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# Selected Issues of the Use of Unmanned Work Platforms in the Prison Service with a View to Internal Security and Human Resources

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***Abstract:***

***Purpose:*** *This article provides a brief overview of unmanned aerial vehicles (UAVs), including military ones, used by uniformed services: the Border Guard and the Police, with particular emphasis on the prison service.*
***Design/Methodology/Approach:*** *A conceptual architecture for a system using unmanned work platforms in prison services is presented, with reference to internal security and staffing capabilities using drone technology. An example prison security scheme is proposed, along with integration and control modules.*
***Findings:*** *Selected technical and logistical aspects of the use of these platforms by national uniformed services are discussed.*
***Practical Implications:*** *The article highlights the potential for specific applications of this technology in the prison system and analyzes selected effects of such applications, taking into account systemic and economic aspects.*
***Originality/Value:*** *An innovative system for protecting prison infrastructure is proposed. The system's structure is open, user-friendly, and cost-effective to implement and maintain.*

***Keywords:*** *Unmanned platforms, prison services, internal security, protection system, infrastructure.*

***JEL codes:*** *O31, O36.*

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## 1. Introduction

In recent years, we have seen a spectacular development of unmanned flying platforms-drones, their technical capabilities, and a rapid increase in applications in different areas of life. Such devices are currently used for private purposes, in the civil economy, in uniformed services, especially in the military. Military applications, including unmanned combat aerial vehicles, have intensified with the outbreak of conflict in eastern Europe, following Russia's invasion of Ukraine.

The use of drones for various purposes by national uniformed services is often publicized in the media, recently, for example, in the context of the need to protect our eastern border, as a flank of NATO and in the aspect of the migration crisis. Drones are used by police for both operational and law enforcement tasks, including law enforcement and traffic control services.

Unmanned aerial platforms and their illegal use can pose a serious threat to the national penitentiary system. Examples of such applications are described in expert studies and available in the media. Author of the study (Ochron, 2024) describes in detail such threats and provides ways to neutralize them. Mentioned in this context of measures taken to protect prisons from unauthorized penetration is, for example, the Correctional Facility in Czarne, Poland, which in 2022 acquired a modern drone neutralizer.

Unmanned flying platforms and their associated equipment can also be used by prison services to enhance the security of their units.

This paper presents the concept of the architecture of such a system using drone technology, examples of its functionality, capabilities, and advantages of its application.

## 2. Literature Review

A significant development in the field of unmanned aircraft use was the establishment of the Remotely Piloted Aircraft Systems Panel (RPAS), whose activities led to new regulations and the development of amendments to the annexes to the Chicago Convention. Technical and technological developments in the field of UAS have led to a holistic approach to adapting airspace to new requirements. The overall assumptions focused on maintaining an appropriate level of safety.

Much attention was paid in literature and procedures to identifying and mitigating threats. In 2017, as part of projects implemented by ICAO, the RPAS operational concept was published, dedicated exclusively to certified unmanned aircraft. EU regulations primarily address the nature of air operations based on risk management. All work, both international and European, focuses on issues related to the safe use of drones.

The implementation of new legal standards, their expansion, and updating are carried out in response to the constantly evolving range of threats posed by continuous technological progress. Work also focuses on registering drone users and defining training requirements. A significant element addressed in the publications is the standardization of drones (CE) and their adaptation to applicable requirements.

Implementing regulations indicate the need to introduce a new classification of UAVs. M. Feltynowski and especially A. Konert strongly emphasized these needs in their analysis of the legal aspects of using unmanned aerial vehicles. This article cites these important publications.

Analyzing scientific materials for the phrase "unmanned aerial vehicles in the service of internal security," we obtain approximately 1,457 results, while for the phrase "security and threats in general," we find approximately 40,000 results. Scientific studies on UAVs do not yet provide a complete state of knowledge about the specifics of the technology.

## 3. Research Methodology

A conceptual architecture for a system using unmanned work platforms in prison services is presented, with reference to internal security and staffing capabilities using drone technology. An example prison security scheme is proposed, along with integration and control modules.

Axiomatic-deductive methods were used to develop a model and diagrams of the basic elements of the prison's security system and its facilities, relying on logical facts, proofs of reliable theorems, and other assumptions about the automation of the design of specific types of systems, such as platforms. A necessary step for this practical proposal was to map the source model to the target model of the entire integration transformation.

## 4. Research Results and Discussion

### 4.1 Review of the Use of Unmanned Platforms by the Military and Uniformed Services with a Particular Focus on National Services

An unmanned flying platform can be considered a type of light aircraft controlled remotely. By definition (Rogowski, 2013; Adamski, 2015) this is an unmanned aerial vehicle (UAV) forming part of an unmanned aerial system (UAS), drone – aircraft which can fly without crew on board and is not capable of carrying passengers, remotely piloted or flying autonomously.

Devices of this type can be classified according to different criteria (Parczewski, Borucka, and Radwan, 2023). It may be ruled by, among other things:

a) purpose - utility function,
b) technical parameters, including in particular drive, power supply (energy source),
c) operating parameters and especially range, unladen weight and dimensions, lifting capacity,
d) on-board equipment and work equipment.

Such unmanned flying platforms can be especially useful and helpful in the activities of national uniformed services. In recent years, unmanned aerial vehicle (UAV) technology, commonly known as drones, has become a key component of modern military systems around the world.

Drones play a significant role in military operations, fulfilling a wide range of tasks: from reconnaissance and intelligence to logistical support and combat missions. With its broad operational capabilities, UAV can provide real-time surveillance of airspace, front-line surveillance, and real-time intelligence. The ability to conduct long-term missions without risking the lives of military personnel makes these technologies extremely valuable on the modern battlefield.

Unmanned aerial vehicles used in the military perform many important operational functions. In intelligence missions, drones are equipped with advanced thermal imaging cameras, motion detectors and geolocation systems for precise terrain monitoring and potential threat detection. With such features drones support the command in planning operational tasks and predicting enemy movements, which is crucial in modern military operations.

Combat drones, equipped with modern reconnaissance technology and weapons, are capable of precise attacks on designated targets. The use of such UAV minimizes civilian and own force losses, which is especially important in asymmetric conflicts, where the enemy operates in hard-to-reach areas, often in civilian areas. In logistical missions, UAVs (Kraszewski, Kaniewski, and Kubicki, 2013) transport supplies and equipment to troops in remote or hard-to-reach areas, such as mountainous areas or conflict zones, which allows for the continuity of operational units' coverage.

Modern conflicts, especially those in urbanized areas, require the ability to respond quickly and precisely to threats. Drones with on-board artificial intelligence and autonomous systems are increasingly used in the military, offering operational, logistical and rescue support.

With the ability to quickly analyze the terrain, these drones can identify threats, which is crucial in emergency situations such as bombings or surprise attacks. This shows that drones are not only a tool of combat, but also operational support in activities related to territorial defense and international cooperation.

The military uses of drones have also inspired uniformed services such as the police, border guard, and prison service to adapt these technologies in their daily operations. In the context of prison services, UAVs play a vital role in monitoring penal institutions, supervising space and preventing threats related to attempts to smuggle contraband or escape. Regular air patrols can inspect hard-to-reach areas, such as external walls, and provide prison guards with quick access to real-time visual data, enabling their immediate m response to suspicious behavior.

In crisis situations, such as riots or escape attempts, drones provide ongoing monitoring of the course of events and support guards in coordinating actions. Automation of these devices allows to reduce the headcount of personnel involved in direct supervision, allowing to optimize human resources. This solution is not only economical, but also beneficial from the perspective of safety of staff, which can be redirected to more specialized tasks.

Drones used in penitentiary facilities contribute to the prevention of contraband, enabling more effective counteracting to smuggling of drugs, mobile phones, and weapons. Equipped with surveillance systems, drones can track suspicious objects in the area around the detention facility, enabling immediate response to potential threats.

The use of drones also reduces operational costs by reducing the number of guards involved in patrols. Thanks to aerial monitoring, personnel can be redirected to more specialized functions, and alarm systems integrated with drones immediately detect threats. In emergency situations such as riots or fires, UAVs provide up-to-date visual data to support the coordination of rescue and evacuation operations.

According to the literature review, unmanned platforms are currently available on the commercial market and can be used in unauthorized activities that threaten the penitentiary system. From the point of view of efficiency and the safety of the prison system operation, human hazards (inmates and prison service) these may be the following unauthorized and undesirable actions with the use of unmanned flying platforms:

1. Risk of smuggling prohibited items. Based on data from French penitentiary units (Ochrona, 2024) only "in 2021, there were 37 unauthorized flights, 5 of which were identified as attempts to smuggle contraband. In 2022, 68 such flights were already observed, of which 29 were found to be used for smuggling. This is an increase of 83% year on year.” (Ochrona, 2024) The most frequently smuggled items include: drugs, alcohol and other stimulants, electronic equipment, mainly phones with SIM cards and memory cards, other storage media, tablets, chargers, batteries, as well as cash and white weapons.
2. Drones-unmanned platforms with appropriate lifting parameters can also be used to deliver items that can help in escape, such as files, metal balls, drills,

crowbars, cutting objects and devices and other such accessories, including sharp objects that can be used as attack tools.

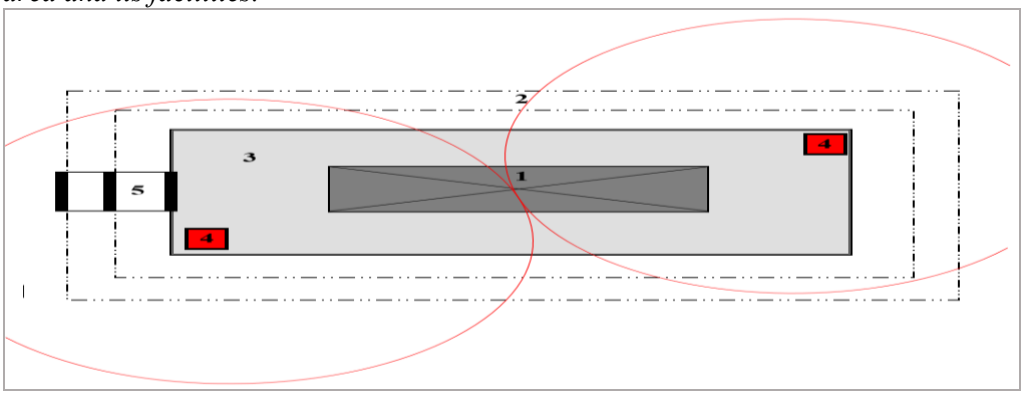
### 4.2 Selected Technical and Logistical Aspects of the Use of Such Platforms by the Prison Service for Internal Security

In view of the growing threats of unlawful actions against the national penitentiary system, measures are being taken to protect prison units from drones. Various measures are used to protect prisons. Depending on the type of threat, these can be the following actions:

- intercepting a flying drone in nets fired from hand-held or stationary throwing devices,
- intercepting a flying drone in a net carried by other drones,
- mesh or lattice partitions,
- recognizing communications and sending own control signals to take control of the flying drone,
- interference with control signals sent by the drone operator,
- interference with satellite geolocation systems, e.g., GPS,
- other direct measures, including, for example, the use of firearms to shoot down, or the use of a water cannon – to prevent flight with a strong stream of water.

In order to broadly protect against the aforementioned threats to the national penitentiary system, unmanned aerial vehicles may also be used. This part of the work presents a concept of the architecture of such a system using drone technology. Fig. 1 shows a diagram of the basic components of such an innovative system, on the example of a single prison block/ building or other building requiring special supervision.

***Figure 1.*** *Diagram of the basic components of the system of protection of the prison area and its facilities.*




***Source:*** *Own study.*

The protected building (1) is located on a fenced plot (3), around which there is an additional external surveillance zone (2) and other supervised objects. The only way to access the building (1) is through the gates (5). On the protected plot (3), in its two opposite corners, operational stations (4) with UAVs were built.

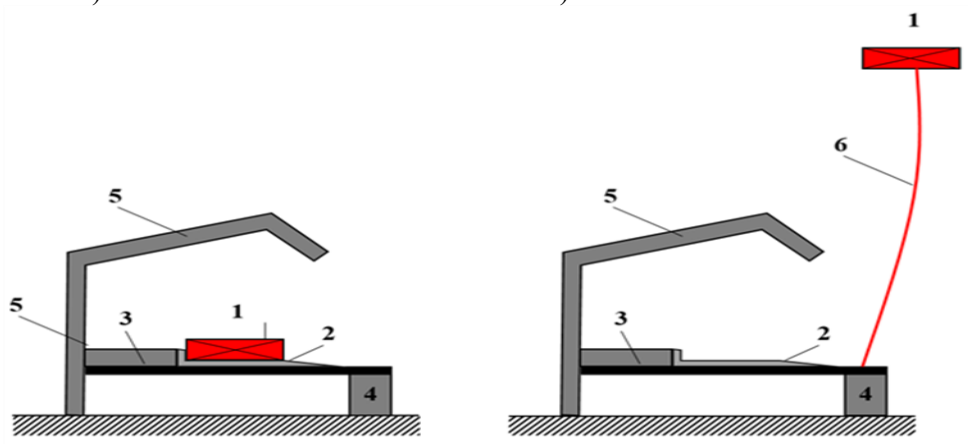
The operational range of a single station in basic tethered mode is limited. Therefore, to improve the effectiveness of the protection system, it is necessary to select the number of cooperating operational stations.

In Figure 1, a red line indicates the operational range of two stations (4) located at the corners of a typical rectangular plot. For a single, typically shaped protected building (1), as shown in Figure 1, this is the optimal set-up.

Diagram of a single operational station (marked 4 in Figure 1) built in the basic variant based on an unmanned tethered flying platform is shown in Figure 2. Figure 2a shows the components of the operational station in the phase of waiting for a drone (1) on the charging dock (2) set on the launch platform (3). The operational station is enclosed by a shield (5) that protects the launch platform, the charging dock, and the operational drone from the impact of atmospheric factors.

***Figure 2.*** *Diagram of a single operational station based on an unmanned flying platform: a) waiting position at the dock, b) working phase - drone in hover/patrol flight.*

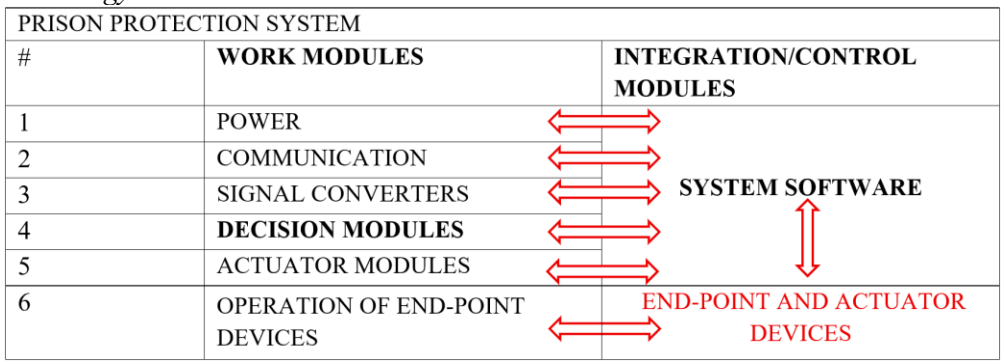
a) b)




***Source:*** *Own study.*

Figure 2b shows the components of the operational station in the working phase when the drone (1) performs a tethered patrol flight. The line (6) holding the drone at operating altitude is also the power line of the flying platform and the wired data transmission bus to the integration/ control module of the protection system shown in Figure 3.

***Figure 3.*** *Diagram of the prison security system architecture concept using drone technology.*




***Source:*** *Own study.*

The structure concept of the prison security system using drone technology, shown in Figure 3, corresponds to various variants of this system, including the basic variants presented in Figures 1 and 2.

The basic variant of the system, described above, is distinguished by its high operating autonomy and the difficulty of disrupting/preventing its operation.

Variants of the prison protection system derived from the basic one may be equipped with different final/executive devices - Figure 3. They can employ another class of unmanned flying platforms with better flight parameters and with richer equipment. Such platforms can have significantly improved functionality, enhancing the performance of the entire protection system. At the same time, this will entail higher costs of the protection system's deployment/commissioning and maintenance.

## 5. Proposals, Recommendations - Analysis of the Possibilities of Specific Applications of this Type of Technique in the Prison Service, Taking into Account the Selected Effects

Modern penal institutions face many challenges that require innovative technological solutions. Unmanned flying platforms can provide important support for these tasks. With their mobility, precision of operation and available on-board equipment with a variety of sensors, UAVs contribute to increasing the level of security and optimizing the daily activities of prison staff.

Key aspects in favor of the growth of the use of such a system in prison service include:

- reduction of the guard headcount while maintaining an elevated level of security,
- effective prevention of smuggling and control of the space around the prison,

- support for operational tasks in crisis situations,
- automation of patrols and integration with surveillance systems.

Traditional methods of prison surveillance, based mainly on the work of guards, are expensive and require sizeable human resources. The introduction of drone systems allows to reduce the number of guards exercising direct surveillance of the prison grounds. Drones can carry out regular, automatic patrols over designated areas, monitoring key points such as exterior walls, courtyards or hard-to-reach areas where keeping personnel could be risky or costly.

Thanks to the use of drones, some personnel can be assigned to more specialized tasks that require contact with inmates or operational activities inside the facility. Reducing the number of guards in outdoor areas not only reduces the labor cost but also enhances security – minimizing the risk of personnel contact with potential external threats.

One of the biggest threats in the penitentiary system is the illegal transfer of items such as drugs, mobile phones, weapons, and money. Drones with high-resolution on-board cameras, motion sensors and GPS systems can effectively monitor the area around the prison, detecting suspicious objects or unusual behavior. With such solutions, the services can react immediately to any attempt to smuggle, increasing the effectiveness of preventive measures.

An example is the use of drones to patrol the borders of a penal facility at times when the risk of smuggling attempts is greatest. When the drone detects a suspicious object, the personnel can immediately direct the appropriate forces to intercept it. Such operations significantly increase the level of safety of inmates and staff, who in an emergency situation can focus on properly identified problems.

Prisons are vulnerable to emergencies such as riots, escape attempts, fires or other events requiring immediate response. Drones are an invaluable aid in these situations, allowing personnel access to up-to-date visual data. The drone can quickly reach the scene of an incident and provide live images, allowing the plant management to quickly assess the situation and take appropriate action.

In the event of riots or escape attempts, the drone can monitor the situation from a safe distance, allowing guards to assess the risks and plan their response well in advance. With up-to-date visual information, prison services are better prepared for effective crisis management, which increases the safety of both inmates and staff. Drones also allow bird's-eye view of the situation, which allows for a more holistic view of the course of events and faster decision-making.

One of the key aspects of drone use is the ability to automate patrols and surveillance. Thanks to programmable schedules, drones can conduct regular inspections of prison areas, especially during hours when the risk of adverse events

is greater. The automation of patrols reduces the need to involve guards in routine surveillance tasks, so that human resources can be optimally used in other areas.

In addition, the drone system can be integrated with other security systems, such as video surveillance, alarm systems, or motion detection systems. If suspicious activity is detected, the drone immediately transmits the data to the control unit, allowing quick action to be taken. Integration with other systems allows to build a coherent and comprehensive surveillance system, which significantly increases the level of security in the prison.

Sensor technologies (Mohammed and Pasam, 2020) used in the monitoring system of penitentiary facilities, using unmanned flying platforms, are an essential element of modern security solutions, providing a higher level of control and response to threats.

In systems of this type, one of the basic elements is a high-resolution video camera, which enables accurate tracking the situation in real time and precisely analyzes images. With these cameras suspicious people, objects, and activities can be constantly identified even in hard-to-reach places, such as the outer walls of the prison, which allows operators to effectively control the area. Video footage is also a valuable piece of evidence to support investigations or legal processes.

An additional, invaluable element are thermal imaging cameras that allow the detection of heat sources, which makes them an ideal tool for monitoring the area at night or in difficult weather conditions. Thanks to this technology, people and/or objects can be detected even without lighting, which is especially important during night patrols. Thermal imaging cameras are excellent when inspecting large spaces, especially during high-risk hours when smuggling or escape may be more likely.

In the monitoring systems of penal institutions, motion detectors are also used for quick and automatic detection of movement in a selected area. These detectors are particularly effective in monitoring fences, exterior walls, and restricted areas. When the sensor detects movement, the drone automatically directs the cameras to the appropriate area, allowing operators to immediately respond to a potential threat (Mahmud, Shah, and Shamim, 2018).

In turn, high sensitivity microphones capture unusual sounds, such as noise associated with an attempt at illegal activity, the sounds of explosions or conversations in places where silence should prevail. Sound sensors are particularly useful when a situation requires quick analysis and action.

With geolocation sensors such as GPS and GLONASS (Alsamhi, 2021) the drone location can be accurately determined, which is crucial when conducting automatic patrols and tracking activities over vast areas. GPS systems allow drones to move smoothly in designated zones and routes, as well as return to the docking station

after the patrol's completion (Savkin and Huang, 2019). In multi-drone system operation geolocation supports real-time coordination, reducing collision risk and improving fleet management (Savkin and Huang, 2019).

Electromagnetic sensors are used to detect and analyze communication signals, allowing the identification of unauthorized devices such as mobile phones. Their detection may be crucial for increasing control of the facility, as remote communication of inmates is one of the main security threats. The system can detect attempts to make calls from outside, which allows to immediately notify staff and prevent unwanted incidents.

Modern prison monitoring systems can also use air quality sensors and gas sensors that detect the presence of poisonous gases, smoke, and other dangerous substances. The detection of such hazards allows for quick response in emergency situations, such as fires or leaks of hazardous substances. Sensors of this type in combination with alarm systems allow instant notification of threats, which significantly increases the security level (Merkisz and Nykaz, 2016).

The introduction of modern sensors for penitentiary facilities monitoring with the aid of unmanned flying platforms makes it possible to increase control over vast areas and automate surveillance processes, which allows optimizing operating costs and better securing the facility.

Integration with other security systems, such as video surveillance and alarm systems, allows you to create a comprehensive, multi-layered protection system that is able to respond appropriately to threats and minimize the risk of unwanted incidents. Technological progress allows the use of drones for several types of operations (Merkisz and Nykaz, 2016).

Deployment of the proposed system of protection of prison infrastructure may lead to a reduction in guard staffing in such facilities. This translates into concrete savings resulting from reduction in the number of these types of jobs. Guard personnel may be employed in other positions requiring direct specialist staffing in a given prison unit.

The pension and retirement scheme poses challenges to retain experienced personnel. Due to ongoing difficulties in recruiting qualified personnel, prison services are forced to hire groups of inexperienced staff, which hampers their day-to-day operations. The key to understanding the need or necessity of applying the proposed technological solutions is to get to know the processes occurring in the area of effective human resource management and how organizations will be able to maximize efficiency (Huff and Schüssler, 2016).

The current labor market policy of modern prisons does not allow considering the effectiveness of human resources management only with a view to cost optimization.

Novel solutions should be looked for, first of all by increasing the quality and value of own human capital (Huff and Schüssler, 2016). The methods used to measure effectiveness in human resource management often do not take into account technological factors (Phillips, Phillips, and Stone, 2003).

No human resources management procedure may be effectively implemented while ignoring the factors that currently affect the way the company operates (Pawlak, 2011) by partially or completely supporting human work with information technologies. Therefore, the general formula (1) of work efficiency, which is modified as needed (working time, speed of response, stress level, and others), should be adjusted to adapt to systemic organization techniques.

$$W = E / N \tag{1}$$

where:

W - work efficiency
E - effect of work
N – workload

The human resources management system (HRMS) can be formally presented in a modified version as (Ficoń, 2000):

$$HRMS <E, R> \rightarrow \max C, \tag{2}$$

where:
E – set of system elements,
R – set of relationships,
C – purpose of HRMS.

Taking into account system modeling in the environment of dynamically changing reality and needs as a sequence of consecutive decisions controlling the processes of HRMS, in accordance with the general assumptions of system analysis the system model ($M_z$) can be decomposed into two consecutive models: the identification model and the decision model.

$$M_z = < MI_z, MD_z >, \tag{3}$$

where:
$M_z$ - mathematical model of the HRMS system,
$MI_z$ - identification model of the HRMS system,
$MD_z$ - decision model of the HRMS system.

Identification model ($MI_z$) initiates the process of mathematical modeling of the HRMS security system, the ultimate goal of which is to develop at the stage of decision modeling ($MD_z$) optimal strategies and procedures for practical action in

view of the adopted criterion for assessing the operational quality of the actual system.

Despite the many benefits of using drones, their introduction also involves some technological and organizational challenges. The cost of buying and maintaining drones can be high, especially for smaller penitentiary units. Moreover, appropriate training of personnel in the operation and maintenance of equipment is required, which entails additional financial costs.

Drones can also be vulnerable to GPS signal interference, which in a crisis situation can limit their effectiveness (Wrzosek, 2022). The potential risk of cyberattacks on a drone system is another aspect that requires special attention. Protection against such threats is essential to ensure the continuity and effectiveness of the surveillance system. In the event of failure of autonomous systems, appropriate backup operating solutions must also be provided.

## 6. Conclusions

The use of drones in penitentiary facilities opens up new opportunities for surveillance and security management. With proper deployment and protection, drone systems can effectively support the day-to-day operations of personnel, increasing the level of control and minimizing the risk of unwanted incidents. In the long term, such solutions can help to reduce operating costs and improve the organization of work in penitentiary units.

The proposed, innovative prison infrastructure protection system has the following features:

- low cost in the basic version,
- flexibility of the proposed architecture and easy implementation e.g., as a complement to existing surveillance and security systems,
- ease of use,
- simplicity of architecture and great possibilities of its adaptation to specific conditions and expansion,
- versatility of application, applicability to increase the safety level of various objects,
- such a system can be used not only by various uniformed services, but also in the civil economy and private organizations.

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