Administrative-Legal Regulation of Ukraine's Space Activities: Challenges in Wartime and Strategic Perspectives

Inesa Kostenko

Ph.D. in Law, Fellow Researcher at the University of Leicester (Leicester, United Kingdom), Researcher at the Research Institute of State Building and Local Self-Government of the National Academy of Legal Sciences of Ukraine (Kharkiv, Ukraine)
E-mail: kostenko.inesa@outlook.com
https://orcid.org/0000-0002-8784-5422

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This article examines the administrative and legal mechanisms for coordinating Ukraine's space activities during martial law and post-war recovery. Particular attention is paid to the impact of large-scale armed aggression on the development of the space sector as a strategic factor in ensuring national security and defense capability. The paper highlights the main issues in legal regulation, including the fragmentation of the legislative base, inadequate coordination between state bodies, and weak integration of the private sector. Key areas for reform are analyzed, such as the modernization of the State Space Agency of Ukraine, harmonization of national legislation with international standards, and the development of public-private partnerships. The importance of space technologies in military intelligence, navigation, and communication is underscored, as well as the prospects for attracting foreign investment to develop the sector. The article contains recommendations for enhancing the effectiveness of state policy in the field of space activities and integrating Ukraine into the international space community.

Keywords: *space activities, administrative-legal regulation, public-private partnerships, national security, post-war recovery, international cooperation*

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Introduction

Recent large-scale armed aggression against Ukraine has precipitated pivotal changes in the global security system, highlighting the critical need for an accelerated development of space activities. These activities are increasingly recognized as central to enhancing national security, defense capabilities, and catalyzing the economic revival of the state. In today's context of

hybrid warfare, space technologies are strategically indispensable, serving as essential tools for reconnaissance, navigation, maintaining continuous communication, and swiftly responding to emerging and ongoing threats. Beyond their defense applications, these technologies also hold potential as catalysts for scientific and technical progress, drivers of innovative development, and key facilitators of Ukraine's integration into global economic processes.

Despite the inherent potential, the effective realization of these capabilities is significantly hindered by systemic flaws in state governance, a fragmented legal framework, and a lack of a cohesive strategic vision. The absence of an approved National Space Program and a definitive Strategy for Space Activities between 2018 and 2023 led to planning and coordination discrepancies, which subsequently resulted in suboptimal implementation of national-scale projects. A dispersed array of functions across numerous executive bodies has critically obstructed the development of a unified strategic direction for the industry (Recommendations, 2024).

With the imposition of martial law, the urgency to reform and modernize the governance of space activities has become more pronounced. It is essential to integrate the national space infrastructure more deeply into the broader state security apparatus. This involves the establishment of a robust space monitoring system, the adoption of advanced Earth remote sensing technologies, the expansion of satellite communication capabilities, and the refinement of navigation systems. These initiatives aim to enhance the nation's defensive capabilities, ensure reliable information support, and promote the sustainable advancement of the space sector post-conflict.

Post-War Challenges and Strategic Directions. The post-war reconstruction phase requires a more profound integration of space activities into the strategic dimensions of national policy. This necessitates not only a restructuring of the institutional architecture but also the creation and implementation of innovative administrative and legal frameworks to facilitate effective coordination. Elevating the State Space Agency of Ukraine's status and capabilities becomes crucial, positioning it as a central actor in formulating and executing a comprehensive national space policy. The agency's modernization and technological enhancement are vital for improving the management and coordination of national space initiatives.

Moreover, the extensive consequences of war pose a formidable challenge to the international community, particularly in terms of reconstruction. Kotsur (2023) highlights that these include widespread human casualties, significant environmental degradation across Central and Eastern Europe, extensive land mining, emerging migration issues, and a rise in the number of socially vulnerable populations and individuals suffering from mental health disorders. Ukraine, alongside several European countries, confronts the arduous task of reconstruction, requiring resources that may surpass its current capacities. The potential reduction in material support post-conflict poses significant risks to timely and efficient recovery. However, a model resembling the post-World War II Marshall Plan could provide a structured approach for rapid economic and infrastructural rebuilding, thereby reinforcing Ukraine's role as a robust partner in the international arena and showcasing the effectiveness of democratic solidarity in mitigating authoritarian influences. The EU's backing for Ukraine's swift reconstruction during the 2023 Ukraine-EU summit underscores this strategic pathway (Kotsur, 2023).

Harmonization with International Norms. The synchronization of Ukraine's national legislation with international legal norms in space activities is of paramount importance. This not only enhances the internal capabilities of the sector but also strengthens Ukraine's position as a reliable and competitive partner in the global space community. Future development strategies

in the post-war period should focus on attracting private capital, fostering joint ventures with international partners, and embedding innovative Ukrainian solutions into global value chains. Establishing effective interactions between state structures and private investors is essential for crafting a new governance model for space activities that combines innovation, strategic resilience, and adaptability to modern challenges.

Implications for Policy. This research intends to provide a detailed analysis of the administrative-legal mechanisms coordinating space activities in Ukraine, the challenges faced by the space sector under martial law, and the prospects for reforming space activity management in alignment with strategic national reconstruction priorities post-war. The findings will inform the development of policy recommendations aimed at enhancing the effectiveness of state policy in space activities and ensuring the strategic development of the sector for long-term national and international benefit.

Current state of administrative-legal mechanisms for coordinating space activities in Ukraine

Ukraine possesses considerable potential in the field of space activities, formed through decades of engineering experience, numerous scientific and technical achievements, and an advanced infrastructure inherited from the Soviet era. The uniqueness of the Ukrainian space sector is characterized by a combination of high-level scientific thought, innovative capacity, and a robust industrial base, enabling the implementation of projects both nationally and internationally.

A critical phase in the institutional establishment of space activities was marked by the approval of Ukraine's first five-year State Space Program, adopted by the Cabinet of Ministers of Ukraine on May 25, 1993. This strategic document outlined the main directions for the sector, including the launch of Ukraine's first satellite "Sich-1," the creation of the "Lybid" telecommunications satellite, active international cooperation, and the commercialization of space activities through agreements with leading global space agencies (History, 2024). These initiatives laid the foundation for the independent development of the national space infrastructure and positioned Ukraine as a reliable partner in the international space exploration arena.

A significant achievement of the first program was Ukraine's involvement in international space missions. For instance, on May 13, 1994, following intergovernmental agreements between Ukraine and the USA, an agreement was reached for a Ukrainian astronaut to join the crew of an American spacecraft. The successful launch of the first national satellite "Sich-1" on August 31, 1995, confirmed Ukraine's technical and organizational capability to independently implement large-scale space projects, opening new opportunities for the development of space science and technology.

An important organizational step was the creation of the National Center for Aerospace Education of Youth in June 1996, aimed at training new specialists in the field of space activities. In August of the same year, the National Center for Control and Testing of Space Means was founded, which played a key role in coordinating the activities of the space sector. These institutions facilitated the formation of a comprehensive management system for the space sphere and engaged young people in scientific research, ensuring the continuity of generations of specialists in the field (History, 2024).

A particularly notable achievement was the space flight of Leonid Kadeniuk, the first astronaut of independent Ukraine, who participated in an international mission aboard the space

shuttle "Columbia" in 1997. The mission's program included conducting unique experiments in space botany, aimed at studying the effects of microgravity on plant development. The research findings were of significant value to fundamental science and applied fields such as the agricultural industry and biotechnology. Moreover, the mission had a substantial educational impact, reaching about 40,000 students from Ukraine and the USA, promoting the popularization of science among youth and solidifying Ukraine's international reputation in the space sector (Vavilova, 2023).

In the early 2000s, Ukraine strengthened its position in the international market for space services, establishing itself as one of the leading space nations. This period was marked by active participation in international projects, infrastructure development, and the introduction of innovative technologies in space activities. As noted by Horbulin, Shevtsov, and Shekhovtsov (2000), Ukraine secured a prominent place in the global space services market through the successful implementation of strategic projects and the creation of competitive space systems. One of the most striking achievements of the Ukrainian space industry in the late 1990s and early 2000s was the establishment of joint ventures that implemented significant international projects. In particular, the "Kosmotras" project, aimed at operating the converted SS-18 missile ("Satan") adapted for commercial use under the name "Dnepr," gained special significance. The successful launch of the "Dnepr" rocket on April 21, 1999, demonstrated the high efficiency of conversion rocket technologies as a tool for Ukraine's entry into the international space services market. This project exemplified successful international cooperation for Ukraine, opening new horizons for the use of space technologies for peaceful purposes (Kuznetsov, 2022).

Leading Ukrainian enterprises, the Yangel Design Bureau "Pivdenne" and the Production Association "Pivdenmash" named after O.M. Makarov, have played a pivotal role in advancing the development of the space industry. Their active participation in international projects, such as the launch of the low-orbital satellite system "GlobalStar," has significantly bolstered Ukraine's international reputation as a reliable partner in space technology.

A project of particular importance was the "Sea Launch," which unified the efforts of Ukraine, the USA, Russia, and Norway. Within this program, the "Zenit-3SL" launch vehicle, developed by the Yangel Design Bureau, was used to launch satellites from the "Odyssey" floating sea platform located in the Pacific Ocean. The first successful launch of the "Zenit-3SL" took place on March 28, 1999. The program witnessed a total of 36 launches, demonstrating the high reliability of Ukrainian technologies and the effectiveness of international cooperation. The Ukrainian side, particularly the chief designer of rocket and space direction, Volodymyr Komanov, exhibited a high level of technical expertise and organizational capability in the execution of this ambitious project (Kuznetsov, 2022).

Thus, the early 2000s marked a defining period for Ukraine's integration into the global space market. Through the adoption of innovative technologies, participation in large-scale international projects, and strengthening of its own infrastructure, Ukraine solidified its status as a key player in the global space arena, showcasing high levels of technical excellence and organizational potential. This era not only underscored Ukraine's commitment to space innovation but also set a foundation for future ventures in the international space industry, emphasizing its capability to contribute significantly to global space endeavors.

Institutional Changes and Strengthening International Cooperation. The appointment of Yuriy Alekseyev as the General Director of the State Space Agency of Ukraine (SSAU) in 2005 marked a significant milestone in the transformation of the national space sector. Under

his leadership, the sector saw strategic reforms in management mechanisms, enhancement of international cooperation, and integration of Ukraine into the European space framework.

A key initiative during this period was the Ukrainian-European TWINNING project (2008–2010), implemented in collaboration with France and Germany. The project aimed to deepen interactions between national space agencies, particularly through the exchange of experiences in regulating space activities and improving the normative-legal base. TWINNING served as a platform for harmonizing Ukrainian standards with European ones, strengthening Ukraine's position as a strategic partner to the EU in the space sector (Horbulin, et al., 2000).

A significant achievement in this direction was the signing of several key international agreements. Notably, the Agreement between Ukraine and the European Union on Cooperation concerning the Civil Global Navigation Satellite System Galileo, ratified by the EU on October 8, 2013, opened new opportunities for the development of navigation technologies in Ukraine. This document not only defined the framework for the implementation of modern satellite systems but also consolidated Ukraine's role in creating a global infrastructure for navigation technologies.

Another crucial step was the signing of the Agreement between the Government of Ukraine and the European Space Agency (ESA) on the use of outer space for peaceful purposes. This agreement laid the foundation for creating the "Ukraine-EU" joint working group, which focused on developing long-term cooperation strategies in the space sector. The joint efforts included the implementation of innovative scientific research, the development of cutting-edge technologies, and the initiation of projects in the fields of Earth remote sensing, satellite navigation, and telecommunications (On the Signing, 2008).

Thanks to such initiatives, Ukraine has strengthened its positive image on the international stage, demonstrating a high level of technical and scientific capability in space activities. This has facilitated the formation of new partnerships with leading space nations, expanding opportunities for integration into global programs and enhancing the use of space technologies for civil, scientific, and innovative purposes.

Challenges and Changes in the Administrative-Legal Regulation of Space Activities in Ukraine (2014–2021)

During the period from 2014 to 2021, the State Space Agency of Ukraine (SSAU) underwent significant internal organizational changes that had a profound impact on the strategic management of the space sector. The frequent changes in leadership, with six general directors over this period, posed serious challenges to the implementation of long-term programs. Notably, the fifth State Space Program (2013–2017) was not fully implemented due to systematic funding shortages, instability in management decisions, and frequent adjustments of goals and objectives (Vavilova, 2023).

A significant step in the legal regulation of space activities was the enactment of the Law of Ukraine "On Amendments to Some Laws of Ukraine Regarding State Regulation of Space Activities" in October 2019. This law opened opportunities for entities of all forms of ownership to participate in space activities, crucial for engaging the private sector in the industry. However, significant issues emerged, particularly the underdevelopment of the legal framework necessary for the effective functioning of public-private partnerships, which limited the full realization of the innovations' potential (The Head, 2019).

Further complications in organizational processes were induced by the Cabinet of Ministers of Ukraine's Resolution No. 819 on September 7, 2020, "Some Issues of the Ministry of Strategic Industries of Ukraine." According to this resolution, SSAU was subordinated to the newly

established Ministry of Strategic Industries. This decision provoked mixed reactions among experts. Instead of the expected optimization of management processes, the creation of a new administrative level led to the complication of bureaucratic procedures and further imbalance between the needs of the industry and the capabilities of state management (Kuznetsov, 2022).

Against this backdrop, on April 12, 2021, during an interdepartmental meeting, President Volodymyr Zelenskyy emphasized the necessity to develop a new scientific and technical space program for 2021–2025. However, the absence of a State Space Program since 2018 continued to pose challenges for the sector, which operated without clearly defined priorities, complicating Ukraine's integration into the international space market (Kuznetsov, 2022).

It is also important to note a significant step for Ukraine in December 2020 – the signing of the agreement to participate in NASA's international Artemis program (Artemis, 2020). This program is aimed at returning humans to the Moon and establishing a prolonged presence on its surface, as well as preparing for a manned mission to Mars. Ukraine's participation in the program is significant as it opens new prospects for integrating national space infrastructure into global initiatives involving advanced technologies and international cooperation. This step underscored Ukraine's potential as a reliable partner in space research and laid the groundwork for deepening cooperation with leading space agencies worldwide.

In the contemporary landscape of Ukraine's rocket and space sector, approximately 40 large enterprises operate alongside numerous small and medium-sized companies specializing in the development of innovative solutions, technologies, and scientific research. Key players include the Yangel Design Bureau "Pivdenne" and the production association "Pivdenmash" named after O.M. Makarov in Dnipro. Their activities have led to the creation of over 400 Earth satellites and the development of launch vehicles, control systems, orientation, and flight trajectory systems.

Ukrainian specialists have achieved significant results in the creation of spacecraft such as "Sich-1," "Ocean-O," "AUOS," "Micron," and launch vehicles "Zenit-3SL," "Dnipro," and "Cyclone-3." The "Zenit-3SL" rocket gained international recognition through its participation in the "Sea Launch" program, and "Dnipro" through the conversion of military technologies into commercial satellite launch projects. Moreover, the "Kurs" docking apparatus, developed by Ukrainian specialists, has become a standard for space missions to the International Space Station. The targeting systems developed in Ukraine are actively used in "Soyuz," "Progress," and "Proton" rockets (Koshova, 2022). Ukraine possesses unique ground infrastructure, including control-correction stations for global navigation satellite systems (GNSS) and a network for monitoring geophysical phenomena. Specifically, the National Unified Network of Reference Stations provides high-precision real-time positioning (RTK), along with a network of seismic and geophysical observations that includes the National Data Center of NSSU and the Main Special Control Center (GCSK) (National, 2024).

It is evident that Ukraine has significant potential in the space sector, based on inherited infrastructure, advanced technologies, and engineering expertise. However, despite substantial achievements, the contemporary development of the industry faces several challenges, including instability in administrative-legal regulation, funding deficiencies, and difficulties in implementing strategic programs. For instance, Ukraine's participation in international projects such as "Artemis" and partnerships with the European Space Agency demonstrates potential for further integration into global initiatives, but consolidating these positions necessitates reforming the legal framework and eliminating structural barriers (Beldav & Rokytsky, 2024).

Thus, ensuring management stability and developing a long-term strategy are crucial steps that will allow Ukraine to effectively utilize its scientific and technical potential and strengthen

its position in the global market for space services. The full-scale armed aggression against Ukraine has created new challenges for the space sector, which has become a critically important element of national security and defense. Space technologies play a key role in providing strategic surveillance, reconnaissance, navigation, and communications for military and civilian structures. In these conditions, the development of space infrastructure and the expansion of Earth remote sensing capabilities acquire special significance for effectively managing defense operations and monitoring battlefield conditions.

Space activities in wartime: challenges and issues

The full-scale invasion of Ukraine by Russia in 2022 created unprecedented challenges for the aerospace sector, jeopardizing not only existing programs but also the very scientific and technological base of the country. The destruction of infrastructure, relocation of enterprises, loss of personnel, and constraints on funding for strategic projects have critically impacted Ukraine's ability to implement long-term space initiatives. Preserving scientific and technical potential requires not only state support but also active engagement of international partners and investors (Beldav & Rokytsky, 2024). In this context, coordinating efforts among state institutions, the private sector, and international organizations is crucial to enhancing the competitiveness of Ukraine's aerospace sector and its integration into global defense and research programs.

Today, Ukraine's aerospace sector faces a number of systemic issues that significantly affect its development and efficacy:

1. Lack of a Unified Space Activity Development Strategy. Despite the ambitious goals set in the National Space Program for 2021–2025, the absence of a comprehensive strategy that accounts for new wartime challenges remains a significant obstacle to industry development. Frequent shifts in priorities and the lack of stable funding greatly complicate the implementation of both national and international projects. For example, after the expiration of the previous program in 2017, a new program was not adopted in time, which disrupted the coordination between state and private sector entities in the industry (Vavilova, 2023).
2. Inefficiency in State Administration. The State Space Agency of Ukraine (SSAU) faces numerous administrative challenges. A key issue is the insufficient coordination among executive bodies. The subordination of the SSAU to the Ministry of Strategic Industries in 2020 (Certain, 2020) introduced an additional bureaucratic barrier that reduced the agility in making crucial decisions. The lack of autonomy in funding and management complicates the strategic planning process and increases dependence on political circumstances.
3. Absence of an Effective Public-Private Partnership Model. Despite significant potential for private sector engagement, the legal framework for public-private partnerships in Ukraine's space sector remains underdeveloped. The Law of Ukraine "On Space Activities" (On Space, 1996) partially regulates these relationships but does not create incentives for active participation by private companies. The lack of tax incentives, grant support, and state funding for startups and small enterprises inhibits the development of innovative projects. This situation contrasts with practices in the EU and the USA, where the space sector is actively developing through private investments and state support. Collaboration between government bodies and space enterprises is identified as a key element in forming an effective space policy for any country. However, several main areas can be distinguished:

4. Policy Development and Regulation. Government bodies define strategic policy and develop regulatory norms for space activities, incorporating contributions from space enterprises. Such collaboration helps to create policies that meet industry needs and contribute to achieving national goals.
5. Funding and Investment Support. The state provides funding and offers investment incentives to support innovation, scientific research, development, and the implementation of space programs. This approach stimulates technological development and enhances the industry's competitiveness.
6. Public-Private Partnership (PPP). Government bodies and private space companies join efforts in public-private partnerships. This allows optimal use of resources, distribution of risks, and the creation of joint ventures for the effective execution of space projects.
7. Research and Development (R&D). Joint participation by the state and enterprises in scientific research enables the development of cutting-edge technologies, expands industry capabilities, and addresses common challenges. Such collaboration stimulates innovation and enhances the competitiveness of the space sector.
8. Provision of Infrastructure and Facilities. Government bodies provide access to critical infrastructure objects, such as launch complexes, testing grounds, or communication networks, essential for the implementation of space missions and commercial activities.
9. Facilitating Dialogue and Supporting the Regulatory Environment. Continuous dialogue between the state and space enterprises helps maintain a regulatory environment conducive to industry development, innovation growth, and increased competitiveness (Karpenko, 2023).

1. ***Personnel challenges in the Ukrainian space industry***

The Ukrainian aerospace sector is experiencing a significant brain drain as highly qualified professionals migrate abroad, substantially weakening the country's human resource base. The lack of targeted programs to support young scientists and engineers, insufficient attention to training students in space-related specialties, and the decreasing prestige of working in the industry threaten the future of the aerospace sector. The primary issues are the aging of the scientific and technical workforce and the lack of motivation among young professionals (Koshova, 2022a).

According to the proceedings of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), a key factor in further progress in space exploration and enhancing the effectiveness of space technologies for addressing global challenges is the targeted training of specialists and fostering youth interest in space science and technology. The conference documents emphasize the critical role of the United Nations as a leading organization in space activities, highlighting the need to engage young people in space projects. This includes participation in the development of space technologies, the popularization of scientific and technological achievements, and facilitating the transformation of promising plans into real projects (Koshova, 2022b).

The importance of developing educational programs and stimulating youth to study in the space field through support for STEM education and the creation of innovative centers, such as

the O.M. Makarov National Aerospace Educational Center for Youth, is also emphasized in the Development Strategies 2023 (Recommendations, 2024).

This comprehensive academic analysis highlights the critical challenges in human resources within Ukraine's aerospace sector. It emphasizes the need for strategic interventions to reverse the trends of workforce aging and brain drain, enhancing the sector's capacity to contribute effectively to both national and global space initiatives. The creation of supportive educational environments and the active involvement of youth in space-related activities are deemed essential for revitalizing the sector and securing its future.

2. ***Challenges in funding and investment in the Ukrainian space sector***

The funding of the space sector from the Ukrainian state budget remains limited, especially during war times when priorities shift towards the defense sector. The development program for space activities for 2021-2025 was prepared before the onset of the full-scale invasion, necessitating its review and adaptation to current challenges. During the second reading of the program, amendments were made to accommodate new priorities and timelines that meet the needs of national security and defense of Ukraine. The total funding for the space program from 2021 to 2025 is projected to be 40.78 billion UAH, with 15.76 billion UAH expected from the state budget. The main expenditure directions include:

- Development of rocket and space technology – 7.6 billion UAH;
- Earth observation systems – 3.96 billion UAH (Draft, 2021).

These areas have become particularly significant in the context of increasing demand for satellite reconnaissance, which ensures the country's defense capabilities and situational control at the front. In 2022-2023, funding was maximized due to the need for space technologies for conducting combat operations and planning (Draft, 2021).

The main source of funding is the state budget, however, additional lawful sources such as investments and private contributions are critically important. The coordination of program execution is carried out by the State Space Agency of Ukraine in cooperation with the Ministry of Strategic Industries. A portion of the resources is directed towards fundamental and applied research (3.3 billion UAH), which stimulates innovation and strengthens Ukraine's position in the international space market.

The key strategic priorities highlighted in the recommendations from the joint meeting "Space in Times of War and Peace" emphasize the need for:

- Implementing a new model of space activities that aligns with wartime conditions and national priorities, with a special focus on using space technologies for national security and defense.
- Integrating Ukraine into the European space market through active cooperation with the European Space Agency (ESA) and the implementation of joint projects.
- Optimizing costs by involving the private sector in executing space projects and implementing public-private partnership mechanisms.
- Developing national systems for space situation monitoring and satellite communication, which are critically important for defense and post-war recovery (Recommendations, 2024).

The investment climate and barriers remain a significant challenge, with insufficient levels of investment in the space sector being a key factor. The absence of effective mechanisms for attracting private capital and imperfect legislation that does not stimulate investors is a concern.

A priority is the systematic modernization of legislation and the implementation of incentives for the private sector, including tax breaks and grants.

3. ***Challenges and imperfections in the regulatory framework of Ukraine's space sector***

The legislative framework governing space activities in Ukraine requires modernization to align with current global trends. The existing state of Ukrainian legislation in the space sector does not meet contemporary challenges. The lack of a systematic approach to updating legal norms and integrating international standards into the national legal system significantly limits the industry's capabilities. A crucial task now is the reform of the legal framework considering global trends, focusing on simplifying the processes for licensing and regulating private space activities. Consequently, the current Law of Ukraine "On Space Activities" from 1996 and its associated subordinate legislation require modernization. The legislative framework reveals several critical gaps, including:

- The absence of mechanisms for implementing international standards in space activities, complicating Ukraine's integration into the global space market.
- Outdated licensing procedures that do not reflect the dynamics of the private sector and the concept of "New Space."
- Insufficiently regulated issues of public-private partnerships, hindering the attraction of investments and the creation of innovative startups.

The updated draft of the Strategy for the Development of Space Activities in Ukraine until 2033 emphasizes the need to adopt a new Law of Ukraine "On Space Activities" that will include stimulating norms for investments and development of the private sector, particularly through public-private partnerships (Recommendations, 2024).

Role of the National Targeted Scientific and Technical Space Program

The National Targeted Scientific and Technical Space Program (the Program) is a crucial tool for strategic planning in the space sector. It is developed based on the Law of Ukraine "On Space Activities" and approved by the Verkhovna Rada of Ukraine following a decision by the Cabinet of Ministers of Ukraine. The formation of the program is conducted in collaboration with the State Space Agency of Ukraine (SSAU), research institutions, executive authorities, and the National Academy of Sciences of Ukraine.

In wartime conditions, the Program is vital for ensuring national security and defense, as space technologies facilitate the monitoring of combat operations, missile threat forecasting, and communication under challenging conditions. As noted by Koshova, S.P., the war has underscored the importance of space technologies not only for development but also for the survival of the country (Koshova, 2022a).

Key Directions for Reform:

- Modernization of Licensing: Programs of the European Space Agency (ESA) highlight the importance of creating a transparent and adaptive licensing system to attract the private sector and stimulate innovation. Introducing simplified procedures for new market participants will enable more active involvement of startups and investors in the sector (Recommendations, 2024).
- Implementation of International Standards: Adapting to European Union standards, as outlined in the Strategy until 2033, will create conditions for harmonizing Ukrainian projects with European initiatives such as the Artemis and Horizon Europe programs.

This will open new opportunities for international cooperation (Recommendations, 2024).

- Development of Public-Private Partnerships: The Strategy identifies public-private partnership as a key tool for the development of the space sector. Introducing mechanisms for co-financing, grants, and tax incentives will attract private capital and facilitate the creation of new high-tech products (Karpenko, 2023).

4. *Challenges of operational response to military threats in the Ukrainian space sector*

Satellite technologies play a decisive role in modern military conflicts by providing intelligence, navigation, and communication capabilities. For Ukraine, which is countering Russian aggression, having its own satellite resources is crucial for autonomous decision-making and effective conduct of combat operations. However, limitations in national space capabilities and dependence on data from international partners pose significant challenges for the country's defense capabilities (Borisikhina, 2022).

Limitations of National Satellite Resources Currently, Ukraine possesses a limited number of its own satellites for Earth remote sensing. The launch of the "Sich-2-30" satellite in 2022 was a significant step forward, yet its technical capabilities do not fully meet the military's need for high-precision data (The Ukrainian, 2021).

Dependence on International Partners Due to the limited capabilities of Ukrainian satellite systems, Ukraine must rely on data from international partners and private companies. A notable example is the collaboration with the Finnish company ICEYE, which provides Ukraine with access to satellite images using Synthetic Aperture Radar (SAR). This was made possible through a crowdfunding campaign led by Sergiy Prytula, which raised approximately 16.3 million euros for purchasing satellite images and a contract for using the ICEYE satellite (The People's, 2023).

The dependence on ICEYE satellites, while beneficial, does not provide full autonomy. Risks include potential access restrictions or delays in critical information if conflicts escalate or if there are disruptions in partner operations.

For instance, satellite images from MAXAR Technologies have been crucial in assessing damages in Bakhmut and other hotspots, demonstrating the importance of foreign assistance but also highlighting vulnerabilities due to the lack of own resources (The Obliteration, 2023).

Although international support offers significant advantages, it comes with risks of limited control over data and potential delays in processing. According to research by Groundstation, the effectiveness of operations often depends on external commercial structures, complicating immediate responses to changing situations (Veritas, 2023).

Successful Use of Satellite Data A key case was the destruction of Russian ammunition depots and equipment facilitated by images from ICEYE satellites. Within six months of acquiring the satellite, Ukrainian intelligence inflicted billions of dollars in damages on enemy military assets, enabled by the satellites' ability to operate independently of weather conditions and time of day (The People's, 2023).

Impact on Decision-Making Speed Satellite data are critical in planning military operations. Having accurate and timely data from space reduces risks to military units, increases the effectiveness of strikes, and minimizes the likelihood of errors. However, dependence on international partners carries the risk of delays in image delivery and possible restrictions on certain areas or strategic assets. For example, companies may refuse to provide images of certain

regions or impose restrictions on the frequency of information updates, significantly reducing command responsiveness.

Other countries' experiences underscore the importance of developing national space capabilities for national security. For example, Finland actively cooperates with Ukraine in the field of satellite technologies, providing access to its resources and helping to develop national capabilities (How, 2023).

This highlights the importance of international cooperation but also points to the need for investment in own technologies. Essential development directions include:

- Developing a national space program: Investing in creating and launching own satellites to ensure independence in intelligence gathering.
- Strengthening cooperation with international partners: Continuing collaboration with companies like ICEYE to access advanced technologies and share expertise.
- Developing ground infrastructure: Creating modern centers for processing and analyzing satellite data to improve the speed and accuracy of decision-making.

The limitations of own satellite resources and dependence on international partners significantly affect Ukraine's defense capabilities. Developing national space capabilities is a strategic step towards ensuring autonomy in decision-making and enhancing the effectiveness of military operations.

Administrative and legal pathways for modernizing space activity management

Effective normative and legal regulation is essential for the development of Ukraine's space sector. It determines the main directions of management, allowing for a systematic and long-term approach to the implementation of state policy in this area. As noted in recent studies, the effectiveness of regulation largely depends on the refinement of national legislation and a thorough analysis of international legal documents that form the legal basis for space activities (Koshova, 2022b).

The legal framework for space activity in Ukraine consists of a combination of laws, presidential decrees, and regulatory acts of the Cabinet of Ministers. For instance, the primary document, the Law of Ukraine "On Space Activity" dated November 15, 1996, No. 502/96-VR, establishes general principles, directions of state management, rules of activity in the space sphere, and specifics of forming national programs. Other important acts like the Law of Ukraine "On State Support for Space Activity" dated March 16, 2000, No. 1559-III, regulate financing and development of the technological and export potential of the industry.

Presidential decrees play a crucial role, for example, "On the Establishment of the National Space Agency of Ukraine" dated February 29, 1992, No. 117, which defined the legal status and tasks of this institution, and "On the National Center for the Control and Testing of Space Means" dated August 12, 1996, No. 698/96, which establishes procedures for rapid response to potential threats to national security. Regulatory acts of the Cabinet of Ministers, such as the "Regulation on the State Space Agency of Ukraine," approved by the resolution dated May 14, 2015, No. 281, ensure the implementation of state policy in the space sector.

However, as highlighted during the recent joint meeting "Space in Times of War and Peace. Strategic Orientations and Priorities," there is a significant need for modernization of the management system of space activities. Participants noted that space technologies are critically important for ensuring security, defense, and sustainable development of Ukraine. They are an

integral part of digitalization systems for the economy and national security. The priority lies in developing national ground monitoring systems, satellite communications, and navigation (Recommendations, 2024).

There is an urgent need to develop a new Space Strategy for Ukraine, which would include measures to reform the space industry, define key directions for international cooperation, and create a coordinating body at the level of the Cabinet of Ministers of Ukraine. A special emphasis is placed on implementing public-private partnerships to stimulate the development of the "New Space" sector, which would allow private business to engage in prospective space projects (Recommendations, 2024).

The discussion of "administrative-legal regulation" in the context of public-private partnership in Ukraine's space sector emphasizes its application not just as a means for managing administrative service fees but as a broader regulatory mechanism. This term, when used in this specialized governance context, signifies the actions of governmental entities concerning their authoritative powers aimed at ensuring public interests. This shift toward a more expansive approach to "administrative-legal regulation" is apparent in its detailed inclusion in legislative texts, such as the Tax Code of Ukraine, which outlines the administration of taxes, duties, customs payments, and social security contributions as comprehensive actions and procedures by regulatory bodies.

The notion of "administrative-legal regulation" in public-private partnerships within the space sector could be more effectively characterized by establishing clearer definitions and norms. Such a redefinition would help clarify the roles and responsibilities of public and private sectors in managing space activities, thereby fostering a more transparent and structured approach to governance. This, in turn, could lead to more efficient management and implementation of space projects and policies, crucial for enhancing the country's defense, security, and sustainable development capabilities (Karpenko, 2023a).

Future efforts should focus on refining the theoretical framework around this term to achieve doctrinal clarity, which would facilitate its formal integration into the legal system. As this term has varying interpretations, achieving consensus on its definition could streamline regulatory practices and enhance the efficacy of public administration in Ukraine's space sector. Thus, the modernization of administrative-legal regulation in this field should be seen as an ongoing priority, essential for aligning national governance strategies with contemporary space industry challenges and opportunities.

Yet, as of 2023, the need for modernization of space activity management was actively discussed in Ukraine, defining it as one of the key directions of state policy in the areas of security and technological development. The draft Strategy for the Development of Space Activities in Ukraine up to 2033 was presented to the Cabinet of Ministers, emphasizing the critical importance of space technologies for defense capability, sustainable development, and the digitalization of the economy. In particular, the document stated that the full-scale military aggression of the Russian Federation brought to the fore the need to use space technologies for controlling state borders, monitoring military groupings, planning defense operations, and managing emergency situations (Draft, 2023).

The Strategy envisaged radical changes in approaches to space activities, aimed at creating new jobs, increasing the level of national security, and integrating Ukraine into the European space market. The document emphasized the necessity of developing a new edition of the Law of Ukraine "On Space Activity," corporatizing state enterprises, creating a "space holding," and engaging the private sector in the development of the "New Space" sector. It also planned

to restore scientific and production capacities and create new technological chains capable of producing competitive space technology. A special focus was placed on integrating Ukraine into the European Space Agency (ESA) and participating in international projects such as "Artemis" and "Moon Village." Meanwhile, it was emphasized the need to activate Ukraine's activities in international organizations related to the use of space (Draft, 2023).

Despite the ambitiousness and relevance of the Space Activity Development Strategy for Ukraine, its non-adoption at the state level by the end of 2023 indicates the presence of deep systemic problems in the field of strategic planning, management, and coordination among state authorities. One of the key obstacles remains the lack of an integrated approach to developing the space sector, reflecting the fragmentation of the legal base, insufficient inter-agency cooperation, and weak interaction with the private sector.

An important aspect is that in the context of current geopolitical challenges, space activity is considered a critically important component for ensuring defense capability and national security. In 2023, the Organisation for Economic Co-operation and Development (OECD) highlighted the significance of space technologies for monitoring military threats, which has become particularly relevant in the context of the war in Ukraine. According to OECD data, the use of space apparatuses for tracking military equipment movements and coordinating defense operations is a strategic tool in the fight for territorial integrity (How, 2023).

However, the lack of adequate state funding for the space sector leads to the stagnation of many promising projects. Regular delays in the allocation of budget funds and the imperfection of public-private partnership procedures significantly reduce Ukraine's competitiveness on the international arena. As noted in an analytical report by New York Post, the successes of companies such as SpaceX have been made possible by close collaboration with NASA and significant investments from the US government (Tapscott, 2024). In contrast, in Ukraine, cooperation between the state and private business remains at a conceptual level, which prevents the rapid implementation of space initiatives and the commercialization of the industry. Additionally, significant technological dependence on foreign partners, particularly until 2014 from the Russian Federation, creates additional barriers to the development of domestic production of space technology. The lack of large-scale import substitution programs and limited access to modern technologies lead to the loss of competitive positions in the global market. This is exacerbated by a personnel shortage and the emigration of specialists abroad, which makes it impossible to implement large engineering projects in a short time (How, 2023).

A significant factor in stagnation is also insufficient coordination among state bodies, which creates a legal vacuum and limits the opportunities for the development of the private sector. The imperfection in the legal regulation of space activity is manifested in the fragmentation of the legislative base and the absence of a single coordination center (Semenyaka, 2021).

In light of the above, the absence of an adopted Strategy for the Development of Space Activities is a critical factor that slows down Ukraine's integration into European and global space projects. To address this issue, it is necessary to:

- Develop an effective public-private partnership mechanism, taking into account the experience of ESA and NASA.
- Introduce clear financial incentives for private sector investment in the space industry.
- Activate efforts on import substitution and the development of own technologies.
- Create a single coordination center that will provide comprehensive management and coordination of inter-agency space projects.

Thus, the acceleration of the adoption of the Strategy and its further implementation will allow Ukraine to reach a qualitatively new level of space activity and ensure its integration into the international space community.

Conclusions

This study has focused on exploring the impact of the state of war on the functioning of the space sector. It was found that space technologies play a crucial role in ensuring national security, strategic defense, and territorial monitoring. However, infrastructure destruction, limited funding, and the emigration of highly skilled personnel significantly complicate the implementation of national space programs. The analysis highlights Ukraine's critical dependency on international partners for satellite reconnaissance, communications, and navigation, which introduces additional risk factors in a wartime context.

A set of administrative and legal measures aimed at overcoming the identified challenges and creating favorable conditions for the modernization of the space sector is proposed. The necessity of adopting a new version of the Law of Ukraine "On Space Activity" is emphasized, along with the development and implementation of a National Space Program that meets current challenges and priorities. Special emphasis is placed on creating a single coordination center capable of providing integrated management of space projects and enhancing the efficiency of collaboration between the public and private sectors.

The research underscores the importance of harmonizing national legislation with European and international standards in space law. A priority direction is identified as enhancing cooperation with the European Space Agency (ESA), NASA, and other leading space agencies, which will allow Ukraine to consolidate its position on the international stage and facilitate the attraction of investments into the space sector. Ultimately, the implementation of the outlined measures will promote the development of national space infrastructure, strengthen defense capabilities, and integrate Ukraine into the global space community.

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