

GOVERNANCE BY NATIONAL ECONOMY

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MILITARY-TECH STARTUPS: NAVIGATING INNOVATION AND RESILIENCE IN EXTREME CONDITIONS

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Abstract

In contemporary global and national challenges, military-tech startups emerge as strategically essential actors in the innovation ecosystem, capable of addressing both security imperatives and technological advancement. The Ukrainian experience demonstrates that under the conditions of armed conflict and economic uncertainty, such startups serve as sources of critical technological solutions for the defense sector and as catalysts for broader economic and industrial resilience. The development of military-tech startups in Ukraine is strategically essential in wartime, characterized by high uncertainty, financial risks, and limited resources.

The purpose of research is to develop a comprehensive approach to the analysis of investment and innovation processes in the regional electricity sector, with a focus on identifying strategic and organizational-economic priorities within the framework of the national energy strategy.

The article analyzes the key factors determining technology startups' sustainability and competitiveness in this area. Particular attention is paid to adapting innovations to the operational needs of military and civilian infrastructure, including developing solutions for security, logistics, communications, and data analytics.

The article considers mechanisms for attracting funding, including venture capital, crowdfunding, and government grant programs, as well as startups' strategies for entering domestic and international markets. Emphasis is placed on institutional and social support from government agencies, international organizations, educational institutions, and innovation clusters.

The article presents successful examples of interaction between entrepreneurs, investors, and government agencies that have accelerated the implementation of advanced technologies and improved operational efficiency. It formulates recommendations to strengthen the military-tech ecosystem in times of crisis, focusing on the need for flexibility in business models, increased collaboration, and the introduction of innovative approaches to risk management.

This study offers a comprehensive approach to assessing and optimizing the potential of Ukrainian startups in wartime, highlighting their key role in strengthening national security and technological leadership.

Keywords: industrial robots, robotics, extreme risks, logistics enterprises, business process optimization, startups, innovations.

JEL: O31, O32, L26, H56, L64, F52, P48

Introduction

Modern challenges, including military conflicts, economic instability, and increased global risks, require technology companies to develop innovative solutions to ensure sustainability and adaptability. Military-tech startups are becoming key players providing unique technological developments that meet defense and civilian needs. In Ukraine, where military actions impose significant restrictions on economic activity, military tech startups play an essential role in shaping the technological landscape and maintaining national security.

In a war environment, startups face unique challenges: the need to quickly scale up, integrate into the defense industry, and attract external financing while minimizing economic risks. The dynamics of the external environment require the development of strategies that allow startups to adapt and remain competitive in local and international markets.

This paper examines key aspects of the sustainable development of military-tech startups, including risk mitigation mechanisms, the use of advanced technologies, and the introduction of innovations in business process management. The focus is on startup sustainability in extreme conditions and the development of strategies that contribute to their long-term development. The obtained results allow us to formulate recommendations for further developing the military-tech ecosystem in Ukraine.

Literature review

Contemporary research is pressingly concerned with the development of startups in conditions of high uncertainty and elevated risks, including economic instability, military conflicts, and geopolitical crises. Central themes include building resilience in business processes, adapting to volatile environments, and leveraging advanced technologies to mitigate risks. These issues are particularly critical for military-tech startups, which operate at the intersection of technological innovation and national security, requiring tailored approaches to address their unique challenges.

Business resilience has been widely examined in academic studies, focusing on its application in crisis. Lin, et al. (2022) explored the use of artificial intelligence to enhance supply chain resilience, emphasizing AI systems' ability to address disruptions in procurement, production, and logistics. Similarly, Nezamoddini, et al. (2020) developed a risk-based optimization model to handle uncertainties in demand fluctuations, facility disruptions, and delays in supply and distribution. Their approach underscores the importance of strategic planning and operational flexibility for startups navigating unstable environments.

Altiparmak, et al. (2006) proposed genetic algorithm-based methods to optimize the performance of supply chain networks, demonstrating how advanced computational techniques can yield efficient solutions for resource allocation and process optimization. These findings are particularly relevant to startups striving to achieve operational efficiency under resource constraints.

Adapting business models to extreme risk conditions is a recurring theme in literature. Gryniv, et al. (2023) highlight the necessity of integrating advanced risk management technologies to build organizational resilience. Barabash et al. (2023) analyze strategies for maintaining the stability of business processes under destabilizing external factors, emphasizing the role of digital tools in fostering adaptability. Sobchuk, et al. (2021) provide insights into resource optimization and rapid response mechanisms that are critical during crises. Pichkur & Sobchuk (2021) investigated flexible governance structures and agile management approaches as essential tools for startups facing elevated risks. These studies demonstrate the need for innovative, adaptable business strategies to ensure sustainability and growth in volatile environments.

The integration of cutting-edge technologies is a cornerstone for the success of military-tech startups. Research by Dzedzickis, et al. (2022) identifies key trends in robotics, such as human-robot collaboration, artificial intelligence, and digitization, which are critical for enhancing operational efficiency and strategic capabilities. Bernardo, et al. (2022) delve into the role of robotics in logistics, particularly in route

optimization, task scheduling, and knowledge representation, noting the importance of semantic knowledge systems for improving collaboration between humans and machines. These technological advancements are particularly relevant to military-tech startups, where precision and reliability are paramount. Adopting these innovations allows such startups to address complex operational challenges while gaining a competitive edge in a high-stakes environment.

Ensuring cybersecurity is a fundamental requirement for military-tech startups, given the critical nature of the information they handle. Research by Yevseiev, et al. (2023) and Svynchuk, et al. (2021) provides detailed analyses of strategies to minimize cyberattack risks. Their findings highlight the importance of algorithms and protocols designed to enhance the resilience of information systems, ensuring the integrity and confidentiality of sensitive data.

Military-tech startups face distinct challenges that set them apart from other sectors. Limited access to financing, navigating regulatory hurdles, and high levels of risk are some of the primary obstacles. Gryniv, et al. (2023) emphasize the role of innovative management tools and cross-sector collaboration in overcoming these challenges. Atzeni, et al. (2021) discuss the benefits of inter-organizational cooperation in mitigating operational costs and facilitating technological advancements. This research is particularly relevant for startups in military tech, where partnerships can accelerate innovation while sharing the burden of high-risk ventures.

In the context of Ukraine, military tech startups operate under exceptionally challenging conditions due to ongoing armed conflict. Gryniv, et al. (2023) and Barabash, et al. (2023) document how Ukrainian entrepreneurs have developed innovative solutions to meet urgent defense needs while adapting to wartime constraints. Sobchuk, et al. (2021) highlight the strategic adaptations made by Ukrainian startups, including restructuring business operations to enhance resource efficiency and resilience.

Despite extensive crisis management and innovation research, the specific challenges face by military-tech startups in wartime conditions remain underexplored. Key issues such as securing investments, managing operational risks, and scaling technological solutions in unstable environments require further investigation. This study aims to fill these gaps by analyzing the sustainable development of military-tech startups in Ukraine, focusing on their operational strategies, resilience mechanisms, and contributions to national security.

By synthesizing these insights, the study seeks to advance understanding of the factors critical to the success and sustainability of military-tech startups, offering valuable guidance for researchers and practitioners alike.

Purpose of research

The research aims to develop a comprehensive approach to analyzing investment and innovation processes in the regional electricity sector, with a focus on identifying strategic and organizational-economic priorities within the framework of the national energy strategy.

Research objectives:

To analyze the current state and trends of investment and innovation activities in the electricity sector at the regional level;

to identify the strategic role of electricity as a key resource for ensuring sustainable socio-economic development of the region.;

to evaluate the institutional and organizational factors influencing the efficiency of energy enterprises;

to substantiate the goals and directions of reforming the electricity sector in the context of global and national energy transformations;

to formulate recommendations for improving the institutional and strategic support of investment-innovation activities in the regional electricity sector.

Materials and methods

In developing this research on military-tech startups, a comprehensive methodological approach was employed to ensure a deep understanding of the challenges and strategies within extreme conditions. The study combined both qualitative and quantitative research methods. Extensive literature reviews focused on recent publications addressing resilience, innovation, and business model adaptation in high-risk environments. This included studies on advanced technologies, supply chain optimization, and risk mitigation.

Primary data were collected through structured interviews with founders and executives of Ukrainian military-tech startups. These interviews explored firsthand experiences, including scaling challenges, resource management, and strategies for technological innovation under wartime constraints. Additionally, data were gathered from government and industry reports, such as those published by Bravel, which provided key insights into grant distribution and investment trends.

Furthermore, a case study approach was used to analyze notable startups' development process and success factors, including the "Baba Yaga" drone initiative. Data on production metrics, investment growth, and employment trends were verified through collaboration with defense industry partners and innovation clusters. Field visits to manufacturing and testing facilities allowed direct observation of production processes and iterative technology improvements under operational conditions.

These methods facilitated a nuanced exploration of macroeconomic influences and micro-level startup operations, formulating actionable recommendations to enhance the sustainability and competitiveness of military-tech enterprises in Ukraine and beyond.

To explore methods for optimizing the development and scaling of military-tech startups under extreme external risks, including limited resources, regulatory complexities, and threats such as those experienced during the armed conflict in Ukraine. The study aims to propose solutions that address operational vulnerabilities, enhance financial sustainability, and foster innovation, thereby supporting the growth and resilience of this critical sector.

Research results

The rapid growth of military tech startups in Ukraine has been propelled by the urgent need to address national security challenges during wartime. These startups operate in an environment characterized by extreme risks, including resource scarcity, logistical difficulties, and constant threats to infrastructure. Despite these challenges, the sector has demonstrated remarkable adaptability and innovation courses with significant support from the government sector and international donors.

The Ministry of Defense and the Ministry of Digital Transformation played a key role in creating conditions for the growth of military tech startups. The introduction of legislative reforms, such as simplifying licensing procedures and aligning production standards with NATO requirements, allowed startups to integrate into global technology chains.

For example, providing startups access to military testing grounds to test products under real combat conditions was a significant step. This accelerated the development process and ensured that products met current wartime requirements.

One of the breakthrough solutions was creating the Bravel platform, which brought together startups, investors, and military experts to collaborate on critical projects. By September 2024, 329 grants had been allocated through this platform, supporting various technologies, from cybersecurity systems to autonomous uncrewed aerial vehicles (UAVs).

In addition, thanks to the implementation of NATO standards (N-CAGE), Ukrainian startups increased the trust of international partners. These codes became a marker of product quality and reliability.

Military-tech startups in Ukraine face several significant challenges:

1. *Financing Constraints.* Many startups struggle to secure sufficient funding. Despite an increase in investment volumes—from \$5 million in 2023 to a projected \$50 million by the end of 2024 – the demand for capital remains high.

2. *Export Restrictions.* Exporting military-grade technologies is heavily regulated, limiting access to international markets and complicating global partnerships.

3. *Resource Shortages.* Limited access to critical materials, coupled with supply chain disruptions caused by ongoing conflict, adds complexity to scaling production.

4. *Operational Risks.* Startups frequently operate in high-risk zones, making infrastructure and personnel safety a constant concern.

Military-tech startups have adopted innovative strategies to overcome these challenges:

1. *Drone Technology.* The production of uncrewed aerial vehicles (UAVs) has significantly increased, with Ukrainian firms scaling capacities to produce up to 4 million units annually. Key advancements include the development of swarm drones, kamikaze UAVs, and reconnaissance drones.

2. *AI Integration.* Many startups are incorporating artificial intelligence to enhance the autonomy and effectiveness of their systems, such as neural networks for target identification and adaptive systems for electronic warfare.

3. *Localized Manufacturing.* Efforts to establish regional production facilities have reduced reliance on imported components, as exemplified by the motor and battery production localization.

The Ukrainian government and private sector have jointly developed a robust support ecosystem to facilitate the growth of military-tech startups:

1. *Grants and Investments:* As of September 2024, programs like Brave1 had awarded over 329 grants totaling \$5 million. These grants support diverse technologies, from robotic systems to electronic warfare tools (Bilousova et al., 2024).

2. *Accelerators and Mentorship:* Initiatives such as the Defense Builder Accelerator provide funding and access to mentorship from industry leaders and military experts (Fig. 1).

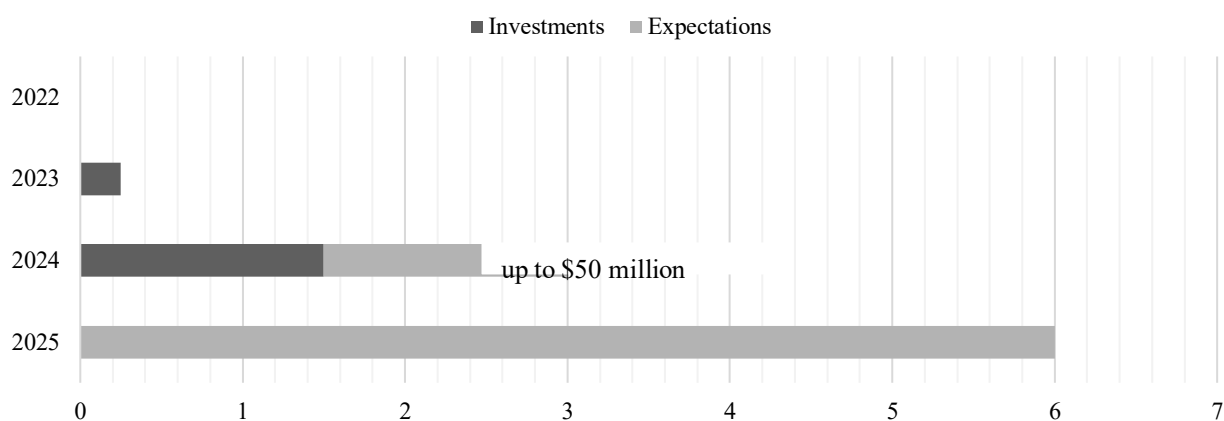


Fig. 1. Investments in Defense Startups, (Bilousova et al., 2024)

Notable Success Stories:

1. *Swarmer:* Specializes in AI-managed drone swarms and raised \$2.7 million in seed funding (Ukrainian Startup Swarmer Closes \$2.7M Seed for Swarm Drones Led by R-G.AI, 2024 (Bajic, 2024; TechUkraine, 2024)).

2. Ailand Systems. Developed autonomous drones for mine detection and secured \$200,000 in investment (The Co-Founders of Ukron Invest \$200k in Ailand Systems, Ukrainian Developer of Drones for Demining (Denysiuk, 2024; Cbinsights, 2025; Crunchbase Inc., 2024).

3. FPV drone production. Several companies have reached mass production levels of up to 12,000 units annually, effectively supplying the Ukrainian Armed Forces. (Kamińska, 2025; Franke, 2025).

Statistical Highlights:

1. *Production Metrics*. As of 2024, Ukraine produces over 3,000 UAVs monthly, with some companies aiming to exceed 10,000 units per month by the year's end (Kamińska, 2025; Bernacchi, 2024; Bezpalko & Danishevskaya, 2024).

2. *Investment Growth*. Funding for military-tech startups has risen sharply, reflecting increased investor confidence and sectoral growth.

3. *Employment Expansion*. As of mid-2024, job postings in the mil tech sector increased by 6.2 times year-over-year, underscoring the rising demand for specialized talent (Bezpalko & Danishevskaya, 2024).

Future Directions:

The military-tech sector in Ukraine is poised for further growth, driven by:

1. Advanced R&D: Investments in AI, robotics, and electronic warfare technologies are expected to expand the capabilities of defense systems.

2. Market Consolidation: As competition intensifies, mergers and acquisitions among startups may streamline the industry and create synergies.

3. International Collaboration: Partnerships with foreign investors and defense organizations are critical for accessing global expertise and expanding market reach.

In conclusion, Ukraine's military tech startups exemplify resilience and innovation under extraordinary circumstances. With continued support from domestic and international stakeholders, the sector holds immense potential to transform defense capabilities and contribute to global security advancements.

Baba Yaga: A Revolutionary Ukrainian Military-Tech Startup

Baba Yaga, an innovative Ukrainian drone project, has revolutionized military technology by providing effective solutions for modern warfare. Designed during the early stages of the Russian-Ukrainian war, this FPV (First Person View) kamikaze drone has proven an effective tool against enemy forces. Named after a legendary Slavic folkloric figure, the startup has developed a reputation for its relentless pursuit of technological excellence and contribution to Ukraine's defensive capabilities. This article explores the journey of Baba Yaga from its inception to its current role in battlefield operations, including the challenges it overcame, its development process, funding strategies, and technological evolution.

Origin and Early Challenges. Baba Yaga's inception was driven by the urgent need for cost-effective and precise weapons to counter armored vehicles and artillery. Initially, skepticism surrounded the use of kamikaze drones, with the market heavily favoring reconnaissance drones. However, the initiative gained traction when soldiers and volunteers began demonstrating their battlefield utility.

The project faced numerous challenges:

1. *Funding Issues*. The startup initially relied on volunteer contributions and crowdfunding, as institutional investment in military technologies was limited.

2. *Component Shortages*. The early models relied on imported parts, such as cameras and sensors, leading to delays caused by disrupted supply chains during wartime. To address this, Baba Yaga is working to localize production where feasible.

3. *Operational Risks*. Testing and production facilities are often located near conflict zones, posing risks to personnel and infrastructure.

4. *Technological Barriers*. Developing a drone capable of carrying explosives while maintaining stability and precision required significant research and testing.

Innovative approaches to these challenges include:

1. *Decentralized Production.* By setting up multiple small production facilities, Baba Yaga minimizes the risk of total disruption during attacks.

2. *Community Engagement.* Leveraging social media and crowdfunding platforms has raised funds and built a strong network of supporters within Ukraine and abroad.

3. *Rapid Prototyping.* Close collaboration with military units allows Baba Yaga to refine its designs based on real-time battlefield needs.

Development Process. The initial prototypes of Baba Yaga were rudimentary and focused on basic flight and payload capabilities. One of the standout aspects of Baba Yaga's operations is the integration of local production networks, allowing for continuous development and iteration of the technology in response to battlefield feedback. This iterative design process ensures that the drones remain relevant and effective in dynamic combat conditions. Through rigorous testing on military training grounds, developers identified areas for improvement. Feedback from field operations led to iterative design enhancements, including:

1. *Enhanced Payload Systems.* Allowing the drone to carry and deploy explosives with precision.

2. *Improved Communication Systems.* Ensuring reliable remote operation even in areas with electronic interference.

3. *Incorporation of AI.* Adding features like object recognition and autonomous navigation to increase mission success rates.

The collaboration between developers, military personnel, and engineers accelerated the refinement process, turning Baba Yaga into a versatile and reliable combat tool.

Current Capabilities & Specifications. The technical specifications of the Baba Yaga drone include (Espresso TV, 2024; Ukraine Today, 2024):

–Six propellers; the same number of mounts for ammunition and several batteries

–Speed–up to 40 km / h with a full load, 80 km / h–without a load.

–Flight altitude–400 m.

–Flight range–10 km.

–Communication range–6 km.

–Flight time–37 minutes without a load and 23 minutes with 10 kg of weight.

In combat conditions and complete darkness, the Baba Yaga drone destroys the workforce, warehouses, and equipment of the occupiers.

Modern iterations of Baba Yaga drones boast impressive features, including:

1. *Payload.* Each drone can deliver up to 20 kg of explosives with high accuracy, allowing it to neutralize heavy equipment such as tanks and artillery.

2. *Range and Speed.* The drones can operate up to 15 kilometers from their launch point at 60-80 km/h speeds.

3. *Night Operations.* Equipped with infrared cameras, they excel in nocturnal missions, making them a “nightmare” for enemy forces.

4. *Cost Efficiency.* Each drone costs approximately \$20,000, significantly lower than many comparable military systems, allowing for mass production and scalability.

Funding and Support. Funding was a critical hurdle initially, with early financing coming from grassroots campaigns and private donations. The Ukrainian government and international allies offered support as the drone's effectiveness became evident.

1. *Crowdfunding Success.* Early campaigns raised thousands of dollars, fueling production and development.

2. *Government Grants.* Platforms like Bravel provided structured financial backing for scaling operations.

3. *International Aid.* Partnerships with foreign technology suppliers enabled access to critical components.



Fig 2. Baba Yaga Drone

Key Benefits and Competitive Advantages of Baba Yaga Drone

1. *Low-Cost Production.* The drones are engineered for affordability, enabling mass production at costs significantly lower than traditional military-grade UAVs. This allows for rapid large-scale scalability and deployment, ensuring that Ukrainian forces maintain a tactical advantage.

2. *High Precision.* Equipped with advanced first-person view (FPV) technology and a manual control system, the drones can deliver precise strikes on armored vehicles, artillery positions, and fortified structures.

3. *Combat-Ready Design:* Payload Capacity: Designed to carry small but lethal explosive charges; Mobility: Lightweight and easy to assemble, allowing soldiers to deploy them within minutes; Range: Effective operational range of several kilometers, depending on battlefield conditions; AI-Enhanced Guidance: Baba Yaga drones incorporate AI-assisted targeting systems to improve maneuverability and accuracy, even in environments with high electronic interference.

The impact of Baba Yaga extends beyond immediate tactical advantages:

1. *Cost-Effective Defense.* Drones' affordability ensures sustained production even under budget constraints, making them a vital asset in prolonged conflicts.

2. *Scalability.* Baba Yaga's approach to mass production and decentralized logistics serves as a model for other startups in the sector.

3. *Future Potential.* Baba Yaga's drones' modular nature and adaptability also position them for civilian applications in disaster management, agriculture, and infrastructure monitoring, ensuring their relevance beyond wartime.

The Baba Yaga drone has become an indispensable tool for Ukrainian forces, combining affordability, precision, and tactical versatility. Its success inspired other startups to develop complementary technologies, further boosting Ukraine's military-tech sector.

The Baba Yaga project exemplifies the resilience and ingenuity of Ukrainian entrepreneurs in the face of adversity. From humble beginnings to a sophisticated military tool, the drone has transformed modern combat strategies and established a benchmark for innovation in military technology. As Baba Yaga continues to refine its technologies and expand its production capabilities, it symbolizes how Ukrainian ingenuity can overcome adversity and make a lasting impact on national defense and global military innovation.

Conclusion

The article comprehensively explores how military-tech startups successfully navigate the interplay between innovation and resilience amidst extreme conditions. Drawing on the Ukrainian context, it sheds light on how these enterprises have leveraged advanced technologies, adapted business models, and fostered robust collaborations with key stakeholders to overcome multifaceted challenges such as economic instability and operational uncertainty. The integration of cutting-edge solutions, including artificial intelligence, robotics, and cybersecurity, demonstrates the transformative capacity of these startups in reshaping modern defense strategies.

The findings underscore that ensuring military-tech enterprises' continued growth and scalability requires a multifaceted approach. Key measures include enhancing localized production to mitigate supply chain disruptions, enacting regulatory reforms to streamline compliance, and cultivating strategic partnerships to facilitate knowledge sharing and resource mobilization. These efforts fortify national defense systems and position military-tech startups as global innovators capable of setting new benchmarks in defense technologies.

The Ukrainian case study provides a compelling example of resilience and innovation under extraordinary circumstances. Startups have employed adaptive strategies and maintained robust stakeholder engagement to thrive in a high-risk environment. However, sustaining this momentum demands resolving systemic barriers such as chronic funding gaps, complex regulatory frameworks, and vulnerabilities in resource logistics.

A holistic policy approach is paramount to overcoming these challenges. This includes fostering a supportive legislative environment, integrating military tech into broader economic and industrial strategies, and leveraging international cooperation to open new markets and secure investments. The evolution of military-tech startups in Ukraine demonstrates their potential to become enduring contributors to national security and global technological progress. Their success reinforces the critical need for sustained investment in innovation ecosystems that align defense priorities with cutting-edge research and development.

In conclusion, the study emphasizes that the strategic development of military-tech startups is a national imperative for Ukraine and a blueprint for advancing defense technology worldwide. By addressing existing barriers and leveraging their inherent adaptability, these startups can serve as catalysts for a new era of security innovation, balancing immediate tactical needs with long-term technological evolution.

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Conflict of Interest None.

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