sciendo
International Conference KNOWLEDGE-BASED ORGANIZATION
Vol. XXX No 1 2024

IMPLEMENTING SMALL COMMERCIAL DRONES IN LAND FORCES OPERATIONS: CONSIDERATIONS FOR OPTIMIZING ISR (INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE)

Laviniu BOJOR, Laurențiu GRIGORE

"Nicolae Bălcescu" Land Forces Academy, Sibiu, Romania
bojor.laviniu@armyacademy.ro, grigore.laurențiu@armyacademy.ro

Abstract: *This study explores the use of small commercial drones in tactical-level military actions, with a particular focus on optimizing ISR (Intelligence, Surveillance, and Reconnaissance) capabilities. During a 3-day tactical exercise, we analyzed the performance of 9 commercial drones, including DJI Mini 3, DJI Avata, DJI Mini 4, and DJI Mavic. The study demonstrated that these drones provide essential capabilities for real-time information gathering, facilitating rapid decision-making and improving the efficiency of military operations. Significant challenges were also identified, such as limited battery autonomy and vulnerability to adverse weather conditions. The results highlight the need for specialized training programs and an integrated approach that combines advanced technology with military tactics. Our findings suggest that commercial drones can significantly enhance the efficiency of military operations, but increased attention is required to understand the challenges that may arise due to the technological limitations of small commercial drones.*

Keywords: Commercial mini drones, DJI, military operations, ISR capabilities

1. Introduction

1.1. The Ubiquity of Commercial Drones

A drone is a small aircraft, an unmanned aerial device, also known as an unmanned aerial vehicle (UAV). Simply put, it is a flying robot that can be remotely controlled by a human operator. Drones have started to be equipped with different sensors capable of offering more functions than air flight. A UAV becomes a UAS (unmanned aircraft system) when the actual drone is used with software, hardware, cameras, radars, GPS, sensors, payloads, the pilot, communications, and other systems necessary to operate the vehicle, including stations ground control or data flow [1]. Our study covers small, commercial drones and in the present paper we refer to the term "drone" in the sense that it covers both the actual flight platform and the other hard or soft components used in Information, Surveillance and Reconnaissance (ISR) process. ISR capabilities express the coordinated and integrated acquisition, processing and provision of timely, accurate, relevant, coherent, and assured information and intelligence for the commander's decisions [1].

In recent decades, drone technology has evolved rapidly, becoming an essential component in most human social domains.

Drones have demonstrated remarkable efficiency in collecting information from remote areas, being used in emergency situations [2] search and rescue operations [3] or wildlife [4]. In agriculture, drones have become an indispensable tool for farmers through the information collected

DOI: 10.2478/kbo-2024-0004

for land efficiency, crop management and the information collected about plant health, the need for irrigation or the application of fertilizers [5]. Commercial drones have revolutionized the way farmers manage and monitor crops, reducing costs and increasing efficiency. Due to their low costs, reduced environmental impact, and ability to provide discreet surveillance, drones have become an essential tool in law enforcement activities, allowing police forces to efficiently monitor large events and respond quickly to emergency situations [6]. Drones are widely used to inspect infrastructure [7] such as communication towers, railroads, energy grid, pipelines or other infrastructure sites because they allow a detailed assessment with minimal risk and low cost. Amazon and UPS have paved the way for efficient drone deliveries based on faster deliveries, lower costs, lower emissions and happy customers [8]. Delivery drones are the future of logistics and urban transport. Along with other emerging technologies, drones are widely used to monitor construction sites, assess work progress or create aerial images for sales and marketing reports in what some authors call smart real estate technology [9].

These examples emphasize the versatility but at the same time justify the ubiquity of civilian drones that can currently be purchased at a relatively low price and used in military actions or to obtain strategic and tactical advantages. The use of drones in military conflicts is not new, and the implementation of unmanned aircraft, controlled by radio, has been tested since the First World War. But the phenomenon of the current deployment of cheap commercial drones in the Ukraine conflict shows us the potential of these small devices to change military techniques, tactics, and procedures. At the beginning of the war, commercial drones began to be used inconsistently, as a necessity that tried to compensate for the lack of military capabilities in the fight against the much stronger Russian army. But the impact and efficiency of Bayraktar drones have been exploited over time and currently many combat brigades are equipped with strike drones and most of them have small reconnaissance drones. This article focuses solely on the ISR aspects of military operations. Future studies will address the implementation of small commercial drones in strike operations, involving the deployment of explosive charges or using FPV (First Person View) drones.

1.2. Literature Review

The use of commercial drones for information gathering in military actions has become a major topic of interest in recent years, particularly in the context of contemporary conflicts [10]. Recent studies have highlighted how commercial drones are adapted and utilized for military purposes to gain strategic and tactical advantages [11]. Certain studies have analyzed the use of commercial drones in military reconnaissance, surveillance, and information gathering missions, providing real-time images and data that are essential for rapid decision-making on the battlefield [12][13]. Mini-UAVs offer essential capabilities to tactical users, allowing them to collect relevant information without the intervention of higher authorities.

The conflict in Ukraine has highlighted the extensive use of commercial drones by both parties involved [14]. Drones are used to monitor troop movements, identify enemy positions, and coordinate precise attacks [15]. Another important study emphasizes how commercial drones have been used for information gathering and supporting artillery operations in the Ukraine conflict [16]. Identifying and transmitting the impact points of autonomous artillery guns is extremely useful because accurate coordinates are essential for calculating firing data and making fire corrections in artillery operations [17]. Drones provide detailed images of the terrain and enemy targets, thus facilitating the planning and execution of attacks [18]. Although commercial drones offer numerous advantages, their use in a military context also presents significant challenges. These include vulnerability to hacking and electronic interference, as well as limitations related to flight duration and payload capacity [19]. While these small vehicles are extremely useful for data collection at the tactical level, they also have limitations such as reduced endurance and vulnerability to adverse weather conditions [20].

Another important aspect is the need for specialized training programs for the efficient operation of commercial drones in military scenarios. These programs must include both technical and tactical aspects to maximize the benefits offered by these devices. Alongside education and training [21], an integrated approach is necessary, combining emerging technologies with military tactics [22].

The use of drones has demonstrated a significant reduction in risks for military personnel and has allowed for the rapid adaptation of battlefield strategies [23], but it also poses significant challenges related to data security and system interoperability [24].

1.3. Research Question and Hypotheses Tested

Our study aims to identify the potential offered by the implementation of small civilian drones in the actions of ground military forces and we set out to answer the following research question: How are commercial drones used for intelligence gathering in military tactical exercises and what are the advantages and the challenges associated with implementing them in military actions?

Based on this research question, we formulated the following hypotheses:

1: The implementation of small-sized commercial drones in tactical-level operations by ground forces significantly increases the effectiveness of identifying and neutralizing threats compared to operations conducted without the support of drones.

2: The use of small drones changes the opponent's course of action.

3: Implementing drones in tactical-level combat scenarios reduces the risks taken by military leaders in the field by avoiding the exposure of personnel to enemy fire.

4: The presence of drones boosts the morale of friendly troops and reduces the will to fight among adversaries.

2. Research Methodology

In this section, we will describe the study design, data collection methods, utilized instruments, and data analysis procedures. The main objective is to provide a clear and detailed framework on how we approached the research regarding the implementation of commercial drones in military intelligence operations.

2.1. Study Design

Our study is exploratory and descriptive, aiming to collect and analyze data regarding the implementation of commercial drones in a military context. It was conducted during a 3-day tactical exercise organized by the "Nicolae Bălcescu" Land Forces Academy (AFTNB) in Sibiu. We acquired 9 commercial drones, which were tested during this tactical exercise involving cadets.

2.2. Experiment Description

To achieve the goals, a total of 9 commercial mini drones (3 DJI Mini 3 drones, 3 DJI Avata drones, 2 DJI Mini 4 drones and 1 DJI Mavic drone) were purchased and 12 students were trained as drone operators. The training period for the cadets was very short, consisting of 1-2 hours per day over the course of one week. The training program included theoretical sessions for familiarization with the drones, computer simulation exercises, and 2-4 hours of practical field exercises. Based on the requests of military leaders, the drone operators were assigned to specific units to carry out designated missions, during which they executed tasks assigned by the military leaders. The operators were instructed before the mission to collect data through photo/video recordings of the missions in which they were involved.

2.3. Data Collection

After each mission, drone operators completed an observation sheet and participated in individual or focus group interviews (depending on their number and the missions carried out) to provide additional information.

Observation Sheet: contained questions aimed at evaluating the technical characteristics of the drones, early detection of threats, clarity and accuracy of the information, impact on adversary behaviour, and risk reduction for military personnel. The complete details of the observation sheet are presented in Annex 1.

Interviews: individual or group interviews were conducted with drone operators and exercise participants to collect additional information. The focus group interviews aimed to explore information that could not be captured in the observation sheets and to test the formulated hypotheses. The interviews were conducted after the missions in a comfortable environment to facilitate open discussions that helped detail the responses from the sheets, address differences of opinion, and understand the reasons behind identified behaviours or attitudes.

2.4. Data Analysis

The collected data and photo/video content were analyzed to achieve the objectives and test the hypotheses by identifying both the advantages and challenges generated by the implementation of drones in military actions.

3. Results

The results obtained from the observation sheets and the interviews conducted during the 3-day tactical exercise identified aspects relevant to our study.

3.1. Technical Characteristics of the Drones

Most operators reported that the technical characteristics of the drones (e.g., flight stability, camera quality, battery life) were adequate for fulfilling the assigned missions but also mentioned limitations regarding their operation in unfavorable weather conditions.

DJI Mini 3 PRO: appreciated for its portability and ease of use, as well as for the optical zoom of its camera. Negative aspects include limitations in flight range due to reduced battery autonomy (the manufacturer claims an autonomy of 34 minutes [25], but the real operational time at the target is approximately 20-25 minutes). Another negative aspect highlighted was the inability to operate in rainy conditions, with the RTH (return to home) function activating automatically in unfavorable weather.

DJI Avata: appreciated for its robust construction and the ability to be operated in enclosed spaces. Operators highlighted its easy maneuverability due to the goggles and joystick. Limitations include low battery autonomy and the inability to collect and send GPS target coordinates, making it less suitable for precise artillery strike reporting.

DJI Mini 4 PRO: appreciated for its improved camera quality, maneuverability, and flight stability. Its small size and camera zoom allowed it to approach targets without being detected. The negatives include the reduced flight range, similar to the DJI Mini 3 PRO.

DJI Mavic: appreciated for its overall performance but noted as being more complex to operate compared to the Mini 3 PRO and Mini 4 PRO models. Positive feedback mentions the camera zoom, longer flight range and night vision capability. The drone's strong point is its IR and thermal sensors, which allow it to carry out night missions (see Figure 1).

Figure 1: Details obtained using the IR sensor, enabling effective night vision capabilities

3.2. Early Threat Detection

Most operators confirmed that the drones provided information that contributed to the early detection of threats that could not have been identified with other tools such as binoculars or the optical equipment of combat vehicles. The ability to deploy and maneuver the drones at varying altitudes and angles facilitated quicker threat identification and provided military leaders with more time to respond.

3.3. Clarity and Accuracy of Data

All operators reported that the information provided by the drones was clear enough to identify and classify the mission objectives. A good example is the fact that the zoom of the camera allowed the recording of details inside the combat vehicles when the top hatch was open. The drones delivered detailed information on fortification lines and provided live streaming of artillery strikes, enabling real-time adjustments to fire support and enhancing the efficiency of target acquisition (see Figure 2).

Figure 2: View of a trench captured by the drone, illustrating its ability to provide detailed images of a fortification line

3.4. Additional Insights

Most operators agreed that the accuracy of the information obtained with the drones was superior to traditional data collection methods previously used.

Operators detailed situations where drones allowed for the identification of indicators related to adversaries, terrain, and other mission-influencing factors that were not visible with other surveillance methods. They also mentioned that drones are not useful in fog, smoke, or wooded areas (vegetation that allows the adversary to conceal themselves).

When drones were operated at close range and the adversary could identify them (due to noise or visual detection), operators observed changes in the adversary's behavior (e.g., additional camouflage measures, changing routes).

All operators considered that the presence of drones contributed to reducing risks for military personnel by minimizing their exposure during field operations. Without drones, commanders in the field would have had to send scouts, who would have been exposed to enemy fire.

Most operators expressed satisfaction with the ease of operating the drones, highlighting the user-friendly interfaces and controls.

3.5. Results from Individual Interviews and Focus Groups revealed several key insights into the operational use of drones.

Operators and military leaders consistently mentioned during discussions that drones improved situational awareness, allowing leaders to have a better understanding of the situation, make better decisions, and plan missions more effectively. Leaders were able to adapt the mission by having real-time access to information about adversary reactions.

Feedback from interviews suggested that the presence of drones positively influenced the morale of friendly troops, as they knew exactly where the adversary was and what their reactions were to their own actions.

Operational challenges were also identified, such as:

- limited flight time due to battery autonomy (during the experiment, drones with standard batteries were used without additional batteries, which limited the flight duration and long-term mission planning);
- vulnerability to weather conditions, such as strong winds and rain, as drones cannot be flown in these conditions.
- inability to collect information in fog, smoke, or wooded areas.

3.6. Summary of Findings

Hypothesis 1: The implementation of small commercial drones has significantly increased the effectiveness of identifying and neutralizing threats. This assumption is supported by the high percentage of operators who reported successfully detecting threats and the superior accuracy of information compared to traditional methods.

Hypothesis 2: The use of drones has changed the enemy's course of action or the behavior of adversaries. This aspect was highlighted by the loss of the element of surprise, with operators noticing changes in the adversary's actions when the drones were visually or optically identified by the enemy.

Hypothesis 3: The deployment of drones reduced the risks to military personnel by minimizing exposure to enemy action, with drones being able to fulfill reconnaissance tasks more quickly and effectively than human scouts. This is strongly supported by the feedback from operators and leaders participating in the exercise.

Hypothesis 4: The implementation of drones boosted troop morale. This hypothesis is supported by feedback and focus group discussions that highlighted the ability of drones to reduce the "fog of war" and improve the understanding of the operational environment.

4. Discussions

4.1. Practical and Theoretical Implications

Commercial drones can and should be integrated not only into the planning process but especially into the execution phases of tactical-level missions. Currently, these capabilities are limited as they are primarily available to units above the battalion level. Our experiment demonstrated the utility of small drones at the platoon and squad levels. The capability of these tools to provide essential data to military leaders shortens the reaction time needed for information support requests and streamlines data traffic. Equipping small tactical units with commercial drones, alongside creating UAV operator functions within small structures (squad and platoon), is an evident reality driven by the evolution of emerging UAV technologies.

Human resources are the most critical asset in military conflicts. Body counts is a determining factor in winning wars, and exposing soldiers to risks decreases troop morale. The use of drones reduces these risks for military personnel by minimizing the need for direct exposure. In our experiment, we did not identify any tasks that a scout could perform better than a small commercial drone. Moreover, drones have proven that they can complete missions with better results than human scouts, such as night vision data collection. Additionally, their sensors facilitate data collection and sharing not only with field leaders but also with tactical command centers.

The collected data show that financial investments are necessary but not sufficient. Budget allocations for equipping small tactical units with drones must be complemented by developing educational programs for training and exercising both operators and military leaders. Tactical unit leaders must understand the benefits and limitations of mini drones, and operators must be well-prepared to use the drones optimally and respond quickly to the leaders' requirements and battlefield changes.

Awareness of technological limitations, such as flight duration (battery autonomy) or inability to operate in rough weather, will further enhance their military utility. Field leaders will know when they can rely on these technologies and when they need to integrate other resources necessary to accomplish their mission.

Our findings show that the presence of drones changes adversary behavior, forcing them to abandon previously established courses of action, particularly those relying on the element of surprise. Furthermore, military forces must also pay attention to the aerial domain of the battlefield to identify threats that drones can develop. Camouflage and deception tactics, as well as efforts to conceal intentions or combat positions, must be adapted as small drones become capable of distinguishing decoys from real targets.

4.2. Study Limitations

While the results are promising, our study has several limitations. The field tactical exercise was conducted over a period of 3 days, which may not be sufficient to fully evaluate all aspects of drone usage. The study involved a relatively small number of drone operators, which may limit the generalizability of the results, or the coverage of all aspects generated by the implementation of small commercial drones in military actions. Although several drone models were used, the study did not cover the entire range of available technologies on the market, and other models may exhibit different characteristics and performance.

The study was limited to the use of small commercial drones, which can be purchased on the open market. Military drones possess different characteristics that may perform better in adverse weather conditions and provide a higher level of security and confidentiality for classified information, which are crucial aspects in real operations.

5. Conclusions

Based on the results obtained in our study regarding the use of small commercial drones in tactical military actions, we have formulated the following conclusions:

Accessibility: Small commercial drones are much more financially and logistically accessible than military drones of similar or larger sizes. They are low-cost, easy to purchase, inexpensive to operate or maintain. The possibility of being bought and used in military actions makes them extremely attractive, especially when military drones with superior characteristics are not available or are too expensive.

Real-Time Data: Drones provide essential data for military decision-making process, such as identifying enemy movements, surveying routes and terrain, monitoring perimeters or areas, correcting fire in real-time or target acquisition. Small commercial drones provide intelligence of similar quality to that offered by satellites, aircraft, or larger military drones (such as Bayraktar), and in some cases, even of superior resolution. Their advantages are more evident compared to higher-class military drones, as they are difficult to detect by radar systems, do not require runways for takeoff/landing, and can be stored in a soldier's backpack.

Reaction Time: With commercial drones at their disposal, tactical commanders benefit from almost instant access to information

about potential threats. This offers flexibility and initiative as it eliminates the need to wait for higher-echelon approvals for informational support, allowing for a swift and efficient response.
Ease to operate: Military cadets, assigned as drone operators without prior experience, managed to operate them without difficulties after brief training and a few practical exercises. This demonstrates that these drones are easy to learn and maneuver, making them ideal for use in short-notice conditions and by personnel with minimal experience.
Low Risks: The use of small commercial drones minimizes the direct exposure of military personnel to dangers. They can perform reconnaissance and data collection missions in high-risk areas, thereby contributing to troop safety and boosting their morale.
Altering Enemy Behavior: The presence of commercial drones in the operational theater forces adversaries to change their tactics and abandon some planned courses of action, especially those relying on the element of surprise. Adapting the adversary's behavior to the presence of drones underscores their importance in military actions. The presence of a drone on the battlefield can cause significant psychological stress among enemy forces, who may feel that their every move is being monitored.
Small commercial drones also present several significant limitations:
Range: The limited flight time imposed by the battery capacity requires the planning of short missions or frequent returns for battery changes.
Weather Conditions: Drone performance is adversely affected by rain, strong winds, and fog, which limits their capability for continuous 24/7 operation.
Operations Security: The confidentiality of data collected by commercial drones may be vulnerable compared to military drones, which benefit from advanced encryption protocols and protection of classified information.
Limited Capabilities: Although commercial drones are useful for reconnaissance and data collection, and some allow for autonomous navigation or tracking function (vehicles or people), they do not have the advanced capabilities of military drones, such as complex anti-jamming protection, encrypted communications, or advanced navigation systems.

Acknowledgements
This study was developed as part of the research project "*Study on the implementation of small Unmanned Aerial Systems in Land Forces operations to optimize and enhance the effects of tactical-level military actions*", funded by the PSCD - Sectoral Research Plan of the Romanian Ministry of National Defense 2024.

References List

[1] N. Figueira, P. Pochmann, A. Oliveira, and E. P. De Freitas, "A C4ISR Application on the Swarm Drones Context in a Low Infrastructure Scenario," in 2022 International Conference on Electrical, Computer and Energy Technologies (ICECET), Prague, Czech Republic: IEEE, Jul. 2022, pp. 1–7. doi: 10.1109/ICECET55527.2022.9872941.
[2] F. Ullah, S. M. E. Sepasgozar, and C. Wang, "A Systematic Review of Smart Real Estate Technology: Drivers of, and Barriers to, the Use of Digital Disruptive Technologies and Online Platforms," Sustainability, vol. 10, no. 9, Art. no. 9, Sep. 2018, doi: 10.3390/su10093142.
[3] V. Puri, A. Nayyar, and L. Raja, "Agriculture drones: A modern breakthrough in precision agriculture," Journal of Statistics and Management Systems, vol. 20, no. 4, pp. 507–518, Jul. 2017, doi: 10.1080/09720510.2017.1395171.

[4] D. Doroftei, G. D. Cubber, and H. D. Smet, "Assessing Human Factors for Drone Operations in a Simulation Environment," in Human Factors in Robots, Drones and Unmanned Systems, AHFE Open Acces, 2022. doi: 10.54941/ahfe1002319.
[5] "DJI Mini 3 Pro - Fly Mini, Create Big," DJI. Accessed: May 26, 2024. [Online]. Available: https://www.dji.com/global/photo
[6] T. Maeda and S. Yamamoto, "Drone Observation for the Quantitative Study of Complex Multilevel Societies," Animals, vol. 13, p. 1911, Jun. 2023, doi: 10.3390/ani13121911.
[7] J. Müller, T. Ehlers, and V. Gollnick, Drone Routing Optimizer for Aerial Inspections of Energy and Railway Infrastructures. 2022. doi: 10.2514/6.2022-3546.
[8] J. I. Walsh and M. Schulzke, Drones and Support for the Use of Force. University of Michigan Press, 2018. doi: 10.3998/mpub.9946611.
[9] D. Day, "Drones for Transmission Infrastructure Inspection and Mapping Improve Efficiency," Natural Gas & Electricity, vol. 33, no. 12, pp. 7–11, 2017, doi: 10.1002/gas.21991.
[10] D. Kunertova, "Drones have boots: Learning from Russia's war in Ukraine," Contemporary Security Policy, vol. 44, no. 4, pp. 576–591, Oct. 2023, doi: 10.1080/13523260.2023.2262792.
[11] K. Chávez and O. Swed, "Emulating underdogs: Tactical drones in the Russia-Ukraine war," Contemporary Security Policy, vol. 44, no. 4, pp. 592–605, Oct. 2023, doi: 10.1080/13523260.2023.2257964.
[12] P. Royo, À. Asenjo, J. Trujillo, E. Çetin, and C. Barrado, "Enhancing Drones for Law Enforcement and Capacity Monitoring at Open Large Events," Drones, vol. 6, no. 11, Art. no. 11, Nov. 2022, doi: 10.3390/drones6110359.
[13] J. Z. Zhang, P. R. Srivastava, and P. Eachempati, "Evaluating the effectiveness of drones in emergency situations: a hybrid multi-criteria approach," Industrial Management & Data Systems, vol. 123, no. 1, pp. 302–323, Jan. 2021, doi: 10.1108/IMDS-01-2021-0064.
[14] S. U. Jan and H. U. Khan, "Identity and Aggregate Signature-Based Authentication Protocol for IoD Deployment Military Drone," IEEE Access, vol. 9, pp. 130247–130263, 2021, doi: 10.1109/ACCESS.2021.3110804.
[15] "Intelligence, Surveillance, and Reconnaissance (ISR) - Presagis." Accessed: May 23, 2024. [Online]. Available: https://www.presagis.com/en/glossary/detail/isr/
[16] "Learning on the Fly: Drones in the Russian-Ukrainian War - ProQuest." Accessed: May 26, 2024. [Online]. Available: https://www.proquest.com/openview/2085c57e92f8e53792724dfe4052a10d/1?pq-origsite=gscholar&cbl=37049
[17] N. A. Pasichnyk, S. A. Shvorov, O. A. Opryshko, A. Dudnyk, B. Oksana, and D. S. Komarchuk, "Prospective of Camouflage Ground Objects to Counter UAVs," in 2023 IEEE 7th International Conference on Methods and Systems of Navigation and Motion Control (MSNMC), Kyiv, Ukraine: IEEE, Oct. 2023, pp. 1–6. doi: 10.1109/MSNMC61017.2023.10328960.
[18] J. Ivan, M. Sustr, O. Pekar, and L. Potuzak, "Prospects for the Use of Unmanned Ground Vehicles in Artillery Survey:," in Proceedings of the 19th International Conference on Informatics in Control, Automation and Robotics, Lisbon, Portugal: SCITEPRESS - Science and Technology Publications, 2022, pp. 467–475. doi: 10.5220/0011300100003271.

[19] A. Kajander, "Russian Invasion of Ukraine 2022: Time to Reconsider Small Drones?," in 2023 15th International Conference on Cyber Conflict: Meeting Reality (CyCon), Tallinn, Estonia: IEEE, May 2023, pp. 313–327. doi: 10.23919/CyCon58705.2023.10181494.
[20] J.-P. Yaacoub, H. Noura, O. Salman, and A. Chehab, "Security analysis of drones systems: Attacks, limitations, and recommendations," Internet of Things, vol. 11, p. 100218, Sep. 2020, doi: 10.1016/j.iot.2020.100218.
[21] S. R. R. Singireddy and T. U. Daim, "Technology Roadmap: Drone Delivery – Amazon Prime Air," in Infrastructure and Technology Management: Contributions from the Energy, Healthcare and Transportation Sectors, T. U. Daim, L. Chan, and J. Estep, Eds., Cham: Springer International Publishing, 2018, pp. 387–412. doi: 10.1007/978-3-319-68987-6_13.
[22] Y. Karaca et al., "The potential use of unmanned aircraft systems (drones) in mountain search and rescue operations," The American Journal of Emergency Medicine, vol. 36, no. 4, pp. 583–588, Apr. 2018, doi: 10.1016/j.ajem.2017.09.025.
[23] Ö. Kanat, "The Significance of Unmanned Aerial Vehicles (UAVs) in Strategic Contexts," vol. 5, pp. 75–87, Dec. 2023.
[24] I. A. Cîrdei, "Training of the Forces for Carrying Out Military Actions in Operational Environments Characterized by the Existence of Hybrid Threats," Land Forces Academy Review, vol. 28, no. 1, pp. 11–19, Mar. 2023, doi: 10.2478/raft-2023-0002.
[25] "UAS vs. UAV: What's the difference? | Inspired Flight Technologies." Accessed: May 23, 2024. [Online]. Available: https://www.inspiredflight.com/news/uas-vs-uav.php
[26] C. Paucar et al., "Use of Drones for Surveillance and Reconnaissance of Military Areas," in Developments and Advances in Defense and Security, Á. Rocha and T. Guarda, Eds., Cham: Springer International Publishing, 2018, pp. 119–132. doi: 10.1007/978-3-319-78605-6_10.
[27] M. Gao, C. H. Hugenholtz, T. A. Fox, M. Kucharczyk, T. E. Barchyn, and P. R. Nesbit, "Weather constraints on global drone flyability," Sci Rep, vol. 11, no. 1, p. 12092, Jun. 2021, doi: 10.1038/s41598-021-91325-w.

Annex 1

OBSERVATION SHEET

Name:
Drone Used:
Mission Start Date: ____________ Mission End Date: ____________
Assigned Mission:
Flight Itinerary:

1. Did the technical characteristics of the drone used allow for the completion of the assigned mission? Please elaborate.
2. Did the drone provide information that contributed to the early detection of threats that could not have been identified without the drone?
3. Was the drone-provided information clear enough to identify and classify the objectives set in the mission?
4. Is the accuracy of the information obtained with the help of the drone better compared to other data collection methods previously used?
5. Did the drone allow the identification of clues (about the enemy, terrain, population, or other factors that may influence the assigned mission) that were not visible with other surveillance means? Please elaborate.
6. Did the enemy change their behavior (e.g., changed course of action, took additional camouflage measures, abandoned the mission, or other measures) in response to the appearance/identification of the drone?
7. Do you consider that the presence of drones contributed to reducing risks for military personnel, especially by minimizing their exposure during field actions?
8. Are you satisfied with the ease of operating the drones?