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BRAVE1 UKRAINIAN DEFENSE INNOVATIONS

Ukraine's Drones Industry: Investments and Product Innovations

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Executive Summary

This report examines the dynamic growth and evolution of Ukraine's drone industry, highlighting the significant investments and innovative product developments that have emerged in response to pressing national defense needs. As the geopolitical landscape continues to evolve, the Ukrainian government has recognized the necessity to scale and localize the production of military equipment, particularly drones, to enhance its defense capabilities. To facilitate this growth, a comprehensive support ecosystem has been established, combining infrastructure development with targeted investments aimed at fostering innovation and local production.

A critical aspect of this ecosystem is the active involvement of investors, who are not only providing capital but are also contributing to technological advancement and deployment. The transition from reliance on angel investors to a broader spectrum of venture capital funding marks a pivotal shift in the investment landscape. The average size of funding rounds has increased significantly, with many startups now raising between $1 million and $3 million, up from the previous average of $500,000. This influx of capital reflects growing confidence in the industry's potential for innovation and profitability.

The report features notable case studies of successful Ukrainian startups, such as Swarmer. Swarmer, which focuses on developing AI solutions for drone swarms, secured $2.7 million in seed funding, demonstrating the viability of its technology in addressing real-world defense challenges.

In addition to investment trends, the report delves into key product development areas within the drone industry, including unmanned aerial vehicles (UAVs), naval drones, ground drones, and electronic warfare systems. Notably, Ukraine's UAV production capacity has undergone a remarkable transformation, evolving from modest early efforts to projections of producing up to 4 million units in 2024. This growth is underpinned by advancements in autonomy, AI integration, and swarm technology, which have fundamentally altered military operational capabilities.

However, the industry faces several challenges that could hinder its progress. These include a lack of financing, restrictions on exports, and competitive pressures from larger international manufacturers. The report underscores the necessity for ongoing innovation and collaboration among industry stakeholders to navigate these hurdles effectively.

In summary, this report articulates a vision for Ukraine's drone industry that is characterized by robust growth, strategic innovation, and significant investment opportunities. The findings emphasize the need for continued support from both domestic and international players to harness the full potential of this burgeoning sector and enhance Ukraine's defense capabilities on the global stage.

Chapter 1. Industry Overview: Trends and Industry Leaders

Support Ecosystem for Drone Development and Investments

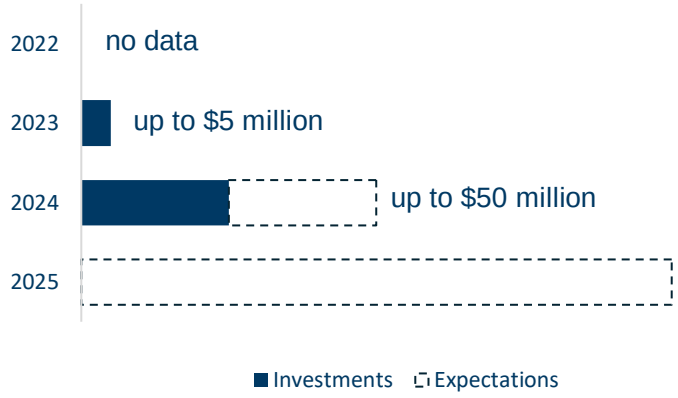
In response to the urgent need to scale and localize the production of military equipment, including drones, Ukraine has developed an infrastructure designed to support both production and development, while also helping attract investment. This structured approach has significantly contributed to the rapid growth of the industry.

The pressing demand for swift innovation and implementation of defense technologies necessitates that investors take on roles beyond simply providing capital. They must actively contribute to expediting technology advancement and deployment by offering mentorship, infrastructure resources, critical networks, and support in overcoming regulatory hurdles. That is why the acceleration model of investments raising has proven highly effective in Ukraine. A significant portion of the investments was secured after the bootcamps.

As companies mature and gain experience, the investment landscape evolves:

- While angel investors were the primary source of capital last year, venture capital funds are now playing a larger role.
- Last year, investments were predominantly from domestic sources, but now the number of foreign investors is steadily increasing.
- The size of investments has grown significantly. Previously, companies typically raised up to $500,000 in seed rounds, but now the average investment ranges from $1 million to $3 million.

Figure 1: Investments in Defense Startups



- There is no data on significant investments in 2022.
- In 2023, startups managed to raise up to **$5 million**.
- In 2024, **$25 million** has already been invested, with expectations of reaching **$50 million** by the end of the year.
- For 2025, investments are projected to grow multiple times, indicating a substantial increase in interest and capital flow into the industry.

Source: Brave1's assessment and expectations

Recent successful cases include:

- **Farsight Vision**, a Ukrainian-Estonian battlefield intelligence platform, that allows drone pilots and users of footage to interact for analytics and situational awareness, using 3D models and orthoimages, successfully raised **€600,000** in investment, with the funding led by the Darkstar coalition.

- **Swarmer**, a Ukrainian startup developing an AI technology called Styx, designed to combine drones into coordinated swarms, has successfully raised **$2.7 million** in investment. The funding round was led by R-G.AI, a U.S. defense technology company, with participation from American funds Radius Capital, Green Flag Ventures, and D3.
- **Osavul**, an AI-powered media intelligence company focused on combating disinformation, has secured a **$3 million** seed investment. The funding came from three European investors: 42CAP, u.ventures, and SMRK.
- **Ailand Systems**, a Kyiv-based startup focused on developing autonomous drones for the remote detection of mines and explosive devices, has received a **$200,000** investment from the co-founders of Uklon.
- **Kara Dag**, a Ukrainian developer specializing in drone countermeasures and electronic warfare systems, has secured an investment from Green Flag Ventures (GFV), the fund led by American entrepreneur Justin Zeefe. One of Kara Dag's standout products is capable of detecting UAVs and saving lives on the battlefield. The amount of investment was not announced.

Case Study: Swarmer

Speak to the Western world in its own language

Swarmer is a Ukrainian startup aimed at scaling autonomous AI solutions for drone swarms, that are not tied to a vendor's platform. Swarmer has successfully closed a $2.7 million seed funding round, with participation from defense technology company R-G.AI, along with American funds Radius Capital, Green Flag Ventures, and D3.

From the outset, Swarmer concentrated on a singular vision—refining their core technology for drone swarms, deliberately avoiding the pitfalls of spreading resources too thinly across multiple directions. This disciplined approach allowed the company to establish a strong technical foundation, positioning it for long-term growth.

The startup’s journey reflects the growing urgency surrounding defense technology innovation. During its early stages, Swarmer secured $50,000 in initial funding with relative ease, largely due to the novel nature of its technology and the pressing need for solutions tailored to the Ukrainian defense landscape. However, as the startup sought to raise $2.5 million, the environment shifted. Investors demanded greater transparency, detailed financial forecasts, operational milestones, and a clear growth trajectory.

Swarmer’s ability to anticipate challenges and prepare accordingly played a critical role in its success. From the outset, the team approached their organizational processes with a long-term strategic perspective, ensuring they were well-positioned for future rounds of investment. By laying this groundwork early, they were able to navigate complex investor expectations and build trust, which proved invaluable as the stakes and funding targets increased.

Company’s strategic focus extended beyond securing capital—it emphasized forming partnerships with investors who could provide not only financial resources but also domain expertise and strategic networks. Cooperation with other key stakeholders in Ukraine's defense sector, such as Brave1, the Ministry of Strategic Industries, and others, has helped with processes such as testing products both on the range and on the front lines, which is crucial to meet the needs of both domestic and international markets.

Company has been concentrated on middle-sized companies in the defense sector, positioning itself for potential future collaboration with larger entities. Ethical concerns surrounding defense technology investments led some investors to shy away from involvement. Additionally, conflicts of interest emerged, particularly among investors already backing similar ventures. Yet, through adaptability and a focused strategy, Swarmer successfully navigated these challenges.

As Swarmer looks ahead to its Series A round, the founders understand that maintaining focus and building on early successes will be crucial. The path forward involves scaling the product, further refining operations, and continuing to attract investors who share the company's vision for sustained innovation in the defense sector.

Key Takeaways:

- Focus on your strengths and excel in what you do best.
- Develop a clear, long-term strategy and a 5+ year development plan.
- Be realistic in your planning, setting achievable milestones.
- Ensure that you maintain reporting and documentation clear and easily understandable to potential investors.
- Equip your team with sufficient skills with focus on further investment attraction.
- Don't cut corners on early stages—invest in proper validation of your ideas.
- Build partnerships not only for funding but also for networking and gaining expertise.
- Maintain open communication with investors throughout the process to build trust and ensure alignment.

Defense Tech Cluster

Brave1 has introduced several initiatives aimed at supporting companies in their development and facilitating connections between investors and companies. One of their key tools is maintaining a database of over 150 venture funds. In addition, Brave1 organizes events where companies can pitch their ideas directly to investors and keeps investors informed about the latest developments in the industry and the most successful teams. This proactive approach has been instrumental in fostering investment opportunities and driving the growth of the sector.

Accelerators and Investors

As outlined above, accelerators have played a key role in the development of investment in Ukrainian defense tech and miltech. In this sector, the roles of accelerator and investor are closely intertwined. Most players serve as both, providing not only capital but also mentorship, resources, and networks to help companies scale and succeed.

Dare to Defend Democracy (D3), a $19 million fund launched in July 2023 with former Google CEO Eric Schmidt among its partners, became one of the first funds to publicly invest in Ukrainian defense startups. Since its inception, the fund has actively supported Ukraine's defense technology sector and currently has 14 companies in its investment portfolio.

MITS Capital was founded in early 2024 by a group of American investors with extensive experience in the defense sector, led by Perry Boyle, a former member of the Point 72 executive committee. To further enhance its strategic capabilities, MITS has also formed a supervisory board comprised of defense industry experts from NATO countries. MITS Capital also offers investment bank advisory and consultant services to Ukrainian defense companies and to NATO-affiliated parties interested in participating in the Ukrainian defense ecosystem.

MITS Capital is the sponsor of MITS Lightning Fund, a venture capital fund that provides seed and growth capital to startups that participate in MITS Accelerator.

Defence Builder is a Ukrainian accelerator for defense startups with a mission to foster the development of the country's defense sector by training new teams and integrating defense and business expertise. The Defence Builder Accelerator program was developed in collaboration with key tech ecosystem leaders, including Genesis, the investment arm of Sigma Software Labs, and the Kyiv School of Economics (KSE). The program's mentors include representatives from Netpeak Group, Skyeton, Airlogix, Finmap, Buntar Aerospace, as well as engineers and military personnel with combat experience who have a deep understanding of battlefield needs.

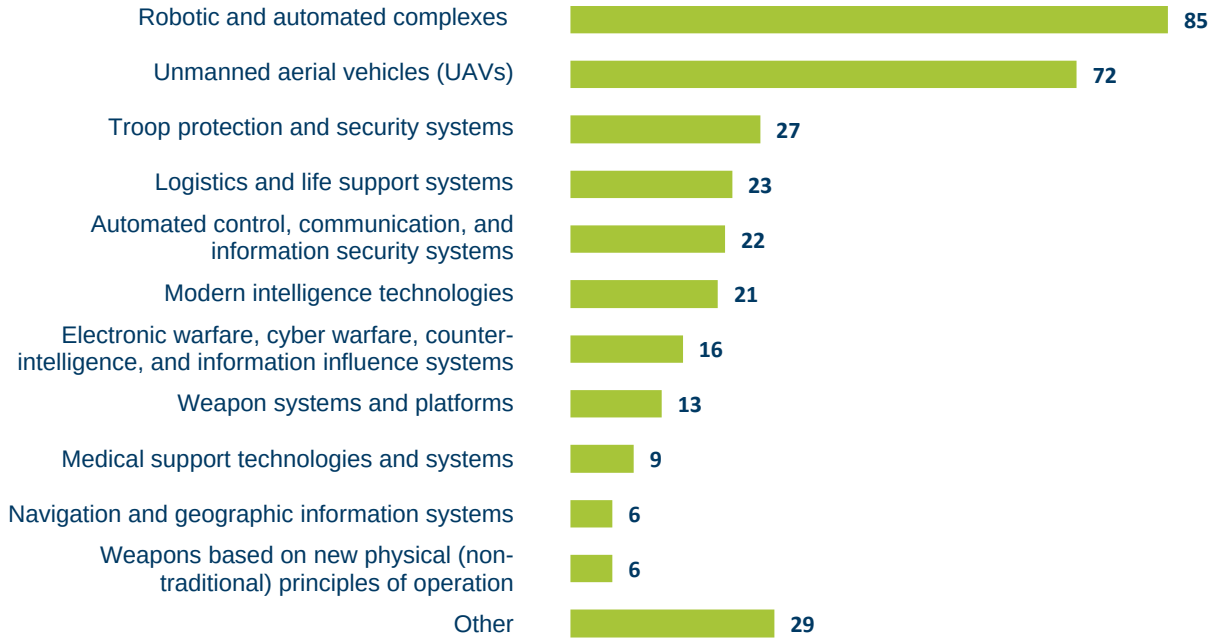
Currently, the Ukrainian startup ecosystem boasts more than two dozen funds, syndicates, and angel investor clubs that are actively seeking opportunities to invest in domestic defense startups. In addition to the aforementioned, other key players in Ukraine's startup ecosystem include the **Ukrainian Startup Fund (USF)**, **Green Flag Ventures (GFV)**, **Innovation Hub**, and **Nezlamni by Uklon**, among others.

Grants

As of September 2024, Brave1 has awarded 329 grants totaling $5 million. Of the grant funds, 44% were used to finance machinery and equipment, 29% for goods and raw materials, and 11% for salaries.

Also, the USF distributes grants for projects related to defense tech via its Dual Use Program.

Figure 2: Grants awarded by Brave1



Source: Brave1

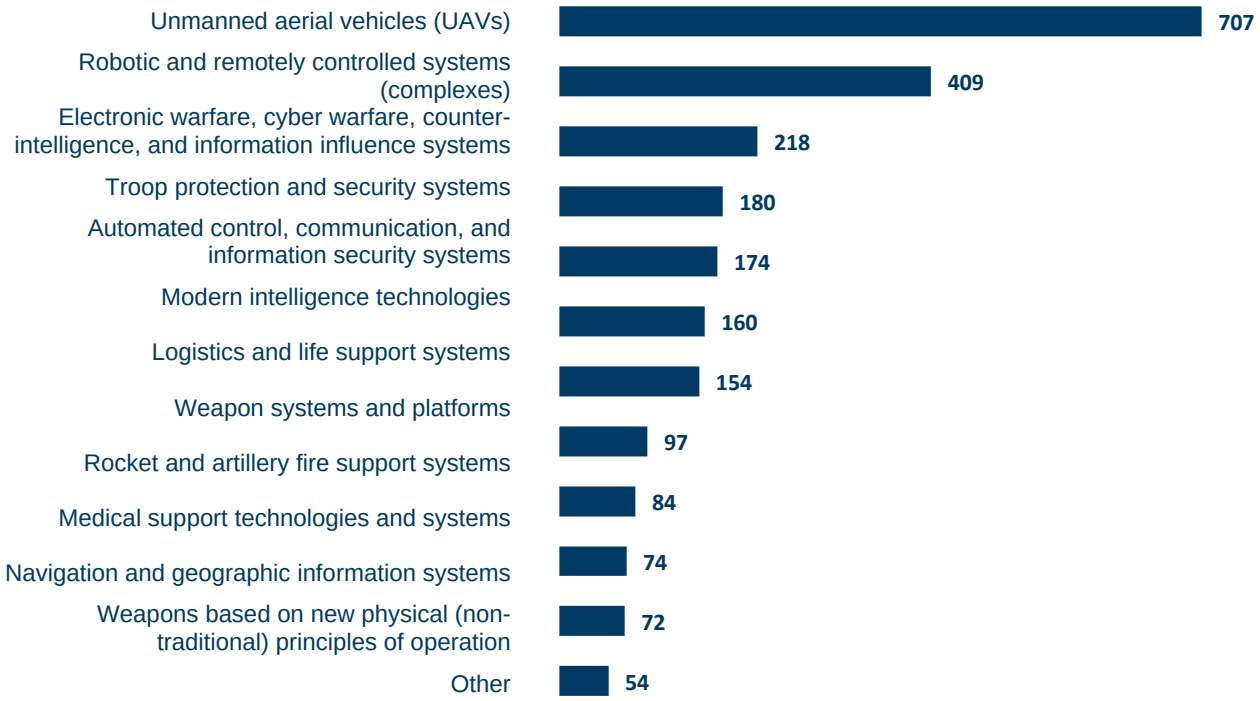
Industry Trends for Producers and Developers

The drone industry in Ukraine has gone through several distinct stages of development:

- **2022: Emergence Phase:** The industry was in its infancy, with most companies just starting up. Many were volunteer-driven, composed of small teams of 3-10 people, and were not primarily focused on investment or profitability. Instead, their main priority was to support Ukraine's defenders.
- **2023: Business Formation:** The industry continued to develop, with more companies beginning to see themselves as businesses rather than volunteer initiatives. Teams expanded, internal processes were established, and the first round of investments was secured by companies like Buntar Aerospace and Himera.
- **2024: Industry Maturation:** The industry has grown significantly. Whereas the government previously sought to procure almost any feasible drone produced domestically, government contracts are now insufficient to sustain all companies. As competition intensifies, companies must either raise investments, merge with other entities, or exit the market.
- **2025: Future Consolidation**: The gap between leading producers and smaller companies is expected to widen, driving further market consolidation. Larger, top-tier producers will likely dominate the industry, leaving others to either collaborate or face challenges in sustaining their operations.

According to Brave1, the dynamics of the industry's development remains strong. Currently, there are over 2,800 applications for various R&D projects.

Figure 3: Current R&D projects in Brave1



Source: Brave1

Additionally, job postings in the miltech sector on DOU increased by 6.2x year-over-year as of June 2024. This significant growth highlights the rapid expansion of the miltech industry in

Ukraine and the rising demand for talent to support innovation and development in the defense technology space[1].

M&A

With the emerging trend of industry consolidation, we anticipate growing opportunities for mergers and acquisitions (M&A). For smaller, less developed companies, this offers a chance to join larger players rather than compete for government contracts. It also provides an opportunity for companies to strengthen their teams with skilled professionals, especially in a challenging labor market. Additionally, M&A can create valuable synergies in organizational processes, technology, and more.

At present, successful examples of M&A in defense tech are rare, but it remains a viable strategy for companies to consider. According to our survey[2], 30% of companies are interested in either the buy or sell side in the future.

Business health

According to the survey, 53% of companies reported net profits of less than 5% or were not profitable at all. Given that 73% of these companies have been operating for less than two years, this is relatively typical for early-stage startups. However, only 30% of respondents indicated that their profits or revenues increased over the past year.

A concerning finding is that nearly half of the companies reported low liquidity, with reserves lasting less than three months.

On a positive note, 26% of companies stated that their investments had already paid off. Additionally, 54% of respondents reinvest more than half of their profits into company and product development, while only 8% do not reinvest their profits. This suggests a strong commitment to growth and innovation within the industry.

[1] AVentures, Dealbook of Ukraine, July, 2024

[2] We conducted a survey as part of our research and received a total of 99 responses. While we believe these responses provide valuable insights, it is important to note that the relatively low response rate may limit the representativeness of the findings. As such, the results should be interpreted with caution and may not fully reflect the broader population's views or experiences.

Chapter 2. Product Development Trends

Unmanned Aerial Vehicles (UAVs)

Since the onset of the war in 2014, the landscape of unmanned aerial vehicles (UAVs) in Ukraine has undergone a profound transformation. Initially, UAVs were rare, mainly developed by volunteer initiatives with limited battlefield applications. These early deployments were sporadic, relying on commercially available drones primarily for reconnaissance missions..

Ukraine's UAV production capacity has experienced exponential growth, fueled by strategic efforts to meet escalating battlefield demands, significant investments in research and development (R&D), and the rapid expansion of an ecosystem comprising over 100 companies and developers. In 2022, output was relatively modest, with production numbers ranging from 3,000 to 5,000 units. However, by 2023, this figure had skyrocketed to approximately 300,000 units. Projections for 2024 suggest the country could produce up to 4,000,000 units. While the sheer quantity of drones has surpassed the Ukrainian government's procurement capacity, the industry is now focusing on improving quality and technology.

One pivotal trend in Ukraine's UAV development is the shift towards greater **autonomy**. Traditionally, UAVs required continuous remote piloting, necessitating constant communication with control centers. Advances in artificial intelligence (AI), machine learning (ML), and sensor technologies have enabled UAVs to operate in semi-autonomous or fully autonomous modes. This shift reduces the need for human intervention, increases mission efficiency, and expands operational capabilities in complex combat scenarios. Autonomous UAVs can navigate difficult environments, conduct surveillance, identify targets, and execute missions with minimal direct control, revolutionizing military operations.

Another major advancement is the integration of **computer vision** and real-time data processing. AI-driven computer vision systems allow UAVs to perceive and interpret their surroundings in real-time, which is essential for tasks such as navigation, target identification, and obstacle avoidance. Equipped with high-resolution cameras and LiDAR sensors, these UAVs can map terrain, detect objects, and make decisions on the fly. Their ability to process vast amounts of data instantly enables them to operate effectively in both urban areas and rugged terrains, even under electronic warfare (EW) conditions that attempt to disrupt their operations.

The development of **swarm technology** represents one of the most innovative trends in Ukraine's UAV sector. AI-managed drone swarms can collaborate and coordinate actions without individual human operators. These swarms communicate and exchange data to accomplish collective objectives such as comprehensive surveillance, target acquisition, and simultaneous attacks. The deployment of UAV swarms significantly enhances tactical flexibility, allowing large numbers of drones to penetrate enemy defenses, while ground-based UAVs can provide support to maneuvering troops or clear minefields. This collaborative behavior magnifies the effectiveness of UAV missions, making them a formidable asset in modern warfare.

In addition to technological advancements, Ukraine has diversified its UAV portfolio, introducing specialized types such as carrier drones, target drones, electronic warfare drones, and kamikaze drones. **Carrier drones**, or "aviamatka," act as platforms for deploying other UAVs, extending the operational range and capabilities of the drone fleet. Target drones are used for testing and training purposes, simulating enemy UAVs to assess the effectiveness of defensive measures. **Electronic warfare drones** are designed to disrupt enemy

communications, block GPS signals, and neutralize hostile UAVs. **Kamikaze drones**, meanwhile, are expendable munitions capable of delivering precise strikes against high-value targets at a fraction of the cost of traditional weaponry.

By 2024, Ukraine is transitioning from ad-hoc UAV deployments to a structured, scalable drone production industry. This shift is driven by the need to bolster defense capabilities and maintain technological superiority in an increasingly complex combat environment. Key elements of this strategy include establishing specialized production facilities, investing in R&D, and collaborating with international partners. Ukraine's UAV ecosystem now consists of over 100 companies and developers, with plans to produce more than 200 new UAV models and reach production capacities exceeding 10,000 units per month. This rapidly growing industry not only strengthens Ukraine's defense infrastructure but also positions the country as a major player in the global UAV market.

Deep Strike UAVs

Ukraine has made remarkable progress in the development of Deep Strike Unmanned Aerial Vehicles (UAVs), despite facing significant shortages in funding, financial resources, and technological capabilities. Overcoming these challenges, the country has managed to assemble a diverse fleet of drones capable of delivering strategic blows to enemy targets.

A pivotal factor contributing to this success has been the active involvement of civil society. Volunteer communities have played a major role, both in the development of UAV technologies and in mobilizing financial resources to support these initiatives. By engaging directly in research, development, and fundraising efforts, civilians have not only provided essential support but have also fostered a spirit of collective responsibility and innovation.

Technologically, the UAV sector in Ukraine has evolved through the innovative use of available resources and expertise from various design bureaus and independent enthusiasts. The initial focus has been on developing cost-effective UAVs that can be deployed in military operations, with advancements in aerodynamics, avionics, and data integration. However, the development process involves numerous technical challenges, including takeoff and landing systems, autopilot configurations, and adapting to various operational environments. Effective testing under electronic warfare conditions remains a critical obstacle, as it is difficult to replicate the complexities faced in combat situations due to the long distances.

Another significant challenge for the development and testing of UAVs is the lack of reliable feedback. In situations where it is unclear whether a drone has successfully reached its target, and if it has not, the reason remains unknown, making it difficult to refine and optimize the technology. This lack of critical data hampers the ability of engineers and developers to identify potential flaws, improve performance, and make necessary adjustments to ensure mission success.

As the industry continues to evolve, several trends are shaping the technological development of UAVs in Ukraine. There is a growing emphasis on integrating advanced navigation systems, improving payload capacity, and enhancing stealth capabilities.

Naval Drones

Naval drones have become pivotal assets, fundamentally reshaping traditional naval warfare strategies. Both surface and underwater unmanned systems are now actively deployed, each offering unique capabilities and technical specifications. Surface drones such as "Mykola" "Magura V5", "Mamay" and "Sea Baby" boast high maneuverability, extended operational

ranges, and significant combat payload capacities. For example, the "Magura V5" can reach speeds of up to 43 knots and carry a payload of up to 200 kg, having successfully neutralized multiple Russian vessels in combat scenarios[3]. In contrast, underwater drones like "Toloka" and "Marichka" offer stealth capabilities and the ability to execute sub-surface strikes, complicating enemy detection and interception efforts. These underwater systems are equipped with advanced navigation and communication technologies, including satellite links and robust encryption, which enhance their autonomy and resilience against electronic warfare tactics.

The rapid development and deployment of naval drones by Ukrainian forces underscore the strategic advantage provided by these innovative technologies in maritime operations. Despite initial challenges such as limited infrastructure and the absence of standardized operational protocols, Ukrainian military units swiftly adapted by creating effective tactics and training programs. This adaptability has facilitated the successful integration of naval drones into a variety of missions, including reconnaissance, patrol, and direct offensive actions against Russian naval assets. The efficacy of these drones has forced the Russian military to implement various countermeasures, including the use of aviation assets, ground-based weaponry, and electronic warfare systems to detect and neutralize incoming drones. Nevertheless, Ukrainian naval drones have maintained high operational effectiveness, compelling Russian forces to continuously revise their strategies and invest in more sophisticated defensive technologies. This dynamic has shifted the balance of power in the Black Sea region, highlighting the critical role of unmanned systems in modern naval warfare.

However, the deployment of naval drones is not without significant challenges. One major threat comes from Russian countermeasures, such as helicopters equipped with FPV (First-Person View) drones designed to target and destroy Ukrainian naval systems[4]. These FPV drones, launched from Russian helicopters, significantly enhance the ability to engage naval drones from the air, complicating the defense against aerial threats. The development of more resilient and autonomous systems capable of withstanding these advanced countermeasures is paramount. Additionally, logistical challenges—including maintaining extensive drone fleets and integrating artificial intelligence (AI) for improved decision-making and autonomous operations—require sustained investment and innovation to keep Ukraine's naval drone capabilities at the forefront of maritime warfare.

Ground Drones

In 2014, the production and utilization of ground drones in Ukraine were virtually non-existent, much like the early stages of naval drone development at the time. Ground drones were largely experimental, with only sporadic deployments and no significant integration into military operations. They remained more of a theoretical asset than a practical tool on the battlefield.

However, the landscape rapidly transformed with the full-scale invasion. Ground drones have since emerged as a critical innovation, addressing challenges similar to those faced by naval drones, such as vulnerability to First-Person View (FPV) drone attacks. The development of ground drones accelerated, led by organizations like Brave1, which prioritized the creation and integration of unmanned ground vehicles (UGVs) into military strategies. Today, a diverse range of ground drones exists, from evacuation drones designed to safely transport wounded

[3] Political Science and Security Studies Journal, The role of naval strike drones in the Russia-Ukraine war, June 2024
[4] Militarnyi, The Russian Black Sea Fleet is training to use FPV drones from a helicopter, September 2024

soldiers from combat zones to combat drones equipped with machine guns and grenade launchers capable of engaging enemy positions.

Despite challenges such as the need for secure communications and the high costs associated with developing resilient ground-based systems, the sector is growing swiftly. The continuous innovation and deployment of ground drones not only enhance Ukraine's operational capabilities but also position unmanned ground systems as indispensable assets in modern warfare, significantly reducing risks to human soldiers on the front lines.

Electronic Warfare

As UAVs continue to develop and find broader applications on the battlefield, countermeasures against them are becoming increasingly important and critical for conducting operations both on the front lines and in the rear.

It is evident that air defense forces cannot manage this enemy threat due to the shortage and high cost of air defense missiles. Therefore, innovative approaches are necessary, with electronic warfare being a key strategy.

Currently, Ukraine hosts a fully functional market of EW system manufacturers, with approximately 80 companies developing electronic warfare solutions—a significant increase from just a few a year ago. On the Brave1 platform, there are already over 130 registered EW solutions, the vast majority of which are short-range systems.

At the onset of the full-scale invasion in 2022, EW systems were primarily used for jamming and radio suppression in troop control channels, countering enemy reconnaissance tools, and protecting Ukrainian systems from enemy precision weapons. These early EW systems operated over hundreds of kilometers and were extremely costly.

The use and quality of UAVs were limited to reconnaissance drones and occasional commercial drones such as DJI, which entered the mass market in 2017. For these purposes, EW complexes like Bukovel-AD, NOTA, Anklav, and a limited number of anti-drone guns like Kverthus and SkyWipper were deployed within the Ukrainian Armed Forces and other units, with up to five system manufacturers operating in the market with very limited production capacities.

By 2023, the dynamic use of UAVs had significantly changed, and existing EW capabilities were insufficient to ensure protection and formulate an effective response to UAV threats. Consequently, there was an urgent need to revise approaches and requirements for EW systems, resulting in the creation of a completely new and unique class of short-range EW systems.

These systems are designed to provide individual protection for single soldiers, specific equipment, or groups. The immediate demand for these systems surpassed the existing and potential capacities of current manufacturers, leading to a surge of new players in the market and the search for alternative solutions that are cost-competitive with UAVs.

Thus, an ecosystem of manufacturers and innovators emerged, now comprising:

- Over 100 companies and developers
- Over 200 new products
- Over 30 products codified
- Production capacities exceeding 10,000 units per month

Meanwhile, the rapidly evolving UAV landscape continues to influence the market, necessitating new and faster countermeasures. The technology change cycle does not exceed three months, requiring increasingly rapid approaches to R&D and scaling.

Currently, the primary challenges in countering UAVs in Ukraine stem from the high volume and advanced capabilities of various drone types deployed by adversaries. Enemy forces deploy over 1,000 FPV (First-Person View) drones daily, operating across a wide range of control frequencies both above and below standard bands (400-1200 MHz for control and 1200, 1400, 3300, 4900, 5200, 5800 MHz for video). These FPV drones are particularly difficult to detect and neutralize due to their diverse frequency usage and sheer numbers.

Additionally, customized commercial drones from manufacturers such as Autel and DJI present significant obstacles. These drones are equipped with specialized firmware, extended control and video ranges, external directional antennas, and powerful amplifiers of up to 20 watts, allowing them to launch from distances of up to 2 kilometers. Such modifications render existing electronic warfare (EW) systems less effective, as they struggle to intercept or disable these enhanced UAVs.

Furthermore, the proliferation of reconnaissance drones like Orlan, Supercam, and Zala has intensified, with their numbers soaring to over 100 simultaneously in the airspace. These drones employ advanced technologies and tactics, including flight in radio silence modes within designated areas and the use of repeaters, which further complicates countermeasures.

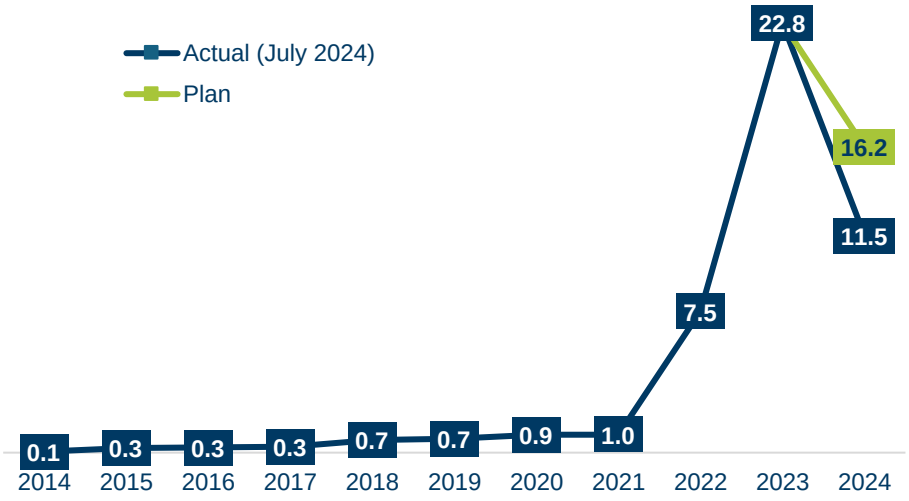
Chapter 3. Issues and Challenges of the Industry

Lack of Financing

Expenditures in the defense and security sector remained a priority throughout 2024. However, the Ministry of Defense's budget for its programs, set at UAH 1,164 billion (approximately $29 billion), is in line with the expenditures from January to August 2023. Given that active military operations are ongoing, the Ministry of Defense will likely need to reassess its budget in the fall of 2024 to ensure sufficient funding for continued defense needs.

Approximately $16.2 billion was budgeted for the development, procurement, modernization, and repair of weapons and military equipment in 2024, representing a 29% decrease compared to actual spending in 2023. Given that by July 2024, the entire $16.2 billion had already been spent, this amount will likely require reassessment as well.

Figure 4: Budget for the Development and Procurement of Weapons



Source: Open Budget

According to the latest budget projection for 2025, a significant increase in this budget line is not anticipated, despite plans to raise certain taxes. However, the Ministry for Strategic Industries of Ukraine reports that Ukrainian arms manufacturers have the capacity to produce three times more weapons and military equipment than the Ukrainian budget can afford to purchase. Their annual production capacity is estimated at **$20 billion**[5]. This creates the growing need for additional financing.

One of the key initiatives addressing the financing gap is Zbroyari, led by the Ministry for Strategic Industries of Ukraine. Zbroyari is a global fundraising campaign aimed at securing $10 billion within a year for the production of Ukrainian weapons. This strategic collection targets partner countries to support the expansion of domestic arms manufacturing. To date, the initiative has successfully raised $750 million, with the highest donations coming from the

[5] Zbroyari, Ministry for Strategic Industries of Ukraine

European Union ($436 million) and Denmark ($215 million), marking a crucial step toward bolstering Ukraine's defense capabilities.

Additionally, on September 18, 2024, the Verkhovna Rada approved the allocation of funds for a new program of affordable loans tailored to defense companies[6]. This program offers preferential lending to manufacturers engaged in the development of Ukraine's defense industry, with an interest rate set at 5%. Companies can borrow up to UAH 100 million for working capital, with a repayment period of up to 3 years, or up to UAH 500 million for investment projects, repayable over 5 years. This concessional lending will be available to enterprises deemed critical to the defense industry by the Ministry for Strategic Industries, helping to strengthen the industrial base essential for Ukraine's national defense. According to our survey, 20.4% of respondents have already raised loans, and 27% of respondents plan to do so in the future.

Attracting investment is another crucial avenue for growth, particularly in the field of unmanned technologies. However, it's important to recognize that investors are primarily drawn to innovations at the intersection of defense and IT. As previously mentioned, ethical considerations often deter investors from engaging directly in military technology (miltech). Additionally, several factors, including the ongoing uncertainty surrounding the war in Ukraine, security risks, and export restrictions, create barriers for companies trying to develop long-term strategies. These obstacles discourage investment in Ukrainian defense companies, limiting their ability to secure funding for growth and innovation.

Restriction of Export

During the period from 2014 to 2018, Ukraine accounted for 1.4% of global arms exports, according to data from the Stockholm International Peace Research Institute (SIPRI)[7]. However, by the 2019 to 2023 period, this share had dropped significantly to 0.4%, representing a sharp 73% decline. In comparison, Russia, while also experiencing a reduction in its global arms exports, saw a less dramatic decrease. Its share fell by 53%, leaving Russia with an 11% stake in global arms exports.

Despite this significant decline, Ukraine maintained its position as the 18th largest arms exporter globally during the 2019–2023 period, according to SIPRI. Its main customers during this time were China (accounting for 59% of exports), Saudi Arabia (12%), and India (11%). These transactions not only contributed to export revenues but also strengthened Ukraine's strategic partnerships with these key countries, reinforcing its role in global defense supply chains despite the overall reduction in its market share.

Ukraine now finds itself in a unique position as both a producer of its own unique technologies, tested in real warfare, and a recipient of high-tech equipment from other nations. This dual role offers Ukraine a distinct advantage, as the practical combat experience gained from deploying its technologies in an active conflict shapes and refines its production capabilities. The unique characteristics and battlefield-proven reliability of these products may be of significant interest to other countries, potentially enhancing Ukraine's position in the global defense market.

To sell weapons on the global market, Ukrainian companies are required to submit an application to the State Export Control Service (SECS). However, since the onset of Russia's

[6] Ministry for Strategic Industries of Ukraine

[7] SIPRI, Trends in international arms transfers, 2023, March, 2024

full-scale invasion on February 24, 2022, the majority of applications from manufacturers have been denied. This is largely due to the pressing need to prioritize Ukraine's national interests, which demand that available resources and military production remain focused on the country's defense efforts. As a result, the export of arms has been heavily restricted during this critical period.

The history of countries involved in wars provides contrasting examples of whether they chose to sell weapons during active conflict. Israel offers a particularly interesting case in this context, demonstrating how a country at war can balance security concerns with arms exports. Despite being in a state of ongoing conflict, Israel has successfully sold surplus military production to bolster its defense industry and foster strategic partnerships.

While safeguarding national interests remains the top priority for Ukraine's defense industry, establishing a well-designed mechanism for arms exports could not only ensure the maintenance of the country's current defense capabilities but also offer significant benefits. A balanced export system could enhance Ukraine's defense potential by generating additional revenues, fostering international partnerships, and improving technological advancements through collaboration.

Additional Export and Tax Revenues

Military production in Ukraine is not evenly distributed across all subsectors, meaning that while the country can produce a surplus of certain types of weapons, it lacks sufficient production capacity in others and requires funds to fill these gaps. Although Ukraine generally relies on military support from other nations, this situation may not apply uniformly across its defense industry. This underutilized capacity could be leveraged for exports.

Exporting arms not only offers a potential solution to capitalize on these excess production capabilities, but it also provides Ukraine with additional funds to invest in the development of new military projects. Moreover, exports could serve as a vital source of foreign currency and tax revenue, helping to strengthen the country's economy during this critical time.

Drone production could serve as a pilot project for reopening Ukraine's arms exports. Since the onset of the full-scale invasion, the drone industry has experienced rapid growth, positioning Ukraine as a significant player in this field. With the industry's swift development, production capacities can be expanded to meet both domestic and foreign demand. Leveraging Ukraine's innovative advancements in drone technology, the country could position itself as a key supplier in the global market, potentially paving the way for broader export opportunities across the defense sector.

Support of Domestic Production

Due to growing competition in a market constrained by government orders, many defense producers in Ukraine face a lack of resources and incentives to expand their production capacity. This situation may led to stagnation within the industry, as companies are not driven to grow and, without opportunities for expansion, they risk falling into decline. As a result, some companies are contemplating relocating abroad to bypass the prohibition on exports, seeking new growth opportunities outside Ukraine.

According to the survey of Tech Force in UA[8], an overwhelming 85% of respondents indicated that they were either considering relocating part of their company outside of Ukraine or had already begun the process. The leading reason for companies considering or relocating abroad is the prohibition on arms exports, cited by 70% of respondents. Following closely,

[8] Tech Force in UA, Forced relocation of arms manufacturers abroad: TFUA survey, August, 2024

62% mentioned missile attacks as a key concern, while 48% pointed to insufficient government orders. Additionally, 38% noted insufficient business profitability and the lack of a consistent government defense order. Other factors include issues with reserving essential personnel (35%) and pressure from law enforcement agencies (35%).

There are already known cases of Ukrainian defense companies moving their production abroad in response to export restrictions. For example, Skyeton has invested €3.5 million in relocating operations, DeViRo has established a company in the Czech Republic, and Ukrspecsystems has set up production in Poland[9].

This trend underscores the pressing need to create favorable conditions for defense companies within Ukraine, as many are looking abroad for growth opportunities and to circumvent export restrictions. Without addressing this issue, the country risks losing significant industry players to foreign markets.

Economy of Scale

The volatile procurement process prevents defense companies from effectively managing their long-term operations, making it difficult to maintain an optimal workforce and adequate stock levels. As a result, costs remain higher than they could be, driving up the per-unit price of military equipment. While stable government contracting could provide some level of predictability for producers, it could also introduce inefficiencies on the frontline. Exporting arms offers a solution by creating additional demand for manufacturers, which in turn could have a positive impact on the domestic market. With increased production volumes, economies of scale could lower the cost of products, making them more affordable for Ukraine's defense forces.

Strategic Military Cooperation

The export of weapons serves as a crucial means of establishing and strengthening strategic partnerships. With Russia failing to meet its commitments on several weapons delivery contracts[10], it risks being perceived as an unreliable contractor by its partners. In contrast, Ukraine has the opportunity to forge strategic partnerships with countries such as India and nations in the Global South. These partnerships not only provide immediate benefits but also create long-term opportunities for Ukraine. Established contracts with foreign customers will help sustain the Ukrainian defense industry after the war, when domestic demand is expected to decrease significantly. By focusing on exports, Ukraine can ensure the continued growth and resilience of its defense sector in the global market.

Challenges for Global Companies in the Ukrainian Drone Industry

Security Concerns

Global companies operating within Ukraine's drone industry face considerable security challenges due to the ongoing war. According to reports by Ekonomichna Pravda[11], GPS trackers have been discovered on trucks at defense enterprises, signaling potential espionage or sabotage attempts. Furthermore, there remains a persistent risk of missile and drone strikes

[9] Ekonomichna Pravda, Ukraine is working on opening arms exports. Why is this necessary during the war?, August 2024
[10] The New Voice of Ukraine, Russia fails to meet its commitments on weapons delivery to India due to war in Ukraine, March 2023
[11] Ekonomichna Pravda, A gift to Russian intelligence. How Ukraine discloses data on its own defense plants, June 2024

by Russia targeting industrial assets. To counter these threats, some companies are exploring the possibility of establishing production facilities underground, offering greater protection against aerial attacks.

Certain Ukrainian enterprises have adapted by renting land and premises in ways that avoid inclusion in public registers, thus enhancing their operational security. However, this practice is unfamiliar to many foreign manufacturers, presenting an additional challenge as they navigate the complexities of the Ukrainian market. Before entering any new market, international companies typically assess all potential risks, with a strong focus on the safety of both employees and assets. This heightened need for security awareness is critical for foreign companies looking to establish operations in Ukraine's defense sector.

Need for a Mentor

Another significant challenge for global companies entering the Ukrainian drone market is the need for comprehensive guidance throughout the adaptation process and market entry. These companies often expect support from mentors who can assist with navigating local laws, certification procedures, and bureaucratic requirements. Such mentors, who may be government-appointed, would provide a step-by-step guide to help bridge cultural differences and align business practices with local norms. This level of support is crucial for successful integration into the Ukrainian market, ensuring that foreign enterprises can efficiently navigate regulatory hurdles and establish a solid operational footing.

Companies should also be prepared to establish processes in Ukraine that may differ significantly from their usual approach in other markets. While external mentors can provide valuable assistance during the early stages of adaptation, the key to long-term success lies in integrating with all key stakeholders within the Ukrainian ecosystem. This includes collaborating closely with defense experts, local manufacturers, and government bodies, as well as tailoring products to meet the specific needs on the frontline. This deep integration will allow companies to better understand local demands and foster stronger, more impactful partnerships within Ukraine's rapidly evolving defense sector.

Additional Resources for Feedback Centers

A critical goal for global companies is the need to develop a system that collects direct feedback from frontline pilots and addresses their operational requirements by establishing a comprehensive support and repair center within Ukraine. This involves setting up effective low-latency communications mechanisms with operators in active war zones, overcoming logistical and security challenges, and investing in local infrastructure and personnel. By directly incorporating pilot feedback and providing on-the-ground support, companies can adapt drones technologies to immediate battlefield needs, improve product performance, and enhance operational readiness.

Case Study: Case Study: Quantum Systems

If You're Not in Ukraine, You Don't Exist

In 2022, the drones developed by Quantum Systems, a company specializing in unmanned aerial vehicles (UAVs), were purchased by Ukrainian volunteers and deployed on the frontline. Their combat effectiveness led to a surge in demand among pilots for training, maintenance, and repair services. Recognizing this critical need, Quantum Systems decided to localize its operations in Ukraine. By 2023, the company had established a Service, Support, Training, and Logistics Center (SSTLC) in Ukraine, followed by local

production and research units. This localization was key to providing timely support and enhancing their UAVs through direct frontline feedback.

Quantum Systems initially focused on training, as their "Vector" drone system required skilled operators. Partnering with Ukrainian Armed Forces' training centers, the company provided pilots with essential knowledge and skills. It then expanded by establishing a local service center to handle repairs and maintenance, reducing equipment downtime.

Despite the security risks of operating in a warzone, the company's German headquarters, led by CEO Florian Seibel, pressed ahead. They saw presence in Ukraine as crucial to staying at the forefront of the evolving UAV industry. By investing in local infrastructure and talent, they gained direct insights and were able to innovate in real time.

Attracting qualified personnel in a conflict zone posed challenges, especially as some employees were subject to military mobilization. Securing strategic enterprise status helped Quantum Systems obtain exemptions for key personnel, while its international footprint aided recruitment by offering opportunities for immediate and long-term career growth.

Drawing on experience from IT support systems, Quantum Systems implemented an automated feedback service, enabling pilots to report issues, seek consultations, and access training resources efficiently. This approach facilitated the systematic collection and analysis of user data, which helped the company identify patterns, address common issues, and make data-driven enhancements to their UAVs.

Frontline feedback led to tangible product improvements. Adjustments included changing the UAVs' color for better camouflage, reinforcing structural components, and integrating anti-jamming GPS antennas. Since the first "Vector" UAVs arrived in Ukraine in 2022, the company has introduced three major revisions. These improvements include the addition of new sensors, an extension of battery life from two to three hours, and ongoing software updates for both the ground station and autopilots, tailored to meet pilots' evolving needs.

One standout project involved equipping UAVs with a domestically produced anti-jamming GPS antenna. The Ukrainian team designed the antenna's casing and installation method from scratch. Integration with the software was achieved through collaboration between the German office and Ukrainian R&D specialists. After rigorous testing, "Vector" UAVs in Ukraine are now equipped with this antenna, representing a fully Ukrainian solution using local components.

Quantum Systems is now tackling challenges common to all UAV manufacturers in the region, such as countering enemy FPV drones. Initially employed by Ukrainian forces to neutralize threats, adversaries have adopted similar tactics to target Ukrainian UAVs. The company is actively exploring countermeasures, with an understanding that multiple solutions will likely be needed, each with varying effectiveness.

Key Takeaways:

- Establishing local operations allows for rapid adaptation and responsiveness.
- Collaborating with local entities who understand the landscape can streamline processes and enhance effectiveness.
- Facilitating easy feedback from end-users supports continuous improvement.
- Attracting and retaining skilled professionals is essential for innovation.
- The ability to adapt quickly to new challenges can distinguish industry leaders.
- Continual product refinement based on real-world use helps maintain relevance and competitive advantage.

Benefits for Global Companies

Global drone manufacturers operating in Ukraine benefit from the unique opportunity to test and refine their products in real-world combat conditions. This dynamic environment presents challenges such as sophisticated electronic warfare tactics, advanced jamming techniques, and threats from enemy drones. The ability to rapidly implement features that address immediate battlefield needs—such as anti-jamming technologies and enhanced camouflage—gives these companies a significant competitive edge over international firms not operating in Ukraine.

A prime example of this advantage is the collaboration between Lithuanian drone manufacturers and the Ukrainian military, which conducted testing in August 2024 to evaluate combat drones under realistic battlefield scenarios[12]. Feedback from Ukrainian military experts resulted in iterative improvements to drone designs and capabilities, ensuring they met the operational requirements of the battlefield. This direct engagement fosters a continuous feedback loop, allowing manufacturers to work closely with Ukrainian engineers to develop new features and adapt technologies based on firsthand experience. As a result, innovation cycles in UAV technology are accelerated, positioning Ukraine as a key player in driving global advancements in the drone industry.

Benefits for Ukraine

Partnerships with international drone manufacturers have significantly accelerated technological innovation within Ukraine's UAV sector. By combining the advanced technologies and expertise of global firms with the practical insights of Ukrainian engineers, these collaborations lead to the development of cutting-edge UAV solutions tailored to modern warfare challenges. This synergy enhances the technical competencies of Ukrainian firms, enabling them to create proprietary technologies and strengthen their competitive position in the global market while benefiting various civilian applications, including agriculture and infrastructure monitoring.

The influx of foreign drone companies stimulates economic growth by attracting investment and creating job opportunities for skilled professionals. Establishing local production facilities and research centers reduces unemployment and boosts regional economic stability. Additionally, the localization of component manufacturing enhances supply chain resilience by mitigating risks associated with international trade disruptions. Developing a domestic supply chain not only ensures a steady supply of critical UAV components but also encourages innovation in local industries, ultimately reducing production costs and enhancing national security by minimizing dependence on foreign suppliers.

Other Issues and Challenges

Brave1 and the KSE Institute have collected feedback from over 90 Ukrainian companies involved in drone development and software creation, identifying several critical issues that impede the industry's growth and operational efficiency. A recent survey revealed significant challenges, including workforce shortages, procurement inefficiencies, competitive pressures, regulatory obstacles, and supply chain disruptions.

Workforce Constraints and Employee Exemptions

[12] Ministry of National Defence Rebublic of Lithuania, Second testing of Lithuanian drones concluded successfully in Ukraine, August 2024

One of the primary concerns is the difficulty in retaining skilled employees due to mobilization process. Companies struggle to reserve key personnel from military service, leading to disruptions in research and development (R&D) activities. The potential loss of specialized staff hampers ongoing projects and significantly slows down innovation within the industry.

Dependence on Imported Components

Ukrainian companies, particularly small manufacturers of FPV drones, are heavily reliant on imported components, with the majority of parts sourced from China. However, efforts are underway to substitute foreign components with domestic or Western alternatives, gradually improving the situation. From January and May 2024, imports of UAV components totaled $41 million, with 89% ($36 million) coming from China, 4% ($1.6 million) from France, and 2.3% ($1 million) from Austria[13]. This heavy dependence on China is a potential vulnerability, as any shortages or export restrictions from China could critically impact Ukrainian drone manufacturers.

Non-Transparent Competition for State Contracts

The process of awarding state contracts is frequently perceived as lacking transparency. Many companies report challenges in understanding the criteria and mechanisms behind contract selection, raising concerns about fairness and equal opportunity. This lack of clarity complicates the ability of businesses, particularly smaller or newer companies, to compete effectively for government contracts, which can hinder the overall growth and innovation within the defense sector.

Competitive Disadvantages Against Large Manufacturers

Ukrainian drone companies face significant challenges in competing with large international manufacturers that benefit from economies of scale. These larger firms can procure components at lower costs through bulk purchasing, allowing them to offer their products at more competitive prices. As a result, smaller Ukrainian companies struggle to match these prices, making it difficult for them to compete.

Regulatory Limitations on Importing Components for Ground-Based Drones

Companies specializing in ground-based unmanned systems face specific regulatory challenges when importing essential components. Current laws do not classify these components as eligible for critical import status, unlike components for other types of unmanned vehicles. As a result, companies struggle to efficiently import the necessary parts for developing and manufacturing ground drones, hindering their ability to scale production and meet growing demands.

Lack of Long-Term Contracting

The absence of long-term contracts with the government creates significant financial uncertainty for drone companies. Without guaranteed future revenue streams, these firms are reluctant to make substantial investments in research and development (R&D) or scale their operations. This lack of stability hampers their ability to innovate and grow, ultimately limiting the industry's potential to meet both domestic and international demands.

[13] The Page, China has restricted the export of parts for UAVs and EW - how will this affect Ukrainian manufacturers, September 2024

Conclusions

In conclusion, Ukraine’s drone industry stands at a crucial juncture, characterized by substantial technological advancements and a growing influx of investments. As the war in Ukraine continues to drive innovation and urgency, the country has emerged as a formidable player in the global drone market, particularly in the context of defense technology. The establishment of a robust support ecosystem has played a pivotal role in facilitating local production, attracting investments, and fostering strategic partnerships that are essential for the industry's continued growth.

The report highlights the strategic initiatives that have propelled the industry forward, including the shift from angel investments to more substantial venture capital funding. As evidenced by successful case studies, startups like Swarmer and Farsight Vision have not only secured significant financial backing but have also demonstrated the potential for groundbreaking technological solutions tailored to meet the unique challenges posed by the ongoing war. This indicates a shift in investor sentiment, with a growing recognition of the potential returns associated with defense-related innovations.

Despite these successes, several challenges persist that could impede the industry’s growth trajectory. Financing gaps, restrictions on arms exports, and the competitive landscape dominated by larger international manufacturers present significant obstacles that must be addressed. For Ukraine’s drone industry to maintain its momentum, it is imperative that stakeholders collaborate to create an environment conducive to sustained innovation. This includes fostering transparency in government contracting processes, enhancing access to funding, and establishing mechanisms to facilitate the export of defense technologies.

The findings underscore the importance of ongoing support from both domestic and international partners. A coordinated effort to build strategic alliances can enhance Ukraine’s position in the global defense supply chain and ensure that its innovations are effectively integrated into broader military strategies. By leveraging the unique insights gained from real-world combat conditions, Ukrainian companies can continue to refine their technologies and maintain a competitive edge in the rapidly evolving drone market.

Ultimately, the future of Ukraine’s drone industry hinges on its ability to adapt to changing circumstances while remaining committed to innovation and collaboration. By prioritizing these values, Ukraine can not only strengthen its national defense but also contribute to the global discourse on military technology, positioning itself as a leader in the advancement of drone capabilities. As the industry evolves, it holds the promise of not only addressing immediate defense needs but also fostering long-term economic growth and resilience within the Ukrainian economy.