INTEGRATION OF FIRST PERSON VIEW (FPV) UNMANNED AERIAL SYSTEMS IN ROMANIAN GROUND FORCES OPERATIONS

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The war in Ukraine is an inexhaustible source of operational lessons for the armed forces. Against the backdrop of the growing operational use of unmanned aerial systems (UAS), this article discusses the potential of integrating FPV systems into the Romanian Armed Forces' ground operations and provides a comprehensive analysis of the potential benefits of such a decision.

Against the background of the need to integrate emerging technologies in the process of force structure adaptation, the study provides arguments in favour of acquiring such a combat technology, based on the experience of the two belligerents in the Ukraine conflict, but also of other actors who have already decided to implement these systems in their own force structure.

In addition, the paper provides a combat functional analysis of the operational use of FPV drones, highlighting the advantages and challenges of this technology in the current military context, as well as potential evolutionary trends. The study concludes that the integration of these systems in the armed forces can bring several tactical advantages, but it is essential that this decision should be well-founded and take into account the specific context and requirements of the Romanian Armed Forces.

Keywords: drone; UAS; strike system; Ukraine conflict; FPV;

Motto:

"The development of drone technology has forever changed the landscape of warfare".

Barack Obama

INTRODUCTION

Beyond the destructive nature inherent in any armed conflict, the war in Ukraine is an inexhaustible source of operational lessons that should be fully exploited in the process of adapting the armed structures and the ways of conducting military operations. In more than two and a half years since the conflict began, it has provided countless lessons.

First, the challenges of force protection have become extremely complex against the backdrop of an increasingly transparent operating environment, brought about by technological developments in surveillance and data collection capabilities, but also by the expansion of long-range precision strike capabilities. These developments have led to the need to adapt military doctrine and practice to meet new threats and challenges.

Decentralising command and control and disposition of forces for their protection is one way of adapting armed operations to the specific challenges and threats of today's confrontational environment. The ongoing conflict in Ukraine has also demonstrated the paramount importance of sustainability. In a conflict of attrition such as this, the ability to ensure long-term logistical support makes the difference between success and failure. It has been crucial in the development of the conflict in Ukraine.

But perhaps the most important lesson at the tactical level is the automatization of the battlespace, with direct implications for the conduct of ground operations. Unmanned aerial systems (UAS) have become a central element of the modern battlefield and are changing the character of conflicts in all domains and at all levels.

Since the beginning of the conflict in Ukraine, these systems have brought about a significant metamorphosis in the paradigms of ground combat. While they also proved their effectiveness in the Nagorno-Karabakh conflict between Azerbaijan and Armenia, where they were described as magic bullets (Hambling, 2020) due to their devastating impact on traditional enemy technology and operations, the Russian-Ukrainian war has led to a significant evolutionary leap in the use of UAS

in support of land forces operations. These systems have had a major impact on the way battles are fought, completely changing the dynamics of the conflict and directly influencing the tactics employed by both sides. Some authors refer to the conflict in Ukraine as the *"drone war"*. (Gosselin-Malo, 2024). Moreover, the role of UAS systems in armed conflicts is expected to increase as the technology continues to evolve, leading to an urgent adaptation of the specific military doctrines of NATO countries (Borsari, 2023, p. 3).

In Ukraine, these systems have proven their effectiveness in surveying the battlefield and providing real-time intelligence for rapid engagement of detected targets. They have also proven their usefulness in neutralising threats by conducting direct strikes on enemy targets. In this landscape, UAVs have been not only an asset for both sides in gaining operational advantages over the adversary, but also a significant challenge in maintaining high operational capability by protecting forces, operations and assets. *"The use of unmanned aerial systems has created a transparent battlefield where there is no hiding place"* (Collins, 2023, p. 8).

Although the two-and-a-half-year conflict has seen a number of adjustments in the use of drones, their role has grown exponentially. From the successful use of the Turkish-made Bayraktar TB2 by the Ukrainians in the early stages of the conflict, to the use of commercial drones such as the DJI modified for reconnaissance and precision strikes, to the integration of kamikaze drones and loitering munitions such as the Switchblade and Shahed, the war in Ukraine has seen a continuous adaptation of UAS systems and their operational use to secure tactical advantage. The Russian-Ukrainian conflict is the first in which commercial drones have been used alongside military drones on a large scale and with significant impact.

Currently, the most widely used UAS systems in the Russian-Ukrainian conflict are FPV (First Person View) (Milasauskas, 2024). They are considered the latest evolution of UAS systems, as demonstrated by both the conflict in Ukraine and the conflict between Israel and Hamas (Operational Environment 2024-2034: Large-Scale Combat Operations, 2024, p. 11). FPV drones are types of aerial platforms equipped with cameras and video transmission systems that provide real-time video data to a ground console controlled by an operator. Their main advantage is their extremely low price compared to others (Borsari, 2023, p. 14). The primary use of these systems is to attack the opponent's capabilities in the contact zone, with both combatants using these drones extensively and successfully.

However, despite their proven operational effectiveness in the Russian-Ukrainian conflict, the Romanian Army does not currently have a plan to acquire and equip its ground structures with such systems (Barbu, 2024, pp. 11-13). This is the *research*

problem from which this scientific endeavour is initiated. In relation to it, *the main research objective* of this study is to bring to the attention of the decision- makers of the Romanian Army the need to consider FPV drones for their acquisition and use in military operations in order to optimize the response to the challenges of the current operating environment.

The research methodology used is qualitative, seeking to understand the nuances of the operational use of FPV drones and to argue the need for it in the context of the specific approaches to the conflict in Ukraine. Accordingly, the argumentation is inductive, drawing general conclusions from systematically collected and analysed data. The main target of the study is represented by the decision-making structures of the Romanian Army, and the results obtained provide solid arguments for the integration of FPV UAS systems into the ground force structures.

Considering the qualitative nature of the study, *the research questions* that have guided the approach to the problem, in order to achieve the aforementioned objective, are as follows:

❖ *What are the characteristics of FPV drones and how can they be interpreted from a military point of view?*

❖ *How have FPV UAS systems been used in the conflict in Ukraine?*

❖ *What are the advantages of using such systems in military operations from a warfighting perspective?*

❖ *What is the approach of international actors to the use of FPV drones in military operations?*

Based on the analysis of secondary data from unclassified open-sources, we have structured this paper in two parts. In the first part, we have provided a military interpretation of the specific design and functional characteristics of FPV drones. In the second part, we have tried to provide answers to the last three research questions. Thus, we have presented and interpreted different examples of the use of these systems in the Russian-Ukrainian conflict, made a functional analysis of their operational use in military operations, and identified different approaches of international actors to this issue.

FPV DRONES – TECHNOLOGY AND FEATURES

Unmanned aerial systems are a complex mechanism that includes both the aircraft and the support network, equipment and personnel required to control it (Joint Doctrine Publication 0-01.1 UK Terminology Supplement to NATO Term, 2023, p. 59; FM 1-02.1 Operational Terms, 2024, p. 80; AAP-06, 2021, p. 134).

In addition to military drones, commercial drones have played an extremely important role in the conflict in Ukraine. The latter have developed steadily over the past two decades. A report last year estimated the value of commercial drone transactions worldwide at around $30.6 billion, with an estimated increase to around $55.8 billion by 2030 (Anwar, 2023).

Even if their capabilities are inferior to military ones in terms of speed, payload, range or sensor quality, and they are more vulnerable to electronic warfare (EW) systems, the conflict in Ukraine has demonstrated their importance and effectiveness in intelligence, surveillance and reconnaissance (ISR) or even target engagement missions. Their much lower cost, ease of access and the need to find solutions to enhance the operational capabilities of ground forces have made commercial drones an indispensable element of contemporary conflict. Their creative exploitation in the Russian-Ukrainian war involved a significant change in the way ground operations were conducted.

A highly effective UAS system in this conflict is represented by FPV (First Person View) drones, which are also the most widely used by both combatants (Milasauskas, 2024). Originally built for entertainment purposes for competitions, they have become a constant in current actions by both Ukrainians and Russians. They are a crucial tool for data collection and target engagement. This section will provide a military analysis of the specific characteristics of this type of system to explore how they can be integrated into combat operations.

It is important to note that the FPV airborne system involves more than just aircraft. For it to work optimally, it also requires specialised personnel to operate it, as well as a control station and VR (virtual reality) goggles. It is also important that the drone has a high-performance video camera for effective terrain monitoring, and a communication link with the control station to operate the drone according to the situation. *Figure 1* highlights the main components of an FPV drone ready for target engagement.

Unlike the other types of commercial drones that have been widely used in Ukraine, where the image the drone records is found on the drone's controller, FPV drones require a set of VR goggles, which makes the experience much more realistic. It is as if the operator is on board the aircraft. This allows the pilot to see what the drone is seeing in real time, giving a bird's eye view of the battlespace and a much greater degree of control.

FPV drones are also equipped with high-resolution cameras that transmit clear and detailed images to the pilot, allowing him or her to have full control

of the mission. What is more, these cameras can also be deployed at night which can ensure the ability to monitor the battlefield 24 hours a day.

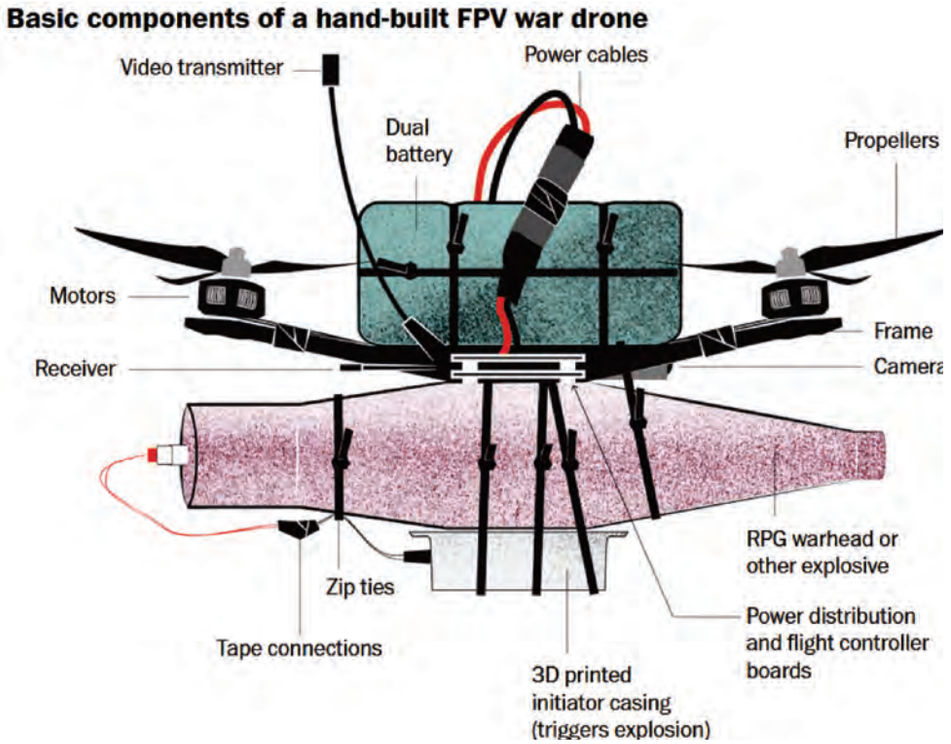

Figure 1: *Component parts of an FPV drone configured for target engagement* (Horton, 2023)

Moreover, they are equipped with advanced stabilization and navigation technologies that increase accuracy, they can hit targets even through tank hatches or the narrow windows of buildings specific to urban combat (Milasauskas, ib.), and are much more manoeuvrable than other types of commercial drones. FPV drones can also be used to destroy optical devices, radars or antennas mounted on the exterior of military vehicles (Ib.), which further demonstrates their effectiveness.

However, because they are operated by humans, the operator's ability to precisely manoeuvre FPV drones is crucial to achieving results. They are the brain of the drone. It is therefore extremely important that they are well trained in order to maximise the potential of these systems. FPV drones require much more skill to operate than other commercial drones. It takes at least two to three weeks to master the skills required to operate such a drone. In addition, operators must undergo certain special medical tests. For example, reaction speed, finger dexterity

or the vestibular system are checked to understand how well the operator is prepared to deal with stress and pressure situations during operations (FPV Drone Control: Exploring Effectiveness and Risks in Military Operations in Ukraine, 2023). All of these imply limitations in terms of identifying and training personnel who can operate such systems.

The most important specifications of FPV drones relevant for combat use are related to the degree of flight autonomy, travel speed or payload capacity. Flight autonomy is dependent on battery autonomy. Most commercial FPV drone batteries have an autonomy of between 5 and 10 minutes.

The higher speed of up to 250 km/h compared to other types of commercial drones, while requiring a higher degree of operator skill, ensures that the enemy's main kinetic measures and electronic jamming systems can be avoided (Rhodes, 2024, p. 11). Destruction by infantry strikes with small calibre weapons is the second most common means of destruction of commercial UAS. The higher speed, combined with the small size of the drone, gives FPV drones a greater chance of survival than the others (Ib., p. 1).

Speeds of up to 250 km/h and battery autonomy mean that the range can be up to 10 km. In military terms, it would mean that it could cover roughly the depth of an enemy's 1st echelon manoeuvre battalion. Therefore, the applicability of FPV UAS systems is in contact, with the potential to affect the enemy's operational capability in this area. The installation of additional batteries, as well as the use of relay drones, has ensured that the Ukrainians are able to extend the range of the kamikaze drones to 10-20 km (How Ukraine's cheap FPV drones are used on the Ukrainian battlefield, 2023), thus having the possibility of attacking the weapon reserves and command points of the enemy's 1st echelon brigades.

In addition, the quality of the integrated video camera, the resistance to extreme weather conditions and the security level of the control system must also be taken into account.

Navigation capabilities such as GPS and obstacle avoidance can also make a difference in military operations.

To ensure effective communication between the drone and the operator, the characteristics of the transmission module and the range of the system are also important.

Given their primary military role, that of target engagement, the payload capacity of FPV drones is an extremely important feature, as it determines the type of munitions they can carry and, consequently, the types of targets they can engage and destroy. Most can carry up to one kilogram of extra weight,

but there are some that are more capable, such as the Ukrainian Skynight, which can carry a payload of up to 2.5 kilograms (McFadden, 2023). In addition, a video presentation highlights that the Ukrainian military has equipped itself with a type of FPV drone capable of carrying a projectile of up to 5 kilograms, significantly increasing its target destruction potential. It was achieved by adding 2 extra engines (6 in total), but it also increased the size of the aircraft. The purpose of this drone would be to destroy buildings and fortifications in which the enemy is hiding in order to facilitate access for smaller drones (Ukrainian new heavy FPV drones with enhanced warheads will be *"nightmare"* for Russians, 2024).

The biggest advantage of an FPV drone is its price. Even the best models cost half as much as a Mavik (Borsari, 2023, p. 14). Thus, the conflict in Ukraine has demonstrated time and again how an FPV drone, whose price starts at $500, can carry a payload that can hit an enemy tank costing several million dollars. Even though the lifetime of FPV UAS systems is days due to their vulnerability to jamming and small arms attacks, the use of a large number of such low-cost commercial drones is financially and operationally cost-effective, compensating for these shortcomings and providing significant tactical advantages, as demonstrated in the Ukraine conflict.

But the main disadvantage of these and other civilian drones is that they are vulnerable to electronic warfare. This is considered to be their Achilles heel. However, the systems have proven to be more resilient to electronic jamming than other commercial systems and can adapt effectively to enemy tactics. The ability to adjust control frequencies, transmit images over a wider range, or receive both digital and analogue types of video transmission make FPV UAS systems more resilient to electronic jamming (Milasauskas, ib.; FPV Drone Control: Exploring Effectiveness and Risks in Military Operations in Ukraine, 2023). Even though they present a certain vulnerability to EW (electronic warfare) systems, few actors can afford to cover the entire front with such devices. In addition, electronic jamming involves emitting a signal that is stronger than the one being jammed, which requires fairly powerful and bulky equipment that is not always feasible for contact manoeuvre units. Furthermore, their use would make EW equipment vulnerable to subsequent attack by their own forces. So, even when not carrying out their strike mission, FPV drones can be used as decoys to create vulnerabilities for the enemy. In addition, recent innovations in areas such as customised frequencies, frequency hopping and automated flight patterns promise to further enhance their effectiveness.

However, FPV technology is critical to the way modern operations are conducted, as evidenced by its extension to other types of platforms, such as unmanned ground

vehicles (UGVs), with Russia already developing such FPV ground kamikaze systems (Russia Produces a Series of Ground FPV *"Kamikaze"* Drones, 2024).

Next, in relation to the military characteristics and interpretations provided above, we proceeded to conduct a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis to objectively assess the appropriateness of integrating FPV systems into military organizations. To ensure a higher degree of fidelity of the results obtained, for each element identified in the SWOT analysis, we also performed a military inference to provide a clearer perspective on the benefits and risks of integrating these systems into operational practice. *Table 1* presents the result of this analysis process.

Table 1: SWOT analysis on FPV UAS systems (author's design)

Strengths	Weaknesses
• **Low cost** – ability to purchase and operate a relatively large number of drones; • **High manoeuvrability** – increased efficiency compared to other commercial drones; • **Operational versatility** – can perform a wide range of missions; • **Small size and high speed** – can provide greater protection against enemy destructive actions; • **Real-time control** – can ensure timely decision making.	• **Limited autonomy** – range limitations; • **Relatively small payload but larger than most commercial UAS** – can successfully engage only certain types of targets; • **Vulnerability to electronic jamming** – technological advancement may ensure its limitation; • **Lacks its own systems to protect against enemy attack** – operator dexterity is the only way to avoid it; • **Dependent on weather conditions.**
Opportunities	**Threats**
• **Technological development –** increasing carrier capacity, range, protection against electronic jamming threats or integrating artificial intelligence to create drone swarms; • **Integrated use with other weapons systems –** making joint warfare more effective.	• **Electronic countermeasures** – vulnerability to electronic jamming; • **Evolution of enemy protection systems.**

ARGUMENTS FOR THE NEED TO INTEGRATE FPV DRONES INTO ROMANIAN ARMY GROUND OPERATIONS

Operational Use of FPV UAS in the Russian-Ukrainian Conflict

Ukraine's extensive use of unmanned aerial systems has demonstrated their effectiveness in gaining tactical advantages against a far superior adversary such as Russia (Borsari, p. 7). Both sides have used these types of systems to remarkable effect for ISR missions, for correcting artillery fire, BDA (Battle Damage Assessment), or for hitting targets by improvising them as kamikaze weapons (Borsari, p. 13). The impact of these systems has been extremely high in this conflict and it is expected to increase, comparable to that of the machine gun in the First World War.

FPV drones have proven to be among the most frequently used weapons in the Ukrainian conflict, where one of the belligerents was unable to gain air superiority due to the overstretch and high efficiency of anti-aircraft systems (Zafra, 2024). It is also due to their increased efficiency relative to the purchase price. The success rate of FPV-type UAS systems in the conflict in Ukraine is estimated to be between 50% and 80% (How could FPV drones change warfare?, 2023). Moreover, some analyses of the use of such systems in the Russian-Ukrainian conflict show a trend towards their increasing use as a means of striking various targets, as can be seen in *figure 2*.

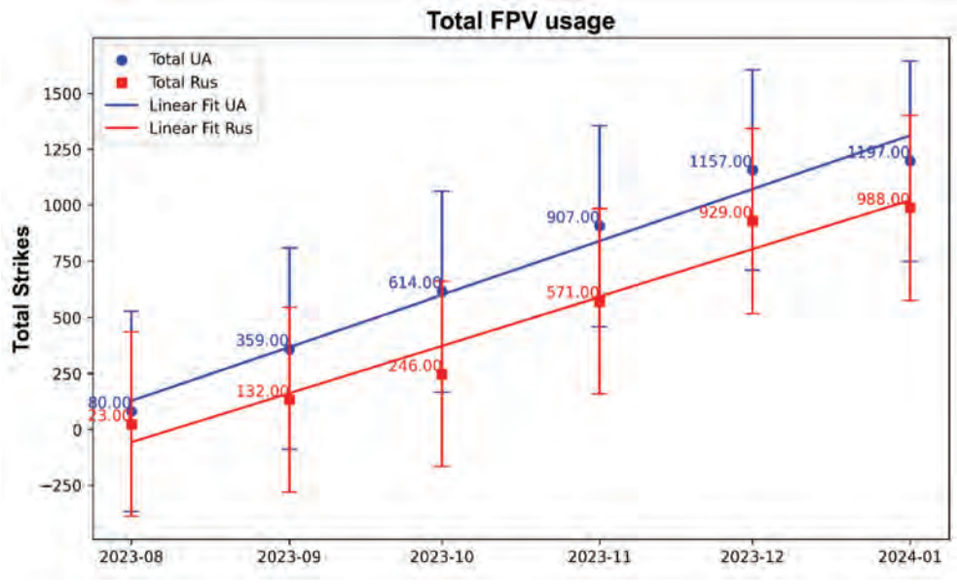

Figure 2: Using FPV drones in the Russian-Ukrainian conflict (Ben, 2024)

Given the complexity of the situation in Ukraine, we believe that it is essential to focus our attention first and foremost on the operational lessons learned from the use of FPV drones in this conflict, in order to implement more effective resource management strategies during military operations, as well as to optimize our own approach to the use of this technology in a military context. We appreciate that such an approach will provide the framework for the Romanian Army to better adapt to the way FPV drones are used in military operations. Furthermore, highlighting the efficiency of the use of FPV UAS systems will contribute to the understanding of the operational need for such aircraft in order to strengthen the Romanian Army's capabilities in the face of the increasingly diverse threats in the current security environment.

There are numerous examples of the use of FPV drones in the Russian-Ukrainian conflict. The analysis conducted presents an approach to how they have been used in different operational contexts in order to understand their versatility and effectiveness in deployed operations.

As noted above, the effectiveness of these types of devices is reflected in the area of contact. Therefore, the targets engaged are those found here. The most common use of these drones is to destroy armoured vehicles, mortars, artillery equipment and artillery because they are equipped with anti-tank missiles (A Drone Worth a Few Hundreds of Dollars against a 240-mm Mortar: Spectacular Destruction of the Tyulpan Mortar at a Distance of 10 km, 2023). Their effectiveness is also proven by the fact that even the most advanced Russian tanks, the T-90 Proryv, have fallen prey to FPV UAS attacks ('$500 – Ukrainian drone, $3 million –Russia's most advanced tank, a skilled operator's hands – priceless', 2024).

They can therefore be used against a wide range of enemy technology, stationary or mobile, such as artillery systems, tanks, armoured fighting vehicles, as well as command posts or observation posts. It should be noted that FPV drones can even engage personnel dug in trenches, an effect that is difficult to achieve with direct-fire weapons (Ukrainian FPV kamikaze drones attack Russian military equipment, 2023).

The Ukrainian military has recently adopted a new way of using FPV drones, equipping them with thermite. Mainly used in metallurgy or welding, thermite is a mixture of aluminium and iron oxide that, when ignited, burns with high heat release (DEX online, 2024), about 2,500 degrees Celsius, enough to corrode iron in seconds. Placing a charge of about 500 g under the drone can have a devastating effect on the enemy. The chemical reaction can be initiated by remote control when the aircraft is near the target area. The Ukrainians have successfully used

such a method, called *Dragon Drone*, to destroy an enemy hiding in wooded areas (What are 'dragon drones', Ukraine's latest weapon against Russia?, 2024).

FPV drones are also believed to have been used by the Ukrainians to destroy much more valuable targets. The destruction of a Russian Mi-24 attack helicopter in August this year in the Kursk region (Ukrainian FPV Drone Rams Russian Mi-24 Helicopter, 2024) or of a rather powerful Murom-P surveillance system (Ukrainian Military Destroyed Russian Murom-P Surveillance System Once Again, 2023), capable of detecting people and vehicles at a range of almost 10 km, are just two of the most high-profile examples.

In addition, the Russian-Ukrainian war has demonstrated a continuous adaptation of how FPV UAS systems can be used. Recently, drone-on-drone engagements have been recorded, demonstrating that these systems are following an evolution similar to that of aircraft in the First World War, when they were first used for reconnaissance, then for fires, and finally for confrontation (Ukrainian MoD highlights 'drone-on-drone' engagements over the battlefront, 2024).

Analysis of the Use of FPV UAS from the Perspective of Combat Functions

It is easy to see the significant role these systems are playing in the ongoing conflict in Ukraine. While the primary mission of FPV drones is to engage targets in the contact zone, these systems can support the performance of multiple combat functions and are perhaps the most versatile capability in the arsenals of both belligerents.

For example, from a **command-and-control** perspective, these capabilities can provide commanders in the contact zone with a greater degree of real-time situational awareness. Moreover, the presence of such capabilities at lower hierarchical levels (battalion/brigade) can support freedom of action and decentralization of command, critical elements of an effective C2 system, as demonstrated in the Russian-Ukrainian conflict. It can thus streamline decision-making and quickly exploit fleeting opportunities as events unfold. In addition, such a capability can support command and control by ensuring more effective coordination of subordinates' actions during difficult moments in the battle. Furthermore, depending on the situation, drones can also act as relays to ensure communication with different structures, thus contributing to their command-and-control capability.

Although, as mentioned above, the main mission of FPV UAS systems is to strike, thanks to the high-performance video camera they can also be used in research and surveillance missions, ensuring the monitoring of the confrontation space, both day and night. The continuous collection of information in real time ensures

a better understanding of the operational situation. These systems can also support the targeting process by identifying targets or ensuring the adjustment of artillery systems. They can also support the Battle Damage Assessment (BDA) process. These are all essential elements of the **intelligence** function.

FPV-type UAS systems can provide firing **manoeuvre** according to the operational situation. They can also support the investigation of troop movement routes to support troop manoeuvre. In addition, they can be used to cover flanks and open gaps between units, provide **force protection**, and monitor their own **logistical** supply lines.

However, the conflict in Ukraine has demonstrated that the two most important combat functions that FPV UAS systems can support are **fire support and reconnaissance**.

As the Russian-Ukrainian conflict has demonstrated, the operational importance of FPV drones is extremely high in terms of engaging a wide variety of targets, as described in the previous section. By equipping them with various munitions, the systems have become formidable precision weapons, capable of providing significant advantages to the user and corresponding negative effects to the adversary. The engagement procedure is simple and consists of three steps:

- *Target identification.* It can be accomplished through proprietary information gathering systems that provide coordinates and an image of the target.
- *Engagement planning.* Once accepted, the target must be approved and the type of engagement (artillery, FPV etc.) selected. In the case of FPV UAS, it is also necessary to select the type of payload specific to the effect to be achieved, define the route and deconfliction with other UAS already on the route, and establish the communication channel with the aircraft.
- *Execution.* The operator receiving the mission manoeuvres the drone to the received coordinates along the specified route, while also performing terrain reconnaissance along the route. He then detects the target and determines how to engage it to achieve the desired effect. It is very important that the operator is extremely well trained, both in handling the drone and in knowing how to exploit the vulnerabilities of the target he is engaging.

It can therefore be seen that in order to operate effectively, the UAS must be manned by a team to approve the target, prepare the payload and aircraft for operation, and pilot it to the engagement area.

Additionally, thanks to the performative camera, all of these successes in neutralizing certain capabilities of the adversary can be recorded and used to influence target audiences, as we can observe almost every day on social media

platforms (Jones, 2023, pp. 21-22). In a conflict for gaining information superiority, this method becomes a crucial one.

One can therefore see the high degree of versatility in the operational employability of FPV UAS systems, as they support numerous combat functions, depending on the context.

The Importance Given by Different International Actors to FPV UAS Systems

First, the importance of FPV UAS is demonstrated by the actions taken by the two belligerents in the Russian-Ukrainian conflict. **Russia** is actively developing FPV drones. One example is the Chinese-made *"Boomerang"* drones, which, even though they use cheap manufacturing materials, are quite efficient (Russia's Boomerang Copter-Class Small FPV Drones, 2023). Due to their affordability and importance, FPV technology has also been deployed by Russia on unmanned ground platforms (Russia Produces a Series of Ground FPV 'Kamikaze' Drones, 2024). It is recognized by Russian specialists that *"the future belongs to compact and agile, short-range FPV drones used at platoon level for reconnaissance and precise strikes"* (Edmonds, 2023).

In addition, Russia has increased production of FPV drones. In April of this year, the country's president announced plans to invest $1 billion by 2026 to develop and purchase such drones, and about $2.2 billion by 2030 (Putin wants "mass production" of drones in Russia, 2024). These significant investments demonstrate the importance Russia attaches to the development and purchase of FPV UAS systems amid the effects of these drones in the conflict in Ukraine. At the end of July 2024, Russian Defence Minister Andrei Belousov announced a production of about 4,000 FPV drones per day for his country, which means about 1.5 million units per year (How Realistic Are Russia's Statements about Production of 4,000 FPV-Drones Per Day?, 2024). In addition, the Russian Federation also recognizes the need for operator training. A Russian report from earlier this year highlights that Russia had trained about 3,500 operators in more than 800 special training facilities so far (3,500 Drone Operators Trained in Russia, Ministry of Defence Claims, 2024). These figures reflect the scale of Russia's investment in this type of weaponry; while demonstrating the importance it has attached to it in the wake of developments in the Ukraine conflict.

In addition, Russia is increasingly focusing on research in this area in order to increase its effectiveness. An extremely important example in this regard dates back to the beginning of the year, when Russian media reported on the development of a Russian FPV drone carrier. It is extremely significant, as it can extend the range of the systems, within the maximum signal limit, to engage targets deep inside

the Ukrainian device (https://www.defensemirror.com/news/36386/Russia_Tests_FPV_Drone_Carrier_in_Ukraine, 2024). The installation of retranslation stations on some of the drones, filters blocking certain frequencies to increase resistance to enemy electronic jamming systems, or the use of 3D technology to realize the drone body are just some of the scientific developments undertaken by the Russians in FPV UAS systems (X, 2023; Russians increase the range and stability of FPV drones, 2024).

Ukraine has also attached great importance to this segment. The accessibility of FPV drones has facilitated their wider operational use in the Russian-Ukrainian conflict. For Ukraine, the accessibility of FPV drones has made it easier to remain competitive even in the face of the numerical superiority of the Russians, against the background of the inconsistent supply of military equipment by the Western allies.

It is noteworthy that the development of this industrial sector in Ukraine has been accelerated, with a significant increase in the number of companies producing drones. Specifically, the number increased from seven in 2022 to about 80 by the end of last year (How Ukraine's cheap FPV drones are used on the Ukrainian battlefield, 2023). The considerable growth within the drone industry demonstrates how important these devices have become in the conflict. Due to their characteristics and ability to provide real-time imagery and intelligence, as well as the possibility of being equipped with munitions, FPV drones have become an integral part of surveillance and target engagement efforts. Moreover, increased affordability and reduced production costs have allowed Ukraine to develop its own FPV drone industry, which has increased the country's capabilities and resources in the face of complex conflict challenges, and has been able to operationally replace and complement much more expensive surveillance and weapon systems.

It is estimated that, by the end of 2023, about 50,000 drones of different types were being manufactured in Ukraine every month, the majority of which are FPV drones (Balashova, 2023). Moreover, the Ukrainian government has allocated about $1 billion this year for investment in its own manufacturing industry (Governmental Portal of Ukraine, 2023), one of the results being the KH-S7 drone in *figure 3*. This FPV-type drone can carry a weight of 1 kilogram within a range of up to 9.5 kilometres. It is also the Ukrainian government's intention to produce 1 million FPV drones by 2024 (Zafra, 2024), with 200,000 already produced in the first two months. (Since the beginning of 2024, Ukraine has produced about 200 thousand FPV drones, 2024).

Figure 3: Ukrainian KH-S7 FPV drone (Ukraine develops KH-S7 FPV drone, 2023)

On 1 July 2022, the Ukrainian government through the Ministries of Defence and Digital Transformation initiated the project *"The Army of Drones"*, which aimed to modernize and expand the use of drones in the Ukrainian military. The roles of this program were to facilitate the acquisition of drones, raise private funds for this purpose, carry out their maintenance and modernization, and train the personnel involved in their operation. The program has been a success, transforming the Ukrainian army into one modern and well-prepared for the challenges of the ongoing conflict (United 24, 2024; Army of Drones, 2024).

In addition, key players in the international community are supporting Ukraine's war effort. One example is the formation of the 11-member *"Drone Coalition"*, including the United Kingdom, Germany, and Poland, which recognizes the importance of drones in today's conflicts and the need to support Ukraine with drones. As a result, the coalition aims to support Ukraine's war effort with 1 million FPV drones (Joint Statement by the Drone Coalition's Ministers of Defence, 2024).

In a move designed to revolutionize the way contemporary military operations are carried out, Ukraine has set up a separate category of forces for Unmanned Systems Forces (USF), announced by President Zelensky in February and made a reality in June this year. Remarkably, it is the first nation to do so (Ukraine's Zelenskiy orders creation of separate military force for drones, 2024; Dangwal, 2024; Bielieskov, 2024). The main roles of the USF include coordination of combat units specialized on UAS, planning deep operations for these systems, identifying lessons and implementing them among the army force structures, developing and updating doctrine specific to the operation of unmanned aerial systems, or recruiting

and training personnel required for the operation of UAS (Hardie, 2024).This decision is a guarantor of increased efficiency in the use of FPV UAS systems in the context of the conflict in Ukraine.

Due to the importance of UAS systems, Ukraine has changed the organizational status of most of its brigades, each of which now includes a UAS company designed to engage targets, with one platoon operating FPV drones (Sahuquillo, 2024; Ukraine is betting on drones to strike deep into Russia, 2024).

Ukraine is also investing in drone research and development. For example, it intends to develop FPV-type drones based on artificial intelligence, which will provide the ability to counter enemy jamming signals and also to attack in swarms of interconnected drones that act compatibly and exchange information with each other in real time to complete the assigned mission (Hunder, 2024). Up to this point, research efforts are focused on elements that can be achieved more quickly, such as reducing engine noise levels or reducing the electromagnetic footprint (Hudson, 2023). These actions have attracted the attention of various international actors, who have begun to attach increasing importance to FPV UAS systems.

In an effort to adapt, the **US Army** is planning to field small commercial drones at the brigade level, based on lessons learned from the Russian-Ukrainian conflict. The process is well underway, with companies already selected for delivery (Judson, 2024). To test their effectiveness, some units have been equipped with such drones since late 2022 (Helfrich, 2022). In March, the US Army announced that it would equip other infantry units with small drones as part of the experiment (Chávez, 2024). According to US officials, infantry platoons of manoeuvre brigades will most likely be equipped with FPV drones starting in fiscal year 2026 (Skove, 2024).

The US Army's Manoeuvring Centre of Excellence is already organizing courses for small drone operators (US Army hosts inaugural drone competition at Fort Moore, 2024), as shown in *figure 4*. The establishment of a school specifically for training FPV drone pilots is also being considered, with the course to last 3-4 weeks (Skove, 2024).

Australia also recognizes the importance of FPV drones in contemporary conflicts. Thus, the Australian defence establishment recognizes the urgent need for the military to learn lessons from Ukraine. The creation of its own FPV drone capability, as well as a specialized training centre, is one of the future directions to follow in the effort to adapt the force structure to the challenges of the current operating environment.

China's military is already training with FPV drones (Kesteloo, 2024; Satam, 2024), and **Israel** is employing them in the conflict in the Gaza Strip (Antebi, 2024).

Figure 4: *Drone operators' course* (Borsari, 2023, p. 5)

Other major states such as **India** recognize the need to adapt their own armed structure by integrating FPV drones (The First Person View (FPV) Drone Revolution: India's Need to Adapt, 2024). In addition, the **Czech Republic** has decided to equip its own forces with FPV UAS systems under the new Army Reconstruction Concept of February this year (Domingo, 2024).

CONCLUSIONS

The way of conducting military operations specific to Western armies, known as manoeuvre warfare, is based exclusively on air-superiority. However, as the conflict in Ukraine has shown, where Russia has a clear superiority in terms of number of capabilities over Ukraine, it has not materialized. Thus, this premise of planning operations in an increasingly congested air environment may not be feasible. The widespread use of unmanned aerial systems has completely changed the way militaries operate. The ability to employ these aircraft can provide a significant operational advantage to any military structure. Moreover, the same contested operational environment poses increasing challenges to the use of medium and large drones (Borsari, 2023, p. 4). For this reason, small commercial drones, especially FPV drones, have become increasingly important in operations. Their low price, but also their high efficiency, have attracted increased attention from military structures.

Moreover, it is expected that advances in emerging technologies such as artificial intelligence will ensure an even greater impact of these systems on the battlefield by increasing their accuracy, operational efficiency and versatility (Ib.).

Within this framework, the present article aims to argue for the need to integrate these systems into the Romanian Army's force structures and operations.

It is recognised that the adaptation process is crucial for the ability of the armed forces to face new threats and challenges specific to the current and future operational environment. In this respect, operational lessons learned from the conflict in Ukraine can provide guidance and inspiration for future strategies, for the effective employment of the Romanian Armed Forces. One of these lessons is the integration of FPV drones into land operations as a multiplier of their effects.

The conflict in Ukraine has demonstrated that UAS systems, with varying degrees of sophistication, autonomy and functionality, have become an integral part of modern warfare. Successfully integrated into advanced combat tactics and operational concepts, drones can offer significant advantages to modern militaries by providing an effective capability for ISR, BDA or even fire support missions. In addition, their impact on the battlefield is amplified by rapid technological development, allowing for continuous improvements in performance and efficiency. Analysing operational lessons learned from the conflict in Ukraine can provide valuable insights into how military operations can be conducted in a complex and volatile environment.

The operational benefits, as well as the actions taken by various international actors regarding the acquisition of FPV drones, are just two solid arguments for the need to adapt the Romanian Army's force structures to the challenges of the current operational environment. In addition, there are some other factors that should be analysed and that may determine such a desire. The ageing population is one of them. It must be recognised that in the near future the human resources available for military service in the event of conflict will diminish. For this reason, we believe that the automation of the army must be a priority. We must also consider the moral impact of losing a drone in combat, which is insignificant compared to the loss of human life. Therefore, maintaining a high level of operational capability may be a consequence of equipping FPV drones. Cost versus effectiveness is also an important factor. The numerous situations in Ukraine show how important they can be in military operations. In addition, maintaining such equipment is certainly much cheaper than maintaining human personnel.

In order to integrate FPV UAS systems, the Romanian Army will have to consider more than just the acquisition of the aircraft. The selection and training of operators, the development of specific operational doctrines and the updating of existing ones, or the rethinking of the combat organisation of units are just some of the measures that will have to be taken. Therefore, we will conclude with what the former head of the Ukrainian Army, General Valerii Zaluzhnyi, wrote earlier this year in his famous article *On the modern design of military operations in the Russo-Ukrainian War: In*

the fight for the initiative: *"Perhaps the most important way to gain an advantage in today's conflicts is to master the entire arsenal of relatively cheap, modern and highly effective means that are rapidly developing"* (Zaluzhnyi, 2024), as is the case with FPV-type UAS systems.

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