ensuring that regulatory frameworks support research and industrial growth, the government creates a thriving ecosystem where academia, industry, and defense sectors work together to foster innovation and technological advancement. Ultimately, these government actions strengthen national defense capabilities while promoting technological sovereignty and economic growth.

The Role of Government in Encouraging Collaboration

Successful collaborations in the defense sector often serve as exemplary models of how the triple helix framework can drive innovation and technological

advancement. One prominent example is the collaboration between South Korea and Indonesia in the development of the KFX/IFX fighter jet. This joint venture, which involves a partnership between the governments, defense industries, and academic institutions of both countries, aims to enhance the capabilities of their respective air forces while simultaneously boosting their defense industries' technological expertise. The project illustrates how cross-border cooperation, supported by government policies and academic research, can result in the development of cutting-edge military technology. The involvement of South Korea's defense industry, Indonesia's PT DI (Industri Pesawat Terbang Nusantara), and academic institutions has led to significant advancements in aerospace technology, strengthening the technological sovereignty of both nations (Armandha et al., 2016).

Another successful example is the Eurofighter Typhoon program, a collaboration between the governments, industries, and research institutions of several European countries, including the UK, Germany, Italy, and Spain. This multinational defense project aims to develop a highly advanced, multi-role fighter aircraft capable of operating in various military scenarios. The collaboration between defense contractors such as BAE Systems, Airbus, and Leonardo, alongside the support of national governments and academic research, has enabled the development of a sophisticated aircraft that serves multiple European nations. Matthews and Al-Saadi (2023) highlight how the collaborative efforts of academia, industry, and government have played a pivotal role in overcoming technological challenges and ensuring the Typhoon's success. Both the KFX/IFX and Eurofighter Typhoon projects exemplify the power of the triple helix model in the defense sector, demonstrating the importance of cooperation in advancing military technology and enhancing defense capabilities.

Barriers and Challenges in Triple Helix Collaboration

While the triple helix model offers significant potential for driving innovation and technological advancement, its implementation faces several challenges and barriers, particularly in the defense sector. One of the primary issues is the gap between academic research and industrial needs. Academic institutions often focus on basic research, while industries are more concerned with applied technologies that can be commercialized or directly integrated into their products. This disconnect can lead to a mismatch between the innovations developed in academia and the practical needs of industries, especially in the defense sector, where technological advancements must align closely with strategic and security requirements (Da Silva et al., 2017).

Another challenge is the lack of coordination among the three entities – academia, industry, and government. Effective collaboration requires clear communication and shared objectives, but differences in organizational cultures and priorities often hinder progress. Academia may prioritize the pursuit of knowledge and academic recognition, while industries focus on profitability and market competitiveness. Governments, on the other hand, have regulatory

concerns and may struggle to harmonize their policies with the needs of industry and academia (Da Silva et al., 2017).

In the defense sector, the complexity of technology transfer and its adaptation to local industries presents additional difficulties. Defense-related innovations often involve sensitive and classified technologies, which can make knowledge sharing and transfer particularly challenging. The adaptation of foreign technologies to local contexts requires significant investment in infrastructure, expertise, and customization to meet national security requirements. Moreover, the protection of intellectual property and maintaining confidentiality are critical issues that limit the extent of collaboration, especially in defense technologies, where strategic interests often take precedence over open exchange (Da Silva et al., 2017). These barriers can hinder the successful implementation of the triple helix model and impede the effective transfer of cutting-edge technology to local industries.

Models and Frameworks for Collaboration

Various models and frameworks have been developed to facilitate collaboration between academia, industry, and government, particularly in sectors such as defense, where technological advancements are critical for national security. One of the most widely recognized models is the synergy model, which emphasizes the interdependent relationship between the three sectors. This model focuses on leveraging the strengths of each entity – academia for knowledge and research, industry for practical application, and government for policy and funding – towards a common goal of fostering innovation. The synergy model encourages continuous communication and collaboration, creating an environment where ideas can be freely exchanged and innovations can be translated into actionable technologies (Sezal & Giumelli, 2022).

Another important framework is open innovation, which promotes the sharing of knowledge and resources beyond the boundaries of a single organization. In the context of the defense sector, open innovation can involve partnerships between universities, industries, and governments to solve complex challenges. By opening up the innovation process, this framework enables the flow of ideas and technologies across institutional boundaries, encouraging cross-sector collaboration and the rapid development of new solutions. In particular, open innovation allows for the integration of external knowledge and expertise, which is crucial in the highly specialized field of defense technology (Sezal & Giumelli, 2022).

Additionally, the collaborative research and development (R&D) model has proven effective in fostering innovation within the defense sector. This model emphasizes the joint effort between academia and industry in conducting research and developing new technologies. Governments play a supportive role by providing the necessary regulatory framework and funding to ensure the smooth functioning of R&D initiatives. By applying these models and frameworks, it is possible to bridge the gap between research, application, and policy, thus advancing the development of defense technologies and ensuring the success of triple helix collaborations (Sezal & Giumelli, 2022).

Benefits of Triple Helix in Increasing National Competitiveness

The triple helix model – comprising academia, industry, and government – plays a pivotal role in enhancing the national competitiveness of the defense sector and promoting technological independence. Collaboration between these three sectors helps ensure that innovative solutions are developed and successfully implemented, reducing dependence on foreign technologies and fostering self-reliance in defense capabilities. Academia, through research and development, provides the theoretical knowledge and cutting-edge innovations that can be translated into practical applications. Industry then utilizes this research to develop products and technologies that meet national security needs, while the government provides the regulatory framework, funding, and policy support necessary to align innovation with national defense priorities (Azhar & Wibowo, 2020).

This collaborative approach is particularly critical in the defense sector, where technological advancements directly impact a country's ability to safeguard its sovereignty. By strengthening the relationship between academia, industry, and government, the triple helix model helps accelerate the development of advanced defense technologies, such as aircraft, military-grade sensors, and cybersecurity systems, which are essential for national security. Moreover, it fosters an environment of technological self-sufficiency, reducing reliance on foreign suppliers for critical defense technologies and components. This can be particularly important in times of geopolitical instability when supply chains for defense technologies may be disrupted (Azhar & Wibowo, 2020).

The impact on national security is profound, as a more competitive and self-reliant defense industry enhances a nation's ability to deter potential threats, respond to emergencies, and maintain a strong defense posture. Ultimately, the triple helix collaboration drives the development of innovative technologies that not only enhance defense capabilities but also contribute to the broader technological advancement of the nation, reinforcing its position in the global arena (Azhar & Wibowo, 2020).

METHODOLOGY

The research method employed in this study is qualitative in nature, utilizing secondary data collection to explore the effectiveness of industry-university-government collaboration in fostering innovation within the defense sector. Qualitative methods are suitable for understanding complex, multifaceted phenomena like the interactions between these three sectors and their impact on technological advancement. Secondary data, including government reports, academic papers, industry white papers, and case studies, will be analyzed to gain insights into the existing collaborations and their outcomes. This approach allows for a comprehensive understanding of the subject matter without the need for primary data collection, particularly in areas where direct access to ongoing collaborations or proprietary information may be restricted (Azhar & Wibowo, 2020).

The study will focus on analyzing existing collaborations in the defense industry, such as the development of defense technologies, military equipment,

and technological innovations. Data will be gathered from various sources, including public government documents, industry reports, and academic publications, to identify successful case studies and challenges faced in these collaborations. These case studies will serve as evidence of how triple helix collaboration functions in practice and its impact on technological development and national security.

Data analysis will be conducted through thematic analysis, identifying common themes and patterns within the secondary data that illustrate the effectiveness of collaboration. This analysis will focus on understanding how well the integration of academia, industry, and government leads to technological innovations, enhanced national security, and self-reliance in the defense sector. Furthermore, the study will highlight key challenges in implementing successful collaboration, such as gaps in communication, regulatory barriers, and lack of coordination. The findings from the analysis will be used to propose strategies for improving collaboration and fostering innovation within the defense sector (Hidayaturahmi & Farida, 2022).

RESEARCH RESULTS AND DISCUSSION

The discussion of this research focuses on the key findings related to the role of collaboration between academia, industry, and government in fostering technological innovation in the defense sector. The study confirms that triple helix collaboration has significant potential to enhance the innovation capacity of the defense industry and contribute to national security. As highlighted in the literature, universities play a critical role as hubs for research and development, where new ideas and innovations are generated. By collaborating with industry, academic institutions can ensure that their research is aligned with practical needs and that their technological advancements are applied to real-world challenges (Akimkina et al., 2021).

The role of the industry in this collaboration is equally important, as it provides the necessary infrastructure, resources, and commercial expertise to scale up innovations. Industry can leverage the research outcomes from universities to develop and manufacture defense technologies that meet national security requirements. However, the industry's involvement does not only pertain to product development; it also includes investment in research, facilitating knowledge transfer, and fostering entrepreneurship. In some instances, the private sector can help bridge the gap between academic research and market applications, speeding up the process of innovation commercialization (Kuswanto et al., 2022).

On the other hand, the government plays a pivotal role in creating an enabling environment for collaboration to thrive. Through policies, regulations, and incentives, governments can shape the ecosystem that supports the triple helix model. Government-backed funding programs, defense contracts, and public-private partnerships are crucial in motivating industry and academia to work together. Additionally, regulatory frameworks help mitigate risks associated with intellectual property, defense secrecy, and technology transfer,

which can otherwise hinder collaboration, especially in sensitive sectors like defense (Hidayaturahmi & Farida, 2022).

Despite the clear advantages of triple helix collaboration, several challenges remain. One of the main obstacles is the gap between academic research and the practical needs of industry. Academia often focuses on basic research and theoretical developments, while industry requires more applied research that can be directly translated into products and services. This misalignment can result in inefficiencies and missed opportunities for innovation (Da Silva et al., 2017). Furthermore, coordination among the three sectors is often hampered by differing objectives, timelines, and priorities. Academia and industry may have contrasting approaches to risk, innovation, and funding, while governments must navigate complex political and regulatory landscapes to facilitate cooperation.

Moreover, in the defense sector, issues related to security and confidentiality further complicate collaboration. Many technological innovations, particularly in defense, are subject to strict confidentiality and national security regulations, which can limit the degree of transparency required for effective collaboration. These challenges underscore the importance of trust and clear communication among all stakeholders to ensure that sensitive information is handled appropriately (Sezal & Giumelli, 2022).

Overall, the study suggests that while there are considerable challenges, the benefits of triple helix collaboration—particularly in the context of national defense and technological innovation—are undeniable. To address the barriers identified, it is recommended that strategies be implemented to strengthen the communication channels between the sectors, align research priorities with national security needs, and enhance regulatory frameworks to support more efficient collaboration. Only through a concerted effort can the full potential of triple helix collaboration be realized in the defense sector, resulting in innovations that are not only technologically advanced but also contribute to national defense autonomy and security.

CONCLUSIONS AND RECOMMENDATIONS

The triple helix model, which emphasizes the collaboration between academia, industry, and government, is essential in driving innovation, particularly within the defense sector. The interconnection between these three sectors creates a synergistic environment where academic research can be translated into practical technological advancements by industries, while the government facilitates and supports this collaboration through policies, funding, and strategic regulation. The effectiveness of this model in fostering innovation and enhancing defense capabilities has been observed globally, with successful collaborations leading to the development of cutting-edge defense technologies.

However, several challenges must be addressed for this model to reach its full potential. Misalignment between academic research and industry needs, along with coordination issues among the three sectors, remain significant barriers. Moreover, security concerns, particularly in defense-related innovations, pose additional complications that require careful consideration. To

overcome these obstacles, it is crucial to strengthen communication and cooperation between academia, industry, and government. Aligning research with national security needs and providing clear regulatory frameworks will ensure smoother collaboration. By addressing these challenges, the triple helix model can further contribute to the growth of the defense sector, improve national security, and drive technological self-reliance.

ADVANCED RESEARCH

Future research should explore the deeper integration of the triple helix model in the defense sector, focusing on case studies of successful collaborations and their long-term impacts on national security and technological advancement. Additionally, examining the barriers to effective knowledge transfer between academia and industry, particularly in the context of sensitive defense technologies, could provide insights for improving collaboration. Further studies could also investigate the role of government policies and regulations in fostering innovation while maintaining national security. Expanding this research to include comparative analyses across different countries could offer valuable lessons for improving the effectiveness of the triple helix model in the defense industry.

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