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Collaboration among NATO's defence innovators: Lessons from Poland

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Abstract

The North Atlantic Treaty Organisation (NATO) is responding to security challenges arising from emerging technologies by leveraging national and multilateral innovation networks to strengthen collective defence and accelerate technological adaptation. NATO partnerships provide a research scope encompassing key policy developments on specific technologies, including artificial intelligence, autonomy, quantum, and data. Poland's innovation ecosystem is analysed to highlight how public–private partnerships with NATO promote alliance-wide strategic objectives aligned with national innovation networks. This comparative case study analyses NATO's Defence Innovation Accelerator for the North Atlantic (DIANA) and the national innovation networks of allies, as demonstrated by the case of Poland. Data was gathered from policy documents, industry reports, and other publicly available sources. Poland's proactive innovation strategy is a model for utilising local strengths to tackle global security concerns and test facilities and accelerator programmes under NATO DIANA. Poland's innovation model provides a significant case study that offers valuable insights for future research and development. Combating the challenges posed by evolving technologies requires adaptable security measures, demonstrated by various examples from Poland's local accelerators and test centres. NATO's approach, involving industry partnerships and defence innovation, provides a model for other allies. The case of innovation in Poland provides a generalisable methodology for studying other national approaches to innovation aligned with the NATO accelerators.

Keywords:

Poland, NATO, innovation, technology, defence

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Introduction
Strategic adaptation regarding dual-use technologies

Russia's full-scale invasion of Ukraine in 2022 heightened security concerns in Europe, prompting Poland to significantly increase defence funding to strengthen military readiness against regional instability. Between 2023 and 2025, Poland increased defence spending from 3% (US International Trade Administration, 2024) to 4.7% of GDP (Wypartowicz, 2024), placing it among NATO's fastest-growing and highest-spending members relative to economic output. Poland's record-breaking defence spending marks a strategic shift towards addressing regional threats and highlights the importance of technological innovation in hardening collective defence.

Poland's national innovation network provides important lessons for aligning national and multilateral engagements to foster a credible, robust, and resilient defence posture while adapting to emerging disruptive technologies (EDTs). This case is focused on the important puzzle of balancing the distinct evolution of the innovation networks of thirty-two NATO allies, which are at different maturity levels, supported by a diverse array of organisations and stakeholders. These innovation networks are part of a regional intergovernmental innovation network of financial, physical, and intellectual resources.

The case of Poland's national innovation network within the NATO Defence Innovation Accelerator for the North Atlantic (DIANA) initiative demonstrates the unique features of the support of relevant organisations and stakeholders. The research questions concern how collaboration between allies can support and facilitate capacity-building regarding specific technologies through the establishment of bilateral and multilateral collaboration. How can NATO DIANA limit competition, enhance trust, facilitate financing, and support access to global networks? The DIANA model provides an extensive array of possible comparative case studies to examine how the transatlantic regional innovation network engages with the national innovation networks of NATO countries.

The Polish case was selected for this focus to understand how significant increases in defence spending translate into increases in dual-use technological sophistication, involving both civilian and military applications. The goal is not to provide a causal metric for how increased defence spending translates into increased innovation or collaboration on technological development. Instead, the goal is to examine how a case where significant increases in defence spending translate into an increasingly mature national innovation network focused on dual-use technologies, supported by the regional innovation network of NATO DIANA.

The transatlantic scope and integration of DIANA bridge innovation in North America and Europe, uniting allies with numerous accelerators and test centres (Greenacre, 2024). DIANA brings numerous sectors and innovation, including universities, startups, corporations, government agencies, and defence organisations, within the governance structure of accelerators and test centres (NATO, 2024a). The multi-sector approach involving public and private actors operationalise competitive challenges, funding, mentorship, and access to NATO resources and leadership (Butcher, 2025). These engagements provide opportunities to study the collaboration involving other allied national innovation networks, filling the gaps in the literature on how national and regional innovation networks interact and collaborate. Specifically, how allies engage within the framework of the unique case of DIANA's approach to dual-use technologies as part of NATO's collective defence.

Collaborative capacity-building among national innovators

The case of Poland's national innovation network demonstrates the advancement of NATO's defence technology priorities, strengthening collective defence to address concerns related to emerging technologies. Poland's unprecedented defence spending demonstrates significant national support for local innovation networks, providing a strong case for coordinated national initiatives aligned with DIANA. The Polish case provides lessons on how regional and national innovation networks interact in the innovation of dual-use technologies. Poland's national innovation network is supported by significant defence spending and public–private partnerships, contributing to the literature by filling the gaps on how the national innovation networks of NATO countries align with alliance-wide regional innovation initiatives like DIANA.

The alignment between Poland's national innovation network and the regional scope of NATO DIANA demonstrates support for strengthening technological agility and collective defence. Poland's contributions include various accelerators and test centres as part of the larger expansion of NATO's strategic objectives focused on the challenges posed by emerging technologies. These facilities support an expanded reach and impact, given that Poland's contributions draw actionable conclusions, hardening future innovation among allies, and providing a methodology for further comparative research on collaborative capacity-building among national innovation.

Literature review

Regional and national innovation networks

NATO DIANA and Poland's national innovation network provide concrete examples of regional and national initiatives converging to address security challenges posed by EDTs. Poland's case provides a unique study focussed on the interrelation between regional network support and national innovation. This study compares the influence of innovation at distinct levels of analysis, seeking to identify numerous lessons applicable to other national innovation networks of allies within the DIANA network.

According to Petraite *et al.* (2022, p.2), national innovation networks are shaped by "attributes, such as shared culture, shaped by common education and work experience [that] make it easier to interact among national borders." There is a "complex pattern of interactions among a wide variety of actors such as firms, universities, and government research institutes… the interactions within the national boundaries are the most relevant" (Petraite *et al.*, 2022, p. 4). Collaboration among organisations is focused on the role of institutional arrangements in fostering national innovation. These "networks" focus on the importance of "trust between the participants, relations usually designed in a long-term perspective, redundancies within the network, options and absence of hierarchy, openness, dynamics, and flexibility, competition between the network actors, independence and voluntary cooperation, and scale economics through cooperation" (Morisson and Pattinson, 2020, p. 6). A regional innovation network can support collaboration within a national innovation network, structuring the approach through integrated support, access to funding, leveraging resources, and strengthening local innovation capacity.

Regional innovation enhances the capabilities of national innovation, balancing local specialisation and global connectivity to facilitate collaboration and drive innovation. With regard to the national innovation networks of countries, a regional approach to

innovation is meant not only to "promote learning and knowledge exchanges but also to reduce fragmentation in their innovation ecosystems… to find effective policy solutions for strengthening innovation networks" (Morisson and Pattinson, 2020, p. 2). Regional innovation occurs when "enhanced learning capacities, innovativeness, and competitiveness, facilitate the exploration of complementarities, and allow for enhanced connectivity with other regions… industry networks, production value chain networks, global networks, university-firm networks, geographic clusters, international trade, foreign direct investments, and international R&D" (Morisson and Pattinson, 2020, p. 5). Regional innovation supports institutional linkages that connect universities, research centres, and other firms within the geographic scope, as formal and informal ties facilitate knowledge exchange and technological learning across countries.

Interorganisational innovation involves collaboration between various organisations within the same region. A comparative approach is applied to different network interactions. Regional innovation involves a distinct set of actors and occurs when organisations "join and recombine key resources, tangible and intangible resources like knowledge, expertise, know-how, infrastructure, personnel, and others, thus allowing the value creation and appropriation by the members" (Gomes *et al.*, 2017, p. 2). When numerous organisations with separate characteristics collaborate to innovate, they provide comparative observations about the diversity between partners. Regional innovation consists of the interaction between distinct organisations and various technologies.

The NATO DIANA and Polish national innovation networks are compared in terms of the interactions of numerous organisations in business, government, and academia, collectively focused on various dual-use technologies. The various actors in an innovation network "have different characteristics, abilities, knowledge, and objectives. They will share their resources, knowledge, personnel, and infrastructure in complex projects by identifying the competencies of each actor involved in the network" (Gomes *et al.*, 2017, p. 3). Various aligned actors from various geographic proximities provide for "customisations offered specifically for local preferences or regulations and standards of different countries" (Gomes *et al.*, 2017, p. 3). The approach of the present study is to comparatively analyse Poland's national innovation network within the NATO DIANA network, as a values-based regional innovation network that connects North America and Europe.

NATO's technological adaptation

NATO has historically adapted in response to opportunities and challenges posed by emerging technologies. For example, precision-guided munitions transformed airstrikes in the 1970s and 1980s, decreasing collateral damage and increasing accuracy. Smaller-scale operations accomplished strategic goals with novel capabilities, providing new opportunities that enabled "targeted disruption" against military systems, especially with vital elements like sensors, command and control systems, and logistics (Maurer, 2023, p. 8). However, precision-guided munitions retained some vulnerabilities, associated with the use of combat deception tactics and electronic warfare as countermeasures, that is, the use of deception and dispersion to undermine the precision of guided munitions (Esposito, 2019, p. 30). These countermeasures combated new threats while maintaining technological advantages and adapting to threats posed by emerging technologies.

NATO's deterrence and defence posture continues to adapt to emerging technologies. In July 2020, twelve professionals from academia and industry formed NATO's Advisory Group on Emerging Disruptive Technologies to provide strategic advice on implementing new technologies (NATO, 2024c). In February 2021, NATO defence ministers approved

a dual-use technology strategy, emphasising the commercial and military uses of emerging technologies and the need for a forum on safeguarding against malicious usage by rivals (NATO, 2024c). NATO's summit in Brussels in 2021 marked a significant milestone in the alliance's adaptation to emerging technologies, as allies agreed to strengthen strategies for "identifying, developing, and adopting EDTs at the speed of relevance, guided by principles of responsible use" and an adherence to international law (NATO, 2021, para. 37). This summit outlined the launch of NATO DIANA as a civil-military initiative to support "start-ups working on dual-use emerging and disruptive technologies" (NATO, 2021, para. 6d). DIANA underscored NATO's commitment to fostering innovation partnerships to bridge national and alliance-wide objectives.

NATO's 2022 summit in Madrid established DIANA to "bring together governments, the private sector, and academia to bolster our technological edge" (NATO, 2022a, para. 11). The 2022 Strategic Concept outlined the opportunities and risks of emerging technologies "altering the character of conflict, acquiring greater strategic importance and becoming key arenas of global competition" (NATO, 2022b, para. 17). The concept stressed the importance of cooperation among allies to develop innovative technologies for defence and security as well as ensuring responsible use while safeguarding sensitive technologies. The establishment of NATO DIANA highlights a recent example of a long-standing commitment to maintaining technological superiority while addressing the security challenges of emerging technological threats.

Critical fields, such as artificial intelligence (AI), data, autonomy, quantum, biotechnology, hypersonic, space, novel materials and manufacturing, and energy and propulsion, have been central to NATO's policy developments on emerging technologies in recent years (NATO, 2024c). NATO DIANA became operational on 19 June 2023, marking a pivotal point towards fostering dual-use technologies for defence and security across the alliance (NATO, 2023b). The initiative involves challenge programmes, where innovators are invited to develop cutting-edge solutions for dual-use technological challenges (NATO, 2024c). The programme offers a range of financial resources, mentorship, education, investor access, accelerator locations, and test facilities for accepted innovators.

In June 2023, DIANA's pilot challenge programme focused on energy resilience, sensing and surveillance, and secure information-sharing (NATO, 2023b). Of the 1,300 applications, forty-four businesses were selected for the first cohort of innovators, announced in November 2023 (NATO, 2023c). DIANA's infrastructure has rapidly expanded, underscoring NATO's focus on fostering innovation, with additional strategic milestones including the launch of the Deep Tech Lab Quantum in Copenhagen at the end of September 2023 (NATO, 2023a). NATO foreign ministers approved the EDT advisory group's strategies on quantum technologies in November 2023 (NATO, 2024f). Over 2,600 applications were received in 2024, and ten companies were chosen to receive €300,000 as part of DIANA's phase II (NATO, 2024e). By March 2024, DIANA's network included twenty-three accelerator sites (up from eleven sites) and 182 test centres (up from ninety test centres) across twenty-eight allied countries (NATO, 2024b). The biotechnology and human enhancement initiative was approved in April 2024 in response to changing technological obstacles (NATO, 2024g). These initiatives demonstrate NATO's flexibility to support improved interoperability to strengthen defence collaboration to overcome barriers.

More than 2,600 applications were submitted in 2025, and over seventy companies from twenty NATO countries joined the accelerator programme. This year's challenge programme highlighted key technological domains, including "energy and power, sensing and surveillance, data and information security, human health and performance, and

critical infrastructure and logistics" (Defence Industry Europe, 2024). The challenge programmes have developed dual-use technologies, with both civilian and defence applications to foster innovations addressing interconnected security challenges and commercial opportunities (Defence Industry Europe, 2024). DIANA provides multilateral collaboration for accelerated technological advancement as well as strengthened resilience, and enhanced interoperability among allies (Vincent, 2023). The challenge programmes enhance NATO's commitment to technical dominance while addressing emerging security threats.

Poland's national innovation network

Poland's national innovation network provides a case within the NATO DIANA framework developing local capacity while supporting the alliance's overarching objectives aligned with NATO's emerging technology policies. This analysis of Poland's network identifies lessons for integrating national and alliance-wide approaches into technological adaptation, illustrating the integration of national and multilateral frameworks to enhance collective defence. Poland's increased military spending between 2021 and 2035 is estimated at $131 billion (US International Trade Administration, 2024). Poland's technical modernisation plan is implementing defence innovation policies, providing an important case of national initiatives resulting from increased defence expenditures. This plan will allocate 524 billion zlotys for defence expenditures, indicating a significant increase in defence expenditures (Wróbel, 2021). In 2024, this increase marks Poland as one of the most prominent investors in defence among NATO allies, reaching 4.12% as a proportion of GDP (Surwillo and Slakaityte, 2024). These investments demonstrate a larger initiative towards technological enhancement in Poland in recent years.

In November 2024, Poland announced a $240 million investment in various technologies to strengthen defence and enhance economic competitiveness (Kurasinska, 2024). Poland's Military AI Strategy 2024–2039 includes a focus on shared standards with NATO and prioritises partnerships with the United States, the United Kingdom, France, and Germany (Ministry of National Defence, Republic of Poland, 2024b). This strategy aligns with NATO's responsible AI principles and seeks to establish organisational structures for international cooperation and interoperability. Poland constructed an AI factory and is developing a Polish large language model, called PLLuM (Kurasinska, 2024). In addition, Poland established an AI centre for military decision-making and created a cyber defence force of 6,500 personnel (Polish Press Agency, 2024). Cybersecurity is a key focus area that provides essential insight into Poland's capability development at the intersection of defence and technology. Poland ranked sixth in the global Cyber Defence Index for 2022–2023 (MIT Technology Review, 2022). The country has invested in space technologies to improve military satellite capabilities by establishing the Geospatial Reconnaissance and Satellite Service Agency. Its national innovation network aligns with NATO's DIANA framework, reflecting a strategic vision to enhance interoperability through a multilateral innovation ecosystem approach.

The Polish Defence Fund (PDF) consolidates the Polish Armaments Group (PGZ) to foster defence innovation. It invests in cutting-edge technology related to AI, uncrewed systems, and advanced materials (Lawrence, 2024). The Polish Development Fund (PFR), announced in July 2023, has invested in the NATO Innovation Fund, a multilateral technology venture capital fund investing in dual-use startups, worth €1 billion (PFR Ventures, 2023). Polish investments in NATO-related programmes, infrastructure, and innovation include PLN 7.8 billion allocated to NATO Security Investment Programme

projects and €42 million invested in the NATO Innovation Fund (Ministry of National Defence, Republic of Poland, 2024a). The PGZ is a state-owned conglomerate of fifty Polish companies, which has increased the global competitiveness of the defence market, doubled production capacity, and integrated international partnerships.

Method

Comparing regional and national innovation

The comparative case study provides an in-depth analysis of the nuances of innovation networks in relation to key variables in the selected regional and national cases. The underlying logic of a regional innovation network is studied through a specific case of national innovation by analysing Poland within NATO DIANA. The multifaceted approach of this study considers a "horizontal look that not only contrasts one case with another, but also traces social actors, documents, or other influences across these cases; a vertical comparison of influences at different levels, from the international to the national to regional and local scales; and a transversal comparison over time" (Bartlett and Vavrus, 2017, p. 14).

This approach seeks to include cultural context and comparison considerations, such that context is "conceptualised as something spatial and relational" (Bartlett and Vavrus, 2017, p. 15). The comparative case study identifies common themes of coordination between national and regional goals through a close analysis of NATO's policy development and Poland's dual-use initiatives. Public–private collaboration is highlighted with specific developments of NATO members, and Poland's defence investment and innovation, which includes materials related to the collaboration with NATO DIANA.

This approach identifies common themes, best practices, and the challenges of adapting security policy to technology. The discussion identifies lessons supporting generalisable strategies tailored to the specific requirements of allies' national innovation networks. Poland was chosen as the primary case study because of its strong network of national public–private partnerships, substantial recent increases in defence spending, active participation in NATO DIANA, and significant investment in the NATO Innovation Fund. Poland provides important lessons on how national innovation networks can complement NATO's strategic approach to emerging security challenges.

Collaborative innovation networks

The comparison identifies similarities and differences between the DIANA regional innovation network and Poland's national innovation ecosystem. An in-depth case study was used to analyse each ecosystem thoroughly. The comparative study focuses on the distinction between a regional innovation network of allies, namely NATO DIANA, and the national innovation network of Poland. The regional focus on NATO DIANA involves the firms, universities, and governments across participating countries of NATO. The regional network is characterised by knowledge pools, complementary expertise, and accelerated innovation cycles through funding and interdisciplinary collaboration.

The national innovation network of Poland connects domestic universities, research institutes, firms, and government bodies, involving openness, density, key stakeholders, and roles in the network (Gomes *et al.*, 2017, p. 3). The national scope fosters innovation

through national policy, local knowledge exchanges, and concentrated investment in research and development. This localised approach uses geographic and social proximity to foster trust, share resources, and structure knowledge transfer at the national level within the context of the regional level of the transatlantic innovation network.

The framework of DIANA provides enhanced learning and the opportunity to leverage complementary best practices from various countries within the alliance. National innovation networks access advanced technologies supporting technological upgrading and improved innovation outcomes (Petraite *et al.*, 2022, p. 2). Multinational networks mediate technological learning and trust among national innovation systems, benefiting domestic innovation strategies (Petraite *et al.*, 2022, p. 5). Regional networks demonstrate the ability to build local innovation capabilities that maximise benefits and support centralised governance and mediation (Petraite *et al.*, 2022, p. 5). In addition, regional innovation networks provide broader access to knowledge, resources, adaptability, and enhanced regional competitiveness, compared to national networks, which rely on domestic policies and government-driven research and development.

Integration within DIANA provides significant opportunities for national innovation, supporting the shaping of policies pivotal to the formation, efficiency, and strategic direction of national innovation networks. A key success factor for regional innovation is flexibility, arising from voluntary participation in open and dynamic networks, which enables adaptation to changing environmental needs (Morisson and Pattinson, 2020, p. 5). Another success factor is diversity among involved actors that allows for broader information flows and effective governance to sustain network activity, while flexibility allows the network to adapt (Morisson and Pattinson, 2020, p. 5). The next section outlines how cooperation among innovation collaborators aligns with support for the initiatives of the regional network. This collaboration highlights Poland's support within the DIANA network and demonstrates how national innovation provides a valued contribution to the regional approach among the network of transatlantic innovators.

Results

Cooperative research

Defence innovation thrives at the intersection of interdisciplinary cooperation and industrial engagement, providing NATO with the tools to adapt to a continuously changing security environment. NATO can coordinate resource deployment with industry alliances and interdisciplinary collaboration to address concerns related to emerging technologies, promoting resilience in a rapidly changing threat landscape. Partnerships between government resources and industry expertise provide cutting-edge technological resources, development, and operationalisation.

Innovation is promoted through information exchange, cooperative research projects, and the spread of best practices to facilitate interdisciplinary cooperation between sectors, including governments, academia, and industry. NATO's accelerator sites foster interdisciplinary collaboration, providing innovators alliance-wide access to facilities, funding, and mentorship (NATO, 2024b). These collaborations maintain creativity among allies while bolstering trust and shared goals. Several test centres and accelerator sites promote innovation by providing mentorship and combining resources to adjust to changing risks, emphasising quick reaction times and supporting multidisciplinary cooperation between public and private sectors.

In April 2024, the NATO Science for Peace and Security (SPS) programme emphasised key focus areas of emerging technologies to counter adversarial uses and novel threats posed by the security implications of advanced technologies (NATO Science for Peace and Security, 2024). This focus underscores NATO's situational awareness, which is evident in the establishment of countermeasures integrating defence, academia, and industry with dual-use innovation based on the NATO SPS programme, to counter adversaries' malicious use of emerging technologies.

The NATO SPS programme highlights the importance of a network approach to addressing critical focus areas, such as climate and energy security, hybrid threats, resilience, cyber defence, and strategic foresight (NATO Science for Peace and Security, 2024). These related efforts demonstrate how integrated innovation targets strengthen defence capabilities. Defence innovation networks support the alignment of workflows among the government, industry, and academic stakeholders. NATO's SPS programme emphasises the value of addressing critical areas related to hybrid threats, cyber defence, and innovation procurement in an integrated manner to help target capability gaps. Enhanced defence capabilities require that NATO expands its network-based approach to foster strong collaboration across sectors, invest in integrated innovation projects, and prioritise resilience to address emerging technologies and security challenges.

Dual-use technologies combine military innovations with civilian applications, offering opportunities for interdisciplinary collaboration. Poland's investment in AI and quantum technologies demonstrates how dual-use innovation can drive defence and civilian advancements (Polish Press Agency, 2024). Poland's increased investment in emerging technologies benefits both military and civilian sectors. Dual-use technologies offer significant interdisciplinary cooperation between military and civilian sectors to promote innovative ecosystems. Knowledge-sharing programmes enhance economic advantages and strengthen defence capabilities in NATO's DIANA network of test centres and accelerators (NATO, 2024b). Joint innovation engagements, such as those between Poland and private industry, further illustrate the strategic and economic benefits of cross-sector collaboration (Czulda, 2024). NATO's DIANA accelerator programme and Poland's joint innovation efforts with industry aim to maximise benefits by sharing information.

Innovation networks operate through built trust and information-sharing, which enhance collaboration between various organisations in national and regional networks. This approach creates "information systems and observations to continuously inform actors with innovation networks… a well-designed information system can guide actors… to ease decision-making processes, to prioritise objectives, and design the most adapted actions" (Morisson and Pattinson, 2020, p. 12). The Polish case suggests how collaboration between regional and national levels support alignment of innovation networks at both levels.

Aligning innovation between DIANA and Poland

Numerous examples depict how Polish innovation is benefited when aligned with NATO's DIANA initiative. Poland has created local accelerators and test centres to enhance its national innovation ecosystems, thereby supporting DIANA and harmonising NATO priorities and national strategies. Poland's defence strategy consistently emphasised alignment between NATO and national interests. The NATO–Poland case demonstrates defence innovation partnerships responding to changing security challenges through collaboration by allies, and involves coordination of resources and committing flexible resilience to adapt to a rapidly evolving threat environment. Interdisciplinary cooperation and defence innovation partnerships have provided allies the ability to rapidly align

commitments and resources to counter security threats. Numerous examples from this approach are detailed, including numerous test centres and accelerators in Poland associated with DIANA, divided according to technology focus areas.

Polish defence industries collaborate with allies to facilitate knowledge transfers and joint venture opportunities through initiatives that facilitate this process. In 2024, Poland hosted the NATO–Ukraine Defence Innovators Forum, which featured 100 start-ups and 400 innovators from seventeen countries, supported by the Polish Ministry of National Defence and national partners to strengthen the allied innovation ecosystem (NATO, 2024d). In 2025, the Ministry of National Defence and Kraków NATO DIANA Accelerator supported the NATO DIANA Defence and Security Days held in Kraków on 5 and 6 February 2025. The event, which included experts, startups, end-users, and investors, aimed to establish collaboration and showcase dual-use technologies (Poznan Supercomputing and Networking Center [PSNC], 2025). Poland's participation in DIANA demonstrates its dedication to dual-use innovation, supported by strong national policies and public–private collaborations.

Numerous national and regional innovation initiatives demonstrate Poland's dual-use commitment. For instance, the Innovation Dual-Use Technology Accelerator (IDA) was launched to assist Polish-registered organisations to address security issues in the Baltic Sea, thereby using regional innovation ecosystems to tackle issues affecting the alliance (Polish Development Fund, 2024). Since its inception in 2023, several Polish firms and institutions that focused on various technologies have joined the DIANA network. The Kraków Accelerator is a NATO DIANA site operated by the University of Science and Technology (AGH) in Kraków and the Kraków Technology Park (Ujazdowski, 2024). The Kraków accelerator focuses on AI and significant data capabilities, promotes dual-use deep tech innovation and supports startups with defence applications (PSNC, 2024). The Polish case demonstrates innovation engagements and collaboration with partners and allies with the aim of contributing to the development of domestic markets and the establishment of a local and national fund supporting domestic engagements.

Numerous other organisations within Poland focus on technological innovation in collaboration with partners and allies, and some of them are presented here with their focus areas to demonstrate the value that Poland gains and adds to the NATO DIANA network. The Łukasiewicz EMAG focuses on cybersecurity, data, analysis, electromagnetic testing, AI data processing, and secure communication (Kraków DIANA Accelerator, 2024). The Łukasiewicz PIAP focuses on robotics, autonomy, hazard detection, AI-driven robotics, and automation technologies. In Warsaw, the Center for Scientific Geospatial Analysis and Satellite Computation (CENAGIS, 2024) focuses on AI research and data.

The PSNC (2024) is located at the Kakolewo Airfield and contributes to advancements in AI, autonomy, and quantum technologies. The Military University of Technology (WAT) is focused on uncrewed systems, mobility testing, and defence R&D autonomy (Kraków DIANA Accelerator, 2024). The Military Institute of Engineering Technology (WITI) is focused on military engineering, materials research, and autonomous systems testing (Kraków DIANA Accelerator, 2024). Poland's involvement in DIANA has enhanced its defence capabilities at the national level, providing lessons on local innovation within the NATO network.

DIANA has provided several clear advantages to Polish companies, such as access to resources and networks through an extensive network of accelerator sites and test centres, seven of which are in Poland. Selected companies received €100,000

to develop and demonstrate innovative technological products in the first phase (Defence Industry Europe, 2024). Successful startups can attract further investment from the €1 billion NATO Innovation Fund, in which Poland has invested a significant amount (PFR Ventures, 2023). Polish innovators work with end users to ensure solutions and receive feedback for development, providing further support for integration with industry.

Participants can access research, infrastructure, and platforms through industry and academic partnerships by collaborating with institutions like AGH University of Kraków and Kraków Technology Park (Gdańsk Tech, 2024). Events that bring international exposure enhance collaboration, such as NATO DIANA Defence and Security Days in Kraków, which connects Polish companies with foreign partners and investors (PSNC, 2025). Another example is the Gdańsk Tech (2024) "Living Lab," which offers Polish companies the opportunity to showcase solutions to potential buyers and increase their exposure.

These numerous examples of Poland's successes in the DIANA network include cases of dual-use technologies developed by Polish companies. In collaboration with the Polish defence industry and naval shipyards, Revobeam by Gdańsk Tech created smart antennas for secure communications, including electronically steerable anti-jamming antennas for uncrewed platforms and IoT devices (NATO DIANA, 2024, p.31). The firm developed a low-cost, energy-efficient anti-jamming antenna for integration with uncrewed aerial vehicle (UAV), in collaboration with UAV manufacturers and the Polish PGZ Naval Shipyard, demonstrating the success of defence sector adoption.

DIANA's 2025 cohort includes four Polish companies focused on wireless communications, robotics, cybersecurity, and quantum technologies: IS-Wireless is advancing secure communications for both civilian and military contexts; Blue Armada Robotics is developing autonomous maritime and aerial robotics platforms for surveillance and environmental monitoring; ResQuant is focused on quantum-resistant encryptions and security solutions to protect critical infrastructure; and Microamp specialises in high-frequency communications for high-capacity data transfers (PSNC, 2025). Table 1 expands on this discussion by presenting a selection of key stakeholders within Poland's national innovation network, divided into three distinct technology categories: AI and big data, quantum technologies, and autonomous systems. Each category includes a DIANA accelerator or test centre in Poland and specific focus area capabilities.

Discussion

Lessons from the DIANA–Poland innovation network

Poland's involvement in DIANA allows the national innovation network to integrate with various local initiatives affiliated with NATO, including the DIANA accelerator in Kraków and numerous other test centres. The integration provides Polish startups and researchers with world-class facilities, mentorship, and markets, such that Polish expertise supports, and is supported by NATO's innovation pipeline (Ujazdowski, 2024). Poland leverages dual-use technologies, focused on civilian and military purposes, to strengthen defence modernisation, resilience, and market opportunities.

Structured collaboration between academia, industry, and governments, such as that involving the AGH University, Kraków Technology Park, and the Ministry of Defence, illustrates an effective structure and a multi-sector collaboration to accelerate deep tech innovation aligned with national development and NATO needs. These observations suggest the importance of NATO's continuing coordination of activities among

Table 1. Selected stakeholders in Poland's national innovation network.

Technology	DIANA–Poland accelerator/test centre	Focus area capabilities
AI and big data	Kraków DIANA Accelerator, AGH University of Krakow, and Krakow Technology Park	AI, big data processing, dual-use deep tech innovation and supporting startups with defence applications
	Łukasiewicz EMAG	Cybersecurity, data analysis, and electromagnetic testing
Quantum technologies	Poznan Supercomputing and Networking Centre (PSNC)	Quantum testing, cryptography, and computing validation
Autonomous systems	Łukasiewicz PIAP	Robotics, autonomy testing, and hazard detection
	Military University of Technology, WAT	Uncrewed systems, mobility testing, and defence R&D
	Military Institute of Engineering Technology, WITI	Military engineering, materials research, and autonomous systems testing

national accelerators, establishing the means for bilateral and multilateral collaboration and partnerships between allies supported by the DIANA framework. Trust-building initiatives involving information-sharing on technological breakthroughs in dual-use innovation underscore the transformative potential of aligning workflows among various stakeholders across sectors. Dual-use technologies support collaboration between defence, industry, and academia to improve civilian industries while bolstering military capabilities.

Lessons from Poland's innovation strategies highlight the importance of aligning national approaches with multilateral defence initiatives like NATO DIANA. Defence research and development function as the foundation of deterrence, enhancing readiness and adaptability while maintaining credibility (Smith, 2023). The cases of multilateral innovation at NATO and localised national innovation in Poland provide generalisable lessons to address emerging technology challenges. National innovation strategies are integrated with regional and international initiatives to support cohesive approaches that enhance defence capabilities. Collaboration between governments, industry, and academia creates robust innovation ecosystems, increasing preparedness, flexibility, and interoperability.

Aligning bilateral and multilateral capacity-building among allies

Poland provides an example of capacity-building within the DIANA framework, as allies collaborate to support strengthened capability development. NATO and allies must prioritise the harmonisation of national innovation strategies with multilateral initiatives to ensure cohesive and scalable approaches to enhancing defence capabilities. Future efforts must foster innovation ecosystems integrating interdisciplinary collaboration to enable effective knowledge-sharing and interoperability among allies.

Efforts to build capacity among allies can leverage shared infrastructure aligned with innovation and common standards to provide structure and inclusive support. Collaboration can focus on specific technologies such that efforts to build capacity are supported by "innovation networks of companies operating in different levels of industrial development,

presenting not only different characteristics and patterns of evolution but also different types of actors in the network composition" (Gomes *et al.*, 2017, p. 10). DIANA provides the framework to account for the cases of evolutionary differences in the study of distinct national innovation networks, based on nuanced differences between bilateral and multilateral capacity-building initiatives.

Innovation networks evolve differently, and the DIANA network facilitates bilateral and multilateral agreements using technology as a focal point to provide capacity-building, which enables stronger and more mature allies to support less mature allies as they foster national capacity. These observations suggest that allies should encourage integrated accelerator and test centre platforms that align national innovation ecosystems with the NATO network to facilitate dual-use technology development and the adoption of engagements to the Kraków and Gdańsk initiatives. Permanent living labs allow for continuous demonstrations and engagement for visibility and adoption of innovative solutions.

Dual-use commercialisation pathways provide policy frameworks that enable startups to scale and sustain innovation for civilian and defence markets to increase defence, resilience and economic impact. Allies must continue to promote cross-border collaboration and knowledge-sharing as well as multinational events, networking, and joint challenges connecting innovators and investors, as seen from Poland's active participation in DIANA. Future research should profile the individual national innovation networks of the thirty-two allies, mapping the interactions between these networks and DIANA, as demonstrated by this research on the case of Poland.

Conclusion

The DIANA–Poland case of regional and national innovation

DIANA is a distributed network of accelerators and test centres that embodies the central characteristics of a regional innovation network, characterized by its geographically dispersed nature and technological focus on dual-use (civil and military) applications (Ricart, 2023). This study has expanded the literature on regional innovation by focusing on the DIANA case, with a transatlantic scope on dual-use technologies. Academic work is just beginning, given DIANA's short history, having become operational in 2023. The DIANA case provides an analysis of the role of local governments and formal institutions in shaping network participation in empirical studies of Polish innovation (Godlewska *et al.*, 2022). This focus on the Polish innovation network within DIANA aims to address limitations in the literature on regional innovation. It highlights how NATO DIANA provides an important and unique case of regional innovation, supported by the significant case of Poland's national innovation.

Future research should address the various challenges encountered by this study, taking into account the limitations faced by the private sector. Navigating the defence sector's procurement, compliance, and regulatory standards is complex, especially for young companies unfamiliar with these processes (Ujazdowski, 2024). Scaling and commercialisation to transition from prototype to market-ready solutions require significant resources, expertise, and support. Innovators within DIANA may receive support that would otherwise be challenging to obtain (Defence Industry Europe, 2024). DIANA involves resource opportunities given that startups often lack the financial, technical, or human resources necessary to rapidly develop, scale, and adapt deep tech solutions for both civilian and defence markets (NATO DIANA, 2024).

NATO DIANA is supported by a consensus-based structuring and leverages global networks to enhance regional innovation through global–local connectivity by strategically connecting with international networks. DIANA fosters dual-use innovation to bridge the civilian and defence sectors, given that many startups lack experience in the defence sector, requiring them to adapt their technologies and models to military requirements, which can be complex and time-consuming (Mundell, 2023). Culture and regulatory barriers can be distinct across business cultures.

The Polish case provides a unique study within the DIANA network, given the specific geographic scope, dual-use focus, and institutional integration across North America and Europe. The existing literature on innovation networks primarily focuses on global and national levels, without addressing the unique opportunities presented by the transatlantic, dual-use context among the thirty-two NATO allies. The institutional governance of DIANA involves a board represented by all NATO nations, with regional offices in London, Halifax, and Tallinn, anchoring its operations across the Atlantic.

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Data Availability Statement

All data used in this study are publicly available in the sources cited in the article.

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