

Review article

## Use of unmanned aviation by State Fire Service (PSP)

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### INFORMATION

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### ABSTRACT

This article describes its author's State Fire Service Officer questionnaire results. The research topic is unmanned aerial vehicle (UAV) usage during service in this formation. The State Fire Service's statutory tasks are threats reconnaissance and rescue tasks during natural disasters. Some State Fire Service units are equipped with UAVs and use them to their full capabilities. Unmanned systems are increasingly employed by many institutions and the state. Unmanned aerial vehicles can be used in search and rescue operations, waste control, or environmental monitoring. The current possibilities of unmanned aviation are very extensive and often save lives. The numerous impacts of unmanned aviation during the COVID-19 pandemic began with their enormous potential and wide scope of operation. Recognition, effective monitoring and further development of UAVs have a significant impact on improving state security. Research results prove undoubtedly that UAV's role in State Fire Service is beneficial, especially during missing person search and firefighting actions. Because of the cyclical character of crises in Poland, it is necessary to equip State Fire Service units with tools like UAVs to fight various threats.

### KEYWORDS

security, unmanned aerial vehicles, threat, mission



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## Introduction

Unmanned aerial vehicles (UAVs) are increasingly noticeable and used in various industries. In the face of the COVID-19 pandemic, unmanned aviation has become an indispensable element in the fight against the virus. The use of UAVs in civil and military aviation has contributed to the expansion of the possibilities within the scope of the performed tasks. The combat use of unmanned aerial vehicles is the future of every army. Regarding unmanned civil aviation, the constant introduction of new functionalities at the UAV minimizes certain threats and modernizes almost every area of the economy. Nowadays, dangerous situations contribute to the development of UAVs, which may replace human resources in some areas. In the face of increased flood or fire hazards, unmanned aviation has become widely employed by state authorities and institutions. At present, UAVs can be treated as a tool to fight the dangers of a different nature. Crime, terrorism, and natural disasters are commonly

perceived as dangerous situations and may disrupt the functioning of any country. The variety of missions conducted by individual services or state bodies enables increasing the scope of activities employing unmanned aerial platforms. The ability to transmit real-time images by the UAV increases the possibility of operating during search and rescue operations by state authorities. An important fact is that unmanned platforms enable the performance of official activities in various conditions. Narrow streets, swampy areas, and open waters are ideal places where UAVs can use their construction capabilities. Unmanned aerial vehicles used during the COVID-19 pandemic have shown and confirmed their reliability. Air reconnaissance, temperature measurements, and the performance of transport services have become an appreciated element of the fight against the virus by many European countries, including Poland.

UAVs used by the State Fire Service contribute to reducing firefighter risks when working under challenging conditions. A flying platform used properly can recognize, for example, a burning building that may collapse. Because of these abilities, fire brigades can be directed to the right places, where appropriate rescue operations can be performed.

A similar situation takes place in the case of fires in huge forest complexes, where the relay of the coordinates of specific fire spots to a person managing a given rescue operation may contribute to minimizing the risk.

Although UAVs help conduct various search and rescue operations, they will never completely replace a man who has to make the right decisions. Nevertheless, unmanned aviation opens new directions and develops specific action patterns for many institutions and state bodies. At present, the level of autonomy of UAVs or robots does not enable the implementation of complex activities and missions. The proper planning process, recognition, training, and a sufficiently fast reaction are the factors that support the state's defense subsystems.

The main goal of the expert interview and questionnaire was to ascertain the opinions of the respondents (State Fire Service officers) about unmanned aviation's usefulness in providing effective support for the State Fire Service. Research tools and gathered information will be described in the next part of the article.

## **1. The use of unmanned aviation by state institutions**

Due to the low maintenance costs of unmanned aerial vehicles, most state authorities and institutions have decided to utilize UAVs to perform their statutory tasks.

Many organizations can use unmanned systems. Forest and fire brigades deploy UAVs to detect fires, monitor the river condition or forest paths, and observe animal migrations. UAVs can be very useful in the mountains, locating missing persons and tracking an avalanche. Moreover, UAVs are perfect for checking the condition of pipelines, searching for mineral resources, and geophysical research [1, p. 65]. The market for unmanned aerial vehicles will change along with the development of technologies and the emergence of new areas in which services can be provided with drones. Unmanned aerial vehicles may transport blood and internal organs at a speed impossible in road traffic, patrol streets, create maps and test air purity [2, p. 305]. The above examples prove the effectiveness of UAVs. State services and bodies in Poland utilize various UAVs to implement projects related to the performance of official tasks.

On December 31, 2021, new UAV FLIGHT regulations were introduced in Poland. There are new flying operation categories depicted in Figure 1.



**Fig. 1.** New flying operation categories

Source: [3].

Open flights are low-risk operations for individuals, and the lowest restrictions concern these flights. Specific operations have medium risk, and a specific operations risk assessment (SORA) is necessary to describe the required conditions for operation safety. The certified category involves the highest operation risk, and these flights should be conducted following rules similar to manned aviation [2, p. 101-105].

Poland uses drones for specialist research conducted, for instance, by the Office of Technical Inspection (UDT)<sup>1</sup>. The drones are resistant to damage, and due to their specific design, they do not cause external damage to the tested electrical installation. In the case of high objects, where access to the electrical installation is difficult, drones turn out to be irreplaceable. UAVs also perform tasks inside the tanks where electrical installations are located, thus illuminating the facility and transmitting the image directly to the monitor operated by a UDT inspector [4]. As Konert noticed, the Regional Inspectorates of Environmental Protection (WIOŚ)<sup>2</sup> use drones to manage waste and control threats [5, p. 72]. Drones allow WIOŚ inspectors to check places where criminal practices occur, e.g., illegal vehicle dismantling. In addition, drone images aid the preparation of audiovisual and photographic documentation of a given area [6]. Border guards utilize unmanned aerial vehicles to perform official tasks related to the protection of the state border. They are equipped with Fly Eye UAV sets, which are perfect for the reconnaissance of the border.

The police use drones to carry out road checks, identify dangerous drivers, measure speed, detect crimes and offenses, and for other statutory tasks. Drones also help the police search for missing people. The main types of drones used by the police are the DJI models [7].

<sup>1</sup> The Office of Technical Inspection (UDT) – a state institution in Poland that supervises and controls the safety process of devices under technical supervision.

<sup>2</sup> Regional Inspectorates of Environmental Protection (WIOŚ) – a state institution in Poland that monitors compliance with environmental protection regulations.

Drones aid the State Fire Service (PSP) in quickly and accurately assessing various emergencies. In addition, drones help effectively protect firefighters during rescue operations [8].

Governments should prepare fire prevention policies to react quickly and detect in advance [9]. Research conducted in Texas shows the effectiveness of fire-extinguishing balls that can be attached to drones. These types of extinguishers could help fight fires [10]. T. Kilby and B. Kilby described a Swiss group that constructed a GIMBAL UAV that can hit obstacles and roll on surfaces. This drone can conduct tasks in small rooms [11, p. 162].

Due to the various functionalities of unmanned platforms, they are applied for various tasks. For example, drones sprayed disinfectants in public places during the COVID-19 pandemic. State services used such solutions in Italy and Spain. In France and Belgium, drones were used to monitor streets and detect large numbers of people. Various messages were issued from the unmanned platforms warning about the spread of the virus [12].

Unmanned aerial vehicles are more and more often perceived as a tool supporting search and rescue operations. UAVs are frequently utilized due to their low cost of operation. Compared to manned aviation, UAVs are much cheaper in use. The current capabilities of UAVs are enormous and will increase in the future. As threats increase, the demand for new unmanned aviation technology is growing. Unmanned aviation is constantly developing, and thanks to technological progress, it can carry out advanced and precise tasks. The exchange and receipt of information by competent state authorities during an emergency can minimize its effects.

Poland ensures security through proper management of various branches of state administration. Moreover, in the era of today's technical possibilities, good armament and continuous modernization of the army and other formations make us feel safer [13, p. 277].

## **2. Results of research on drone use by the State Fire Service**

The research was conducted among 48 State Fire Service officers serving in units belonging to the Provincial Headquarter of State Fire Service in Lublin. The primary method used in the research was a questionnaire and an expert interview (with one PSP officer). There was one main topic in the conducted questionnaire and an expert interview: drones' usefulness for State Fire Service operations<sup>3</sup>. Unmanned aerial vehicle systems and their usage in various State Fire Service tasks were the main subjects of research conducted by the author. The main research problem was the following question: In what tasks of the PSP would a drone be useful?

The central part of the anonymous survey was the question about useful drone functionalities for the performance of official tasks by the PSP. The respondents often replied that drones would help the PSP search for missing people, inspect flood embankments, identify and locate large fire outbreaks, measure air chemical composition, and control the condition of rivers and water. Most of the surveyed persons agreed that drones would be useful in performing official tasks of the State Fire Service. Respondents often described the infrared camera as UAV's functionality helpful for missing person search, fire reconnaissance, and precise localization. The author focused on the PSP officers' opinions about possible UAV's usage for supporting tasks conducted with equipment already available to the PSP. According to most respondents, drones could execute tasks in challenging localizations. This is difficult

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<sup>3</sup> The questionnaire included items concerning gender, age, years in service, waste management drones' usefulness, PSP tasks, and drone functionalities. For the purposes of this article, the expert interview focused only on drone usefulness for the PSP.

during firefighting when often the environment does not allow to localize the fire or flood epicenter. Respondents also indicated drone usefulness for firefighting equipment transport to difficult localizations.

An expert interview with an officer of the State Fire Service showed that unmanned platforms would be instrumental in performing tasks under PSP Act. Aerial control and monitoring of large forest complexes during a fire or flood would be very efficient. Direct relay of information from the air to the command post far away from the place of danger is highly recommended. A PSP officer in charge of a given search and rescue operation would be able to manage the relevant rescue and firefighter units properly. Because of specialized flying platforms equipped with infrared cameras, it is possible to conduct effective threat identification at nighttime. This kind of solution would be helpful in large-scale rescue, search, and firefighting operations. Modern drones have a lot of functionalities that, together with compatibility, could support PSP officers.

The analysis of UAV employment by firefighting units showed that they are used both in Poland and Europe. The State Fire Service performs its statutory duties based on the provisions of the State Fire Service Act dated August 24, 1991. The basic tasks of the State Fire Service include identifying fire and other local hazards, organizing rescue actions during fires or natural disasters, and eliminating local threats [14].

Global changes and research show that new technologies are implemented more often to meet human needs. The threats and civilization challenges that disturb the existing balance allow using new technologies in environmental protection, fire protection, rescue operation, public order, and safety. The above is possible thanks to new technologies [15, p. 170]. Unmanned aerial systems will improve the capabilities of air surveillance and reconnaissance. The UAVs equipped with multisensor systems will enhance their capabilities because of radar and synthetic apparatus usage. The employment of a wide range of technical devices in the future will provide most categories of reconnaissance information [16, p. 144].

Proper reconnaissance and aerial observation help gather valuable information for saving human life and health. During search and rescue operations, information on the specific location of a given threat is critical. In case of large fires, the firefighter unit's area of responsibility is extensive. Fire outbreak reconnaissance should be correctly coordinated to deploy all different units taking part in the action effectively. Combining the optoelectronic capabilities of the UAV with the experience of the officers of the State Fire Service gives a great chance to eliminate fire hazards.

Ensuring security is the responsibility of many people and institutions. Ensuring safety is the responsibility of the citizens themselves. It is also the statutory responsibility of the police, commune or district local governments, and many institutions responsible for security [17, p. 402]. State institutions are responsible for providing the correct level of security. Using UAVs during search and rescue operations improves the potential of individual state services. The efficiency of state bodies during crises depends on the tools used by relevant services. UAV technology undergoes enormous innovation and continuous development.

## Conclusions

Preventing unfavorable events is very important from the point of view of state security. Crises must be properly supervised and controlled. Crisis management is an element of national security management, consisting of organized defense and protection against external and

internal threats [18, p. 104]. Crisis management is a unique type of organization, institution, and country management during dynamic and time-compressed situational challenges which hit directly in safety standards of this organization [19, p. 287]. Due to the development of civilization, our life becomes more comfortable. Unfortunately, modern technological advances have made us dependent on them. The disruption and destruction of critical infrastructure may pose a threat to human life and health and, consequently adversely affect the functioning of the state [20, p. 179]. Continuous technological development causes many risks, including terrorist threats. Modern lifestyle causes criminal groups to implement new forms of activity, including UAV usage. Procedures for conducting search and rescue operations are also constantly changing. The efficiency of operation depends on the quick and properly analyzed decision process.

Only a few State Fire Service units are currently equipped with unmanned aerial vehicles. It could be caused by lacking specialized personnel and constantly changing unmanned technology learning processes.

An example of saving human lives by UAVs is the rescue operation during the flood in Madrasa, India, where over 200 people were saved. Security services used drones to search for survivors and people trapped in ruins. Unmanned aerial vehicles monitored the risk areas. Thanks to the functionalities of the drones, it was possible to locate about 200 people. The images of the road were relayed for careful analysis. Direct image relay made it possible to send rescue units to the identified locations. According to the National Disaster Response Force (NDRF) data, over 25,000 people lost homes during the above-mentioned flood. The flood destroyed urban infrastructure, and the increasing rainfall completely devastated the telecommunications networks within two days. People could not access transportation services, the Internet, or electricity. Thanks to unmanned aviation, the number of victims of this disaster was reduced [21]. Another example of innovation in unmanned aviation is the launch of the world's first intelligent high-capacity airborne firefighting device. The EHang 216F drone designed by the Chinese EHang specializes in firefighting on high-rise buildings (skyscrapers). Due to a large number of such constructions in China, the EHang 216F may become the basic equipment of Chinese fire brigades. The maximum operational altitude of this type of drone is 600 m. The drone has a load capacity of 6 extinguisher projectiles and 150 liters of firefighting foam. Additionally, this unmanned platform is equipped with a varifocal camera, allowing quick fire identification. The drone can locate the place of fire with high accuracy with a laser sight and use extinguisher projectiles and foam to fight the fire [22]. There are many examples of effective UAV usage like this, proving that these devices are becoming more reliable.

Taking into account the variety of UAV application possibilities in rescue and firefighting operations, UAVs can be divided according to their use. The basic one is the utilization of UAVs to perform terrain imaging, training, and training UAV pilot skills. On the other hand, the specialist UAV usage includes the above-mentioned tasks and additionally ensures data collection from various sensors, image transfer to external devices, and the data processing capability. The main areas of UAV usage by firefighting units include observation, infrared imaging, mapping and antiflood protection verification, structure safety assessment, threat identification, mapmaking, delivering small loads, etc. [23].

Undoubtedly, during each search and rescue operation analysis, we will find a problem that can be solved with an unmanned platform. Unmanned technology has certainly taken the economic market. UAV use by various state institutions is critical to maintaining an adequate

security level. The current development of UAVs is related to their new tasks' requirements. Modern unmanned technologies influence new reconnaissance potential, both civil and military.

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### Conflict of interests

The author declared no conflict of interests.


### Author contributions

The author contributed to the interpretation of results and writing of the paper. The author read and approved the final manuscript.

### Ethical statement

The research complies with all national and international ethical requirements.

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## Biographical note

**Rafał Parczewski** – LTC, PhD Eng., assistant professor at the Military University of Technology. His scientific interests are unmanned aerial vehicles in various state security systems and issues related to Poland in Schengen Area. The author is also interested in ICT systems used by state services and institutions to maintain a high-security level. Participant in numerous conferences about UAV usage in search and rescue operations.

## Zastosowanie lotnictwa bezzałogowego w jednostkach Państwowej Straży Pożarnej (PSP)

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### STRESZCZENIE

Artykuł opisuje wyniki przeprowadzonych badań wśród funkcjonariuszy Państwowej Straży Pożarnej (PSP). Tematem przeprowadzonych badań było wykorzystanie bezzałogowych statków powietrznych (BSP) w realizacji zadań służbowych PSP. Do głównych zadań ustawowych Państwowej Straży Pożarnej należy m.in. rozpoznanie zagrożeń (głównie klęsk żywiołowych) oraz ich zwalczanie. Niektóre jednostki organizacyjne Państwowej Straży Pożarnej są wyposażone w bezzałogowe statki powietrzne i wykorzystują w pełni ich funkcjonalności. Systemy bezzałogowe są coraz częściej używane przez wiele instytucji państwowych. Bezzałogowe statki powietrzne mogą być przydatne podczas prowadzenia akcji poszukiwawczo-ratowniczych, kontroli odpadów



czy monitoringu środowiska. Obecne możliwości lotnictwa bezałogowego są bardzo rozległe i często ratują życie oraz zdrowie ludzkie. Liczne przykłady wykorzystywania lotnictwa bezałogowego podczas pandemii COVID-19 pokazały ich ogromny potencjał i szeroki wachlarz możliwości. Wyniki przeprowadzonych badań udowadniają, że BSP są przydatne w Państwowej Straży Pożarnej, zwłaszcza podczas prowadzenia poszukiwań osób zaginionych czy w trakcie akcji gaśniczych. Z uwagi na cykliczny charakter występowania sytuacji kryzysowych w Polsce konieczne jest wyposażanie jednostek Państwowej Straży Pożarnej w BSP.

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**SŁOWA KLUCZOWE** bezpieczeństwo, bezałogowe statki powietrzne, zagrożenie, misja

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