

The issue of using unmanned aerial vehicles during armed conflicts in the 21st century

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Abstract— The article analyzes the growing role of drones in modern military operations and their impact on modern battlefields. The aim of the article was to present the evolution of unmanned aerial vehicle technology, their application in various types of armed conflicts and to identify key challenges related to their use. The research was conducted by analyzing literature, reports and international documents. The article discusses three main aspects of the use of unmanned aerial vehicles. The work focuses on the genesis and development of drone technology, presenting their first intelligence applications and their later transformation into a key combat tool. The article analyzes the contemporary applications of unmanned aerial vehicles, taking into account their importance in asymmetric, hybrid and special operations. Attention is paid to their role in intelligence collection, precision attacks and military logistics. The work also focuses on the future of drones, the development of autonomous technologies and the legal and ethical challenges resulting from their use. Particular emphasis is placed on the problems of responsibility for combat decisions and the risks associated with the autonomy of systems based on artificial intelligence. The research results indicate the growing importance of unmanned aerial vehicles in modern armed conflicts, both in terms of operational effectiveness and minimizing the risk to personnel. At the same time, significant challenges have been identified, such as the need to adapt military strategies, the development of defense systems and the need to develop international legal regulations regarding their use. The conclusions from the conducted research confirm that unmanned aerial vehicles will play an increasingly important role in future armed conflicts. However, their growing presence on the

battlefield requires a responsible approach, especially in the field of legal and ethical regulations and integration with existing combat systems.

Keywords— Unmanned aerial vehicles, new technologies, security, armed conflicts, military weapons.

I. INTRODUCTION

Unmanned aerial vehicles (UAVs), popularly known as drones, have become one of the most groundbreaking tools used in military operations in the 21st century. Their dynamic technological development, versatility of applications and growing role on the battlefield have made UAVs play a key role in modern armed conflicts today. Initially used only for reconnaissance and intelligence purposes, over time they have become an important element of combat operations, enabling precise attacks, real-time data collection and conducting operations in difficult and inaccessible conditions.

The development of drone technology allows for the implementation of increasingly complex missions, and their increasing autonomy poses new challenges for modern armed forces related to the integration of these systems with traditional forms of combat. Modern conflicts, especially those of an asymmetric and hybrid nature, show the wide range of



possibilities offered by UAVs, while at the same time revealing gaps in defense systems and issues related to ethics and international law. The use of drones raises many controversies, especially in the context of protecting civilians, responsibility for combat decisions and the autonomy of systems based on artificial intelligence.

The aim of this work is to analyze the use of unmanned aerial vehicles in armed conflicts in the 21st century, with particular emphasis on their technological evolution, impact on the conduct of warfare and challenges related to their growing presence on modern battlefields. The work will discuss both the technical aspects of drones, their integration with modern combat systems, and the ethical and legal issues that accompany their use in war operations.

Chapter one is devoted to the genesis and development of UAV technology, as well as their use in conflicts to date. The second chapter focuses on contemporary applications of drones, analyzing their impact on military strategy and operational activities in various conflicts. The third chapter is an attempt to look into the future - it discusses the potential directions of technological development of UAVs, as well as the challenges facing the armies of states and the international community, especially in the context of legal and ethical regulations related to their use.

In the face of dynamic changes in the way military operations are conducted, drones are becoming an indispensable element of modern armed forces. Their further development will be crucial not only for the effectiveness of military operations, but also for shaping future regulations regarding the use of modern combat technologies. This work aims to bring closer the issue of the use of unmanned aerial vehicles in both the technological and ethical-legal context, which can be a valuable contribution to the discussion on the future of war in the era of modern technologies.]

II. EVOLUTION AND DEVELOPMENT OF UNMANNED AERIAL VEHICLE TECHNOLOGY

Unmanned aerial vehicles (UAVs), commonly referred to as drones, have become an integral part of modern armed forces, significantly influencing the way war operations are conducted. UAVs are flying units that can be remotely controlled or operate autonomously based on programmed tasks and artificial intelligence systems. Depending on their purpose, they can perform a variety of roles - from reconnaissance to direct combat operations. Drones are classified according to various criteria, such as range of operation, maximum flight altitude, time in the air or combat capabilities. The most general classification includes tactical, operational and strategic drones, which reflects the scope of their applications (A. Konert, P. Kasprzyk 2021, p. 2).

Tactical drones are small units with limited range and operational time, usually used for local missions, such as observing the battlefield or providing precise intelligence data in real time. In turn, operational drones, such as the MQ-1 Predator, can conduct more complex operations at longer

distances, often equipped with precision weapons. Strategic drones, such as the MQ-9 Reaper, are designed for long-range operations and can operate autonomously, using advanced navigation systems and artificial intelligence to identify and neutralize targets (J. Adamski, 2007, pp. 50-52).

The origins of unmanned aerial vehicle technology date back to World War I, when the first experimental flying machines, such as aerial torpedoes, appeared. However, the real development of this technology took place only after World War II, when the USA and the Soviet Union began to develop remotely controlled aerial systems for espionage purposes. In the 1960s and 1970s, drones were mainly used for reconnaissance missions, although their combat potential was limited at that time due to technical and operational challenges, such as short flight time and lack of precision (W. Laqueur 1986, pp. 91-104).

The breakthrough came in the 1990s with the development of new navigation technologies, such as the Global Positioning System (GPS) and advanced optical and radar sensors. At that time, the United States began to invest heavily in the development of drones, and programs such as the MQ-1 Predator became a milestone in the history of UAVs. The Predator, equipped with high-resolution cameras and the ability to carry weapons, proved to be an extremely effective tool in intelligence and counter-terrorist operations (Ł. Lizis, 2015, pp. 57-65).

Since the beginning of the 21st century, the development of drones has accelerated, largely due to advances in the field of miniaturization of electronics, autonomous navigation systems and the development of artificial intelligence. Unmanned aerial vehicles began to be used not only by the armies of the most powerful countries, but also by smaller countries and non-governmental organizations, which led to a significant increase in their role in armed conflicts (J. Chojnacki, D. Pasek 2017, pp. 177-185).

Today, unmanned aerial vehicles have become one of the key elements of modern combat systems. The use of drones in military operations is based on their ability to conduct a variety of activities – from monitoring the area, through collecting intelligence data, to precise attacks on targets located on distant battlefields. Modern drones are equipped with advanced navigation systems, thermal imaging cameras, radars and satellite communication systems, which allows them to be controlled in real time from anywhere in the world (M. Gregorski 2017, p. 139).

One of the most famous modern combat drones is the MQ-9 Reaper, which was designed as a more advanced version of the MQ-1 Predator. The Reaper is characterized by a greater load capacity, a longer operational range and the ability to conduct both combat and intelligence missions. Thanks to advanced optoelectronic systems, such as multispectral cameras and sensors, Reaper can monitor targets even in difficult weather conditions, making it exceptionally effective in counter-terrorist operations (M. Senn, J. Troy 2017, pp. 183-186).

Another important element of UAV technology are autonomous drones, which are becoming increasingly important in warfare. Although in most cases drones are still

remotely controlled by operators, the development of autonomous systems allows for increasingly independent missions, including the identification and elimination of targets without direct human involvement. Such solutions are particularly useful in situations where communication with the operator may be disrupted or impossible, for example as a result of electromagnetic interference (T. Aleksandrowicz, K. Liedel 2010, pp. 10-17).

One of the latest examples of advanced UAV technologies is the use of artificial intelligence (AI) in data analysis and decision-making systems. AI allows drones to analyze huge amounts of data in real time, identifying patterns and anomalies that may suggest the presence of an enemy or specific strategic targets. These systems are also able to predict enemy movements, which increases the effectiveness of military operations and minimizes the risk to friendly units. An example of the use of AI in UAVs are autonomous “loyal wingman” systems, which support manned aircraft, increasing their operational range and combat capabilities. Modern drones are also used in broadly understood reconnaissance operations. Reconnaissance drones, such as the Global Hawk, are capable of conducting multi-hour missions at high altitudes, providing real-time intelligence data. Such UAVs are used to monitor conflicts around the world, from war zones to areas with a high risk of terrorism. These drones play a key role in the military strategy of many countries, acting as a preventive element and enabling rapid response to threats (K. Leśniewski 2017, pp. 142-143).

UAV technology is evolving towards increasingly close integration with other combat systems, such as advanced air defense systems, missile systems and fifth-generation combat aircraft. An example of such integration are operations within the network-centric battlefield, where drones operate as elements of a coordinated operation, cooperating with manned aircraft, ground units and intelligence systems. Thanks to such cooperation, it is possible to conduct complex operations with high precision and minimal own losses.

Drones are also used in maritime operations, where they act as reconnaissance platforms, but also as an element of anti-submarine defense systems. The use of UAVs in the navy contributes to increasing the fleet's reconnaissance capabilities, as well as to precise monitoring and neutralization of threats.

The development of unmanned aerial vehicle technology since the beginning of the 21st century has significantly changed the way war operations are conducted. Drones have become not only a reconnaissance tool, but also a full-fledged element of combat systems, capable of precise and effective operations on various battlefields. With the further development of autonomous technologies and artificial intelligence, the role of UAVs in future conflicts will only increase, which makes unmanned aerial vehicles one of the key elements of contemporary and future military strategy (K. Leśniewski 2017, pp. 144-149).

III. THE USE OF UNMANNED AERIAL VEHICLES IN ARMED CONFLICTS OF THE 21ST CENTURY

Unmanned aerial vehicles (UAVs) have become one of the key tools in the arsenal of modern armies over the 21st century, playing a decisive role in various types of military operations. Drones enable intelligence, reconnaissance and combat operations, making them exceptionally versatile and effective means on the modern battlefield. As technology has developed, UAVs have begun to perform increasingly diverse functions, including offensive and defensive operations, as well as support activities such as medical evacuation or supply delivery (M. Bucholc 2012, pp. 172-175). In intelligence and reconnaissance operations, UAVs are invaluable due to their ability to monitor the area for long periods of time without exposing manned units to danger. Drones such as the MQ-1 Predator or MQ-9 Reaper are equipped with advanced optical sensors, thermal cameras and radars, which allows for constant surveillance of a specific area, both day and night, regardless of weather conditions. Thanks to this, UAVs provide military command with precise and up-to-date information on enemy movements, which increases the effectiveness of planning combat operations and allows for a quick response to the changing situation on the battlefield (M. Bucholc 2012, pp. 175-177).

Drones also play a significant role in combat operations, especially in the field of precise attacks on strategic targets. Thanks to the ability to carry precision weapons, such as guided missiles or aerial bombs, UAVs can effectively neutralize enemy military installations, vehicles or troops, while minimizing the risk of civilian casualties. Remotely controlled UAVs also enable offensive operations in hard-to-reach places, where manned aircraft or ground forces would have limited operational capabilities. The use of UAVs in this type of operations allows for precise attacks from a long distance, which reduces the risk for pilots and military personnel (J. Pawłowski 2004, pp. 42-45).

The use of unmanned aerial vehicles in armed conflicts has significantly influenced the change of military strategies around the world. Drones, due to their versatility, ability to stay in the air for long periods of time and the ability to conduct precision attacks, have become an indispensable element of modern military operations. Their ability to operate in dangerous zones, where the risk to manned aircraft would be too high, has revolutionized the way warfare is conducted (Ł. Lizis 2015, pp. 35-38). One of the most important elements that has influenced military strategy is the ability to conduct operations in an asymmetric mode. Drones allow for attacks on targets located in enemy territory, minimizing the risk to one's own forces. This approach has proven particularly effective in wars with terrorist groups, where drones are used to eliminate key leaders and infrastructure, without the need to engage large land units. In addition, UAVs have revolutionized the way reconnaissance and intelligence operations are conducted. Thanks to drones, military commands can collect huge amounts of data in real time, which allows for more precise and faster tactical decisions. This ability to gather information on an ongoing basis allows not only for monitoring the enemy's movements,

but also for early detection of threats and minimizing losses on the part of our own forces (K. Leśniewski 2017, pp. 138-141).

Another important aspect is that drones reduce the costs of military operations. Compared to manned aircraft, UAVs are cheaper both to produce and maintain. In addition, their use minimizes the risk of loss of human life in air operations, which is of great importance from both a political and social perspective. Thanks to this, troops can engage in high-risk operations without exposing crews to direct danger (T. Jasudowicz 1997, pp. 15-17).

The introduction of UAVs has also influenced the change of tactics in defensive operations. Modern armies are increasingly investing in the development of anti-drone systems aimed at countering threats related to unmanned aircraft. The use of technologies such as radars to detect drones, systems to disrupt their communication or kinetic weapons to neutralize UAVs is becoming a key element of defense against modern air threats (A. Szpak 2013, pp. 34-36).

The use of unmanned aerial vehicles in armed conflicts also raises a number of ethical and legal challenges. One of the most important problems is the issue of responsibility for decisions made by drone operators, especially in the case of attacks that lead to civilian casualties. Many international organizations and human rights defenders point out that the use of drones can lead to the escalation of conflicts and violations of international law.

Critics emphasize that drone operations, especially in so-called drone wars, are often carried out without proper control and supervision, which can lead to disproportionate losses among the civilian population. In response to these concerns, some international organizations and governments are trying to develop new legal regulations that would aim to increase transparency and accountability for the use of UAVs in war operations (A.S. Hashim, G. Patte 2012, pp. 9-12).

Another important ethical issue is the issue of drone autonomy. The development of autonomous technologies raises questions about the extent to which machines should make life-and-death decisions without human involvement. Although most modern UAVs are still controlled by operators, the development of artificial intelligence systems poses challenges to the international community related to the need to develop appropriate legal and ethical regulations (P. Łubiński 2015, pp. 194-196). The use of unmanned aerial vehicles in 21st century armed conflicts has significantly changed the way warfare is conducted. Drones have become not only a tool for precision attacks, but also an important element of intelligence and reconnaissance. However, their growing role in war operations is associated with numerous legal, ethical and technological challenges that will require further development of international regulations and standards of operation in the future (P. Łubiński 2015, pp. 191-193).

IV. THE FUTURE AND CHALLENGES OF USING UNMANNED AERIAL VEHICLES IN ARMED CONFLICTS

The future of unmanned aerial vehicles (UAVs) in armed conflicts is closely linked to technological progress, which has

accelerated at an unprecedented pace in recent years. There is a constant development in the field of miniaturization, system autonomy, and the ability to perform increasingly complex operational tasks. The use of drones in warfare has evolved from simple reconnaissance missions to full-fledged combat operations, in which UAVs play a key role. In the future, this trend will deepen, making drones even more versatile and effective on the battlefield (T. Zieliński 2018, pp. 220-223). One of the most important directions of technological development of UAVs is their increasing autonomy. Currently, most operations involving drones require the involvement of an operator who controls the unit remotely. However, more and more emphasis is being placed on the development of autonomous systems that will be able to make decisions independently, analyze data in real time, and perform tasks without human participation. Autonomous drones of the future will be equipped with advanced artificial intelligence (AI) systems that will allow them to recognize targets, avoid threats, and adapt their actions to the dynamically changing situation on the battlefield.

Another important trend in the development of UAVs is integration with other military systems, which leads to the creation of comprehensive combat networks. Drones will be able to cooperate with manned aircraft, missile defense systems, and land units, creating an integrated combat environment. Such coordination will allow for more efficient use of resources, increased effectiveness of operations, and minimization of losses. In the long term, UAVs may become a key element of the so-called "urban warfare of the future", in which autonomous systems will operate in a complex, urbanized environment, where traditional combat methods may prove ineffective (A. Śliwoska 2019, pp. 61-72).

Drones are also becoming increasingly diverse in terms of their size, tasks, and capabilities. In addition to large combat drones capable of carrying advanced weapons, there is a dynamic development of micro-drones and nano-drones that can be used for precise reconnaissance missions and operations in limited spaces, such as buildings or underground bunkers. These new categories of UAVs open up completely new possibilities for conducting field operations that would previously be unavailable to traditional military units (A. Śliwoska 2019, pp. 74-75).

Despite the dynamic development of UAV technology, their full integration with the armed forces and command structures encounters a number of challenges. One of the key problems is ensuring smooth communication between drones and operational units and command. In combat situations, where the enemy may use advanced jamming measures, drone systems must be resistant to attempts to disrupt communication, which involves the need to develop new communication protocols and security measures. UAV systems must also be integrated with existing command networks, which requires the modernization of IT and logistics infrastructures (W. Bieńkowski 2013, pp. 152-153). Another challenge is managing large amounts of data generated by drones in real time. UAVs equipped with modern sensors, cameras, radar systems and other advanced technologies provide huge amounts of information that must be

quickly analyzed and used by the military command. The development of data processing systems and artificial intelligence is becoming crucial in the context of effective management of this information, in order to provide the command with full situational awareness and the ability to make tactical decisions at the right time (W. Bienkowski 2013, pp. 153-155).

Modern armed forces are also faced with the challenge of adapting strategy and tactics to the increasing participation of UAVs in combat operations. Traditional combat methods, based on the maneuverability of manned aircraft and infantry, must be supplemented with new procedures and action schemes, taking into account the versatility of UAVs. The introduction of drones also requires a change in the way soldiers and combat system operators are trained. New competences in the field of drone operation, real-time data analysis and coordination of actions with other units are becoming crucial in the training of modern military (S. D. Bachmann, 2013, pp. 260-266).

Unmanned aerial vehicles play a special role in asymmetric conflicts and hybrid warfare. In such conflicts, the opponent, usually lacking conventional armed forces, uses irregular and asymmetric methods to eliminate the technological and military advantage of the stronger opponent. In such conditions, UAVs are used by both regular and irregular forces, which poses an additional challenge for modern armies (S. D. Bachmann, 2013, pp. 250-253).

In hybrid conflicts, drones can be used by terrorist groups, paramilitary groups or other irregular forces as tools for sabotage, espionage or even direct attacks on enemy targets. An example of this phenomenon is the attacks carried out by the Islamic State in Syria and Iraq, where small civilian drones modified to carry explosives were used. Such attacks were cheap, easy to carry out and difficult to detect, which showed the enormous potential of UAVs in hybrid warfare (Ł. Kulaga 2017, p. 108).

The growing importance of drones in asymmetric conflicts poses challenges for states related to the development of anti-UAV defense systems. The response to these threats is advanced countermeasure technologies, including radar systems for detecting small drones, electromagnetic weapons that disrupt communications, and laser systems capable of neutralizing UAVs. However, the development of such defense technologies is associated with high costs and complicated logistics, which means that there are still gaps in protection against such threats (Ł. Kulaga 2017, pp. 108-109).

V. CONCLUSIONS

Unmanned aerial vehicles (UAVs) are one of the most groundbreaking innovations that have changed the face of modern armed conflicts. Their dynamic technological development, growing autonomy and versatility of applications have made drones an indispensable element of modern armed forces, playing a key role in combat, intelligence and logistics operations. In the 21st century, UAVs have evolved from tools

supporting reconnaissance operations into precision combat systems that can perform tasks on battlefields where manned units are unable to operate or their use would be too risky. Analysis of the use of drones in armed conflicts reveals both their undeniable advantages and numerous challenges. The positive aspects include increased precision of attacks, the ability to conduct operations in hard-to-reach places and minimizing the risk to human personnel. However, with the growing role of UAVs, new dilemmas arise, especially those related to ethical and legal issues. The problems of responsibility for combat decisions, the risk of civilian casualties, and the growing autonomy of drones force the international community to develop new regulations that will ensure the controlled and responsible use of this technology.

Contemporary armed conflicts, especially those of an asymmetric and hybrid nature, show that UAVs can be used not only by states but also by irregular groups, which increases the risk of escalation of violence and difficulties in controlling the situation on the battlefield. In response to these threats, advanced drone defense systems and technologies to counteract their use in an illegal or unethical manner are being developed.

The future of unmanned aerial vehicles in armed conflicts is undoubtedly related to further technological development, especially in the areas of artificial intelligence, miniaturization and integration of combat systems. As drones become more advanced, further adaptation of military strategies and operational procedures will be necessary. At the same time, the international community must urgently continue to work on appropriate legal regulations to ensure that their use is consistent with the principles of humanitarian and international law.

In summary, unmanned aerial vehicles have already significantly influenced the way modern warfare is conducted and will continue to play a key role in future conflicts. Their growing role is not only changing the face of war, but also posing new challenges for states and international organizations that will require a responsible approach, both in terms of technology and regulation.

VI. REFERENCES

- Adamski J., (2007) *Nowe technologie w służbie terrorystów*, Warszawa.
- Aleksandrowicz T., Liedel K., (2010) *Zwalczanie terroryzmu lotniczego*, Szczytno.
- Bachmann S. D., (2013) Targeted killings: Contemporary challenges, risks and opportunities [w:] „*Journal of conflict & Security Law*”, no. 18(2), Oxford
- Bienkowski W., (2013) Bezzałogowe aparaty latające na polu walki - nowe wyzwanie dla prawa wojennego czy powtórka z historii [w:] „*Młody Jurysta*”, no. 3, Warszawa.
- Bucholc M., (2012) Użycie bezzałogowych aparatów latających w sytuacji konfliktu zbrojnego. Wybrane aspekty z zakresu międzynarodowego prawa humanitarnego [w:] „*Polski Rocznik Człowieka i Prawa Humanitarnego*”, no. 3, Olsztyn.
- Chojnacki J., Pasek D., (2017) Historia wykorzystania bezzałogowych statków powietrznych [w:] „*Rocznik Bezpieczeństwa Międzynarodowego*”, no. 11(1), Wrocław.

- Gregorski M., (2017) Regulacje dotyczące bezzałogowych statków powietrznych w prawie Unii Europejskiej w kontekście międzynarodowym [W:] „Studia Europejskie. Centrum Europejskie Uniwersytetu Warszawskiego”, no. 2 (82), Warszawa.
- Hashim A. S., Patte G., (2012) „What is that buzz?” The rise of drone warfare [w:] „Counter Terrorist Trends and Analyses”, no. 4(9), Singapur.
- Jasudowicz T., (1997) Prawa człowieka w konfliktach zbrojnych . Rekonstrukcja międzynarodowego prawa humanitarnego, Toruń
- Konert A., Kasprzyk P., (2021) UAS Safety Operation - Legal issues on reporting UAS incidents [w:] „Journal of Intelligence and Robotic Systems”, no. 103(51), Washington.
- Kuługa Ł., (2017) Używanie dronów w celu zwalczania międzynarodowego terroryzmu w świetle „ ius in bello” [w:] „ Zeszyty Prawnicze”, no. 17.1, Warszawa.
- Laqueur W., (1986) Refections on terrorism [w:] „Foreign Affairs”, no. 65(1), Washington.
- Leśniewski K., (2017) Podniebny zabójca czy skuteczna broń ? Wykorzystanie dronów bojowych na asymetrycznym polu walki w kontekście międzynarodowego prawa humanitarnego [w:] „ Internetowy Przegląd Prawniczy TBSP UJ”, nr 4(34), Kraków.
- Lizis Ł., (2015), Bezzałogowe statki powietrzne jako główny środek zwalczania międzynarodowego terroryzmu - aspekty prawne. „ Bezpieczeństwo. Teoria i Praktyka”, no. 1, Kraków.
- Łubiński P., (2015), Ku zwiększonej autonomiczności. Postępująca autonomiczność kluczowych procesów decyzyjnych w systemach bojowych [w:] K. Kowalczevska, J. Kowalczewski, Systemy dronów bojowych. Analiza problemów i odpowiedź społeczeństwa obywatelskiego, Warszawa.
- Pawłowski J., (2004) Broń masowego rażenia orężem terroryzmu, Warszawa.
- Senn M., Troy J., (2017) The transformation of targeted killing and international order [w:] „Contemporary Security Policy”, no. 38(2), Kraków.
- Szpak A., (2013) Selektywna eliminacja w międzynarodowym prawie humanitarnym, „ Międzynarodowe Prawo Humanitarne”, no. 4, Gdynia.
- Zieliński T., (2018), Dylematy użytkowania autonomicznych systemów bojowych w odniesieniu do podstawowych zasad międzynarodowego prawa humanitarnego [w:] „Humanities and Social Sciences HSS”, no. 25, Rzeszów.