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Opportunities and Threats of Using Unmanned Aerial Vehicles (Drones) in Improving National Security Culture

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Abstract:

Purpose: *This article examines the opportunities and threats associated with the use of unmanned aerial vehicles (UAVs) in the context of national security culture. It aims to identify how UAV technology influences the resilience of national security systems and to propose preventive, systemic solutions that strengthen security culture through the integration of legal, organizational, and technological mechanisms.*
Design/Methodology/Approach: *The study adopts a systems-based analytical framework combining systems analysis, normative and legal analysis, desk research, and a conceptual case study of the proprietary UAVOcheck application. The findings are further supported by a secondary analysis of qualitative data from 15 in-depth expert interviews conducted between 2022 and 2024 with specialists representing the aviation, regulatory, operational, and national security sectors.*
Findings: *The results demonstrate the dual nature of UAV technology. While drones significantly enhance operational capabilities, situational awareness, crisis response, and critical infrastructure monitoring, they also generate new risks related to airspace violations, asymmetric threats, operator anonymity, and regulatory gaps. The study identifies the technology distribution stage as a critical but underdeveloped element of preventive security policy.*
Practical Implications: *The article proposes integrating preventive verification mechanisms into the UAV sales process through the UAVOcheck application. Such solutions can improve operator accountability, strengthen regulatory compliance, reduce systemic vulnerabilities, and enhance national resilience to emerging security threats.*
Originality/Value: *The study introduces a preventive, systems-oriented perspective to national security culture by extending security responsibility beyond public institutions to include commercial stakeholders. It contributes an original conceptual model that incorporates the technology distribution stage into national security infrastructure and presents UAVOcheck as an innovative preventive instrument supporting security by design.*

Keywords: *Unmanned aerial vehicles, drones, national security culture, UAVOcheck application.*

JEL codes: *C10, F50, K10.*

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1. Introduction

The starting point for analyzing the opportunities and threats arising from the use of unmanned aerial vehicles is defining the essence of national security culture. This category refers to the values, norms, attitudes, and behavioral patterns ingrained in society and state institutions, aimed at ensuring the security of the state and its citizens. It encompasses both the level of threat awareness and the willingness to respond to them in a systemic and responsible manner.

In the context of the dynamic development of unmanned technologies, security culture is becoming a determinant of the state's effective adaptation to new security challenges.

The development of unmanned aerial vehicles (UAVs) is a manifestation of the broader process of security techno-logicalization. Airspace is no longer a domain reserved exclusively for state entities and manned aviation, but is becoming an area of commercial, civilian, and potentially criminal and hybrid activity.

The objective of this article is to identify the opportunities and threats arising from the use of UAVs in the context of national security. The practical objective of the study is to identify directions for improving systemic and organizational solutions that enhance national security culture in the context of the dynamic development of UAV technology.

The main research problem was defined as follows: How does the use of unmanned aerial vehicles (UAVs) affect the level of national security culture? Specific problems can be divided into specific categorizations:

1. What functions and tasks UAVs can contribute to strengthening a national security culture?
2. What threats to national security are posed by uncontrolled or improperly regulated drone activity in airspace?
3. How does the development of UAV technology influence the attitudes, awareness, and behaviors of security stakeholders?
4. Do existing legal regulations and systemic solutions support the development of a safety culture in the area of drone use?

5. What organizational, educational, and technological activities can mitigate the risks associated with the use of UAVs and enhance their positive impact on the national security system?

The originality of this study lies in introducing a preventive and systems perspective to the security science discourse, focusing on the distribution of unmanned aerial vehicle (UAV) technology as a crucial, yet under-recognized element of the national security system. The literature on the subject is dominated by analyses of the operational use of UAVs, threats to airspace, legal regulations, and counteracting terrorist or sabotage incidents. Less frequently, however, is the significance of the sales phase as the moment that initiates the user's relationship with the system of national security norms and responsibilities.

The article's contribution to security studies is:

- Expanding the concept of national security culture by incorporating control and education mechanisms operating outside the traditional state apparatus, including in the commercial sector. The article demonstrates that security culture is not solely the result of public institutions' actions, but rather the result of the interaction of market, technological, and administrative entities.

- Proposing a new level of operationalization of national security, encompassing the stage of introducing technology into the market as an element of security infrastructure. In this approach, national security is not limited to responding to threats but encompasses designing solutions that minimize risk at the level of access to technology.

- Introducing the concept of distributed security responsibility, according to which economic entities participate in the process of building state resilience through the implementation of verification and information procedures.

This concept is embodied in the proprietary UAVOcheck sales application, which serves as a verification tool for drone buyers and operators at the purchasing stage. This solution represents an organizational and systemic innovation and aligns research on preventive instruments for strengthening national security. This article thus contributes to the growing research on the state's adaptability and resilience to new technologies, demonstrating that building a culture of national security requires a shift in emphasis from reactive actions to preventive, systemic solutions.

2. Literature Review

The literature on unmanned aerial vehicles (UAVs) covers many legal, technological, and ethical aspects, as well as practical and futuristic applications. Publications describe futuristic visions of drone implementation in various industries. However, reliable studies in the area of aviation safety, containing

estimated data, are less common, and access to them has been provided primarily by airspace control authorities and research institutes. Within an interdisciplinary approach, literature can be divided into specific categories:

- Law/regulations – as technology develops, new legal challenges arise. Scientific publications describe regulations regarding the use of UAVs, privacy, security, and legal liability issues;

- Technology/engineering – studies on UAV design, systems, sensors, and software. These publications often focus on innovations in aerodynamics, materials, and system autonomy;

- The future – many publications speculate on development trends, technological innovations, and their impact on various industries;

- Applications – literature describing the directions of UAV implementation, their effectiveness, and the benefits of their use;

- Ethics and Society – studies covering ethical issues related to drone operation, their impact on society, surveillance issues, and potential security threats.

The dynamic development of UAV operational capabilities is a premise for further research and ongoing analyses in this area. Many studies examine how drones can pose a threat to manned aircraft, especially in the context of collisions.

These publications often analyze incidents and propose solutions to minimize the risk. Despite the collection of this data, however, a critical risk analysis to guide action is often lacking. A catalog of measures to limit the unwitting use of UAVs by amateurs is still lacking.

In the area of specialized data from scientific studies, source materials from global research institutes and organizations implementing new solutions in the field of drone implementation were of greatest importance. These include the University of Alaska Technical Report "Investigation of Drone Applications to Improve Traffic Safety in RITI Communities" (Ban, 2023), the University of Michigan study "Drones and support for the use of force" (Walsh, 2018), and the University of Southampton's concise publication "Advanced UAV aerodynamics, flight stability, and control: novel concepts, theory, and applications" (Pascual, 2017).

The substantive scope of the work is also largely based on the scientific achievements of national institutes, primarily the Institute of Aviation. The foundation for the hypotheses is a study resulting from a series of conferences organized by the Łukasiewicz Research Network with high-class specialists, containing several supported forecasts – "Scenarios for the development of the drone market until 2040" (Institute of Aviation – Research Network, 2024).

The literature search and development of the theoretical and empirical foundations for this article utilized the findings from the author's dissertation (Bolz, 2025) on the concept of using unmanned aerial vehicles (UAVs) to ensure aviation safety. This dissertation provided a significant source of analytical knowledge and empirical material, encompassing both a literature review and the results of qualitative research conducted with experts.

For the purposes of this study, a secondary analysis of the collected research material was conducted, particularly the conclusions drawn from individual in-depth interviews, as well as data relating to identified threats and opportunities related to UAV operational performance. The obtained results were reinterpreted in the context of national security culture, allowing for their adaptation to a new research perspective.

Thus, the author's dissertation from 2025, entitled "The Concept of Using Unmanned Aerial Vehicles (UAVs) to Ensure Aviation Safety," provided not only a theoretical starting point but also an empirical basis for in-depth qualitative analysis. The translation of the results of previous research into the purposes of this article was complementary and served to extend the existing findings to include a systemic dimension, relating to opportunities and threats to national security and shaping a safety culture in the area of the use of unmanned aerial vehicles.

3. Research Methodology

Every action undertaken in the field of security must be aimed at achieving specific results, conditioned by the existence of precisely defined, measurable goals confirmed by scientific research. A method is generally understood as a system of assumptions and rules that allow for the ordering of practical or theoretical activities to achieve the intended goal.

In scientific literature, the concept of a research method is defined as follows: it should be assumed that it is a method of research characterized by both specific actions (research procedure) and the use of appropriate research tools, moreover, in a repeatable manner. The essence of a research method should aim to coordinate the procedure with the intended research goal (Apanowicz, 2002).

Research is embedded in the systemic security paradigm, according to which national security is viewed as a dynamic, multidimensional system of interconnections between entities, regulations, technology, and social factors. In this approach, unmanned aerial vehicles are treated not only as a technical tool but also as an element of the security environment, influencing both the level of threats and threats.

An analytical perspective based on the dichotomy of opportunities and threats was adopted, which captures the ambivalent nature of drone technologies. This approach

allows for an assessment of the impact of UAVs on national security culture, both in terms of strengthening (e.g., through the development of operational capabilities and situational awareness) and destabilizing (e.g., by generating new asymmetric risks).

Taking the above into account, we can clearly define the methodological framework. Therefore, the article employs:

- System analysis of the security environment,
- Normative and legal analysis of UAV regulations,
- Desk research method,
- Conceptual case study element (a proprietary sales application as a model for a preventive solution).

Systems analysis was the primary research method, allowing for the identification of relationships between:

- UAV technology,
- State institutions responsible for security,
- Legal regulations,
- Commercial market entities,
- Individual users.

The use of systems analysis demonstrated that national security culture is an emergent category, emerging from the interactions of many entities, and not solely the result of state actions.

The normative and legal analysis revealed that the legal system focuses primarily on the drone operation phase, while the distribution phase remains relatively weakly embedded in the preventive security system. As a result, an area of potential vulnerability is emerging that may impact the level of national security culture.

The desk research method was used to:

- Review the scientific literature in the field of security sciences,
- Analyze reports from international and national institutions regarding drone incidents,
- Identify technological trends and directions of development in the UAV market,
- Compile data on threats and positive applications of drones.

This allowed us to place the considerations in the current context of national security and to validate the adopted analytical model.

A significant methodological element is a conceptual case study of the proprietary UAVOcheck sales application. This study serves as a model and serves to illustrate

the possibilities of implementing preventive solutions within the national security system.

As part of this research component:

- The functional assumptions of the application were defined (identity verification, authorization confirmation, educational component),
- Its place in the security system structure was determined,
- The potential impact of implementing the application on reducing the risks associated with the uncontrolled distribution of UAVs was analyzed,
- Its importance for improving security culture through preventive mechanisms was assessed.

The use of a conceptual case study allows for a transition from the theoretical to the applied level, which enhances the practical value of the article and its contribution to security science.

Methodologically, the article aligns with the research on the adaptability and resilience of national security systems to new technologies, demonstrating that effectively improving security culture requires the integration of legal, organizational, and digital solutions at the technology distribution stage.

4. Research Results and Discussion:

4.1 Opportunities and Threats Arising from the Operability of Unmanned Aerial Vehicles

The use of unmanned aerial vehicles can contribute to improving national security culture by:

- Increasing the effectiveness of border and critical infrastructure monitoring,
- Supporting crisis management operations,
- Developing reconnaissance and preventive capabilities,
- Raising situational awareness of public services and administration,
- Shaping new standards of inter-institutional cooperation.

The educational function is also crucial – disseminating knowledge about the responsible and lawful use of drones can strengthen pro-safety attitudes in society.
At the same time, the development of UAV technology generates threats that can undermine security culture, especially in the absence of appropriate regulations and oversight. Key threats include:

- Violations of airspace and critical infrastructure,
- Use of drones for criminal or terrorist activities,
- Difficulty identifying operators,

- Overloading air traffic control systems,
- Possibility of conducting reconnaissance operations against state institutions.

These threats are not only technical but also cultural in nature, as they can lead to an erosion of public trust in institutions responsible for security.

To further identify the real threats resulting from the increased operational use of unmanned aerial vehicles, a qualitative study was conducted in the form of an extended expert interview. The study formed the empirical portion of the author's dissertation addressing the concept of using UAVs in ensuring aviation safety (Bolz, 2025).

A total of 15 individual in-depth interviews were conducted with experts representing the aviation, operational, regulatory, and national security communities. The research was conducted between October 2022 and November 2024, capturing the dynamics of regulatory and operational changes in the UAV field. Analysis of the collected empirical material enabled the identification of key categories of opportunities and threats that directly impact the level of national security culture.

Table 1. *Classification of the surveyed experts*

Expert Interview	
Institution	**Number of interviews conducted**
European Union Aviation Safety Agency	1
Civil Aviation Authority	1
Head of the Air Traffic Service of the Armed Forces	1
Air Force Institute of Technology	4
Special Unit	1
Air Ambulance Service	1
Commercial UAV Operators	3
Aircraft Navigator	1
Light Aircraft Pilot	1
Helicopter Pilot	1
TOTAL:	15

Source: *Authors' own research.*

As part of this interview, based on the experiences of the experts participating in the study, critical areas requiring strengthening were identified (Bolz, 2025). Based on the identified problem areas, corrective measures were proposed that could improve the current situation.

Table 2. *Critical areas of UAV activity*

Problem area	**Suggestions for possible solutions to the identified problem**
Level of training of operators	Verification of the training program and examination in the drony.ulc.gov.pl system, in particular issues in areas such as "airspace use restrictions" and "aviation regulations".

Low awareness of UAV operators	Verification of the training program (including the examination method – mainly the issue of online examinations) and imposition of increased penalties/fines for crimes related to the inappropriate (sometimes also unintentional) use of UAVs.
Civil-military information flow	Military air traffic controllers are not provided with information in the absence of a telephone notification. A significant element contributing to improved safety would be the military's acquisition of the Pansa UTM system.
Operator registration	Every operator must be registered. Drones can pose a serious threat, and balancing safe operation is a demanding task, requiring constant monitoring of the situation and the implementation of appropriate tools.
Systems for taking control of drones operating illegally	Efforts should be made to implement systems for taking control and potentially neutralizing drones operating in violation of authorization. There are many popular solutions worldwide that should also be applicable in Poland. For example, the incident at Warsaw Chopin Airport: a flying object was identified, the pilot reported seeing a dangerous object, but unfortunately, a lack of appropriate equipment prevented the drone from being removed.
Airport security	When analysing the balance of benefits and losses resulting from attempts of unlawful intrusions of undesirable UAVs into airports, the priority is to prevent any foreign UAVs from entering this area of critical infrastructure – even if the use of appropriate tools would prevent the movement of all UAVs, including airport ones.
Controlled airspace	Currently, there are no clear procedures for the use of UAVs in controlled airspace or for the transfer of command and responsibility.
Increased UAV operability	Due to the increased operational use of UAVs, most aviation safety systems require adaptation to the current airspace situation. Reorganizing the existing safety system in light of the current dynamics of unmanned technology is no easy task. Threats include unauthorized UAV intrusions, flying into crowds or crowded areas, and aerial video recording in residential areas.
Risk assessment	The prices and availability of various types of UAVs are changing to the benefit of users, disproportionately to the level of work on risk assessment and estimation. Current risk assessment work should be enhanced.
EMERGENCY procedure	According to PANSA regulations, establishing an operational zone is a 24-hour process. As part of the rapid response procedure (EMERGENCY) during search operations, there is a clear need to provide a separate provision for special cases.

Source: *Authors' own research.*

Experts unanimously pointed out that the increased availability and operability of UAVs generate several systemic threats, which can be grouped as follows:

- <u>Threats to aviation safety:</u>
  - violations of controlled zones and control centers,
  - incidents near airports and critical infrastructure,
  - difficulties in identifying operators in real time,
  - overloading air traffic control systems.

In the opinion of respondents, the growing number of incidents involving drones in controlled airspace indicates insufficient awareness among some users and the insufficient effectiveness of preventive mechanisms.

- <u>Asymmetric and hybrid threats – experts emphasized the potential use of UAVs for:</u>
  - Conducting illegal reconnaissance of critical infrastructure,
  - Disrupting mass events,

- Sabotage or terrorist activities,
- Disinformation and demonstration operations.

It was noted that the low barrier to acquiring UAV technology increases the state's vulnerability to irregular activities.

- Systemic vulnerabilities – key issues identified include:
- Lack of full integration of operator databases,
- Insufficient control during drone sales,
- Limited traceability of devices in the event of violations,
- Dispersion of institutional responsibilities.

At the same time, experts emphasized the significant potential of UAVs in increasing the level of national security.

- Strengthening the state's operational capabilities:
- Border monitoring,
- Support for the operations of the Police, Border Guard, and emergency services,
- Rapid situational awareness in crisis situations,
- Inspection of critical infrastructure.

- Development of situational awareness – drones enable real-time data collection, which increases response efficiency and shortens decision-making time.

- Building a technological and regulatory culture – experts pointed out that the development of the UAV market contributes to:
- Professionalization of the operator community,
- Development of training and certification,
- Increased legal awareness of users.

At the same time, it was emphasized that this potential is fully realized only under the conditions of a properly designed supervision and prevention system.

The conducted research confirms the ambivalent nature of UAV technology. On the one hand, drones strengthen the state's operational potential and increase the effectiveness of actions in crisis situations. On the other hand, their uncontrolled proliferation increases the level of systemic risk, particularly in the areas of aviation safety and critical infrastructure protection.

4.2 Legal Aspects and Regulations of Aviation Institutions

Shaping a safety culture in the use of drones requires consistent and adequate legal regulations, as well as a clear division of responsibilities between entities responsible for airspace oversight. Integrating systems for monitoring, identifying,

and responding to incidents involving UAVs is crucial.
Building the legal awareness of drone operators and developing preventive and control mechanisms is also crucial. UAV flights, like manned aircraft, are subject to detailed regulations under both national and international law. The legal framework is based primarily on EU regulations and national implementing acts. The most important regulations include:

- Convention on International Civil Aviation, signed in Chicago on 7 December 1944;
- Aviation Law Act of 3 July 2002;
- Regulation of the Minister of Transport, Construction and Maritime Economy on the classification of aircraft of 7 August 2013;
- Regulation of the Minister of Transport, Construction and Maritime Economy on the exclusion of certain provisions of the Aviation Law Act from the application to certain types of aircraft and on the definition of conditions and requirements for the use of these aircraft of 26 March 2013;
- Regulation of the Minister of Transport, Construction and Maritime Economy on technical and operational regulations for special category aircraft not subject to the supervision of the European Aviation Safety Agency of 26 April 2013;
- Regulation of the Minister of Transport, Construction and Maritime Economy on qualification certificates of 3 June 2013; – Regulation of the Minister of Infrastructure of 11 June 2010 on flight bans or restrictions for periods exceeding three months;
- Commission Implementing Regulation (EU) No 923/2012 of 26 September 2012 establishing common rules of the air and operational provisions regarding air navigation services and procedures;
- Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency.

Experiences resulting from the mass use of Shahed-136 combat unmanned aerial vehicles (also known as loitering munitions) during the armed conflict in Ukraine have significantly changed the perception of threats posed by UAV technology in the national security dimension.

They have revealed the scale of drones' asymmetric potential and their ability to impact not only military targets but also critical infrastructure, energy facilities, and civilian space. They can identify targets, simplify operator work, and even automatically capture and track objects. It is also no secret that artificial intelligence-based support and various elements of automation are already in place.

Although Shahed-type systems are strictly military in nature and operate outside the scope of civilian aviation regulations, their use generates important implications for assessing the effectiveness of existing regulations regarding civilian UAVs.

These experiences indicate that:
- UAV technology is dual-use, and the line between civilian and military applications can quickly blur in crisis situations.
- National airspace is becoming vulnerable to low-cost and difficult-to-detect threats, necessitating a review of existing surveillance and response models.
- A security culture must encompass not only civilian operators but also the country's systemic preparation to counter drone threats.

Experiences resulting from the use of Shaheds (Kaszuwara, 2026) indicate the need to:

- Expand security analyses to include an asymmetric threat component,
- Integrate aviation regulations with regulations concerning critical infrastructure protection,
- Strengthening access control mechanisms for technologies with dual-use potential,
- Develop preventive tools that also cover the UAV sales and distribution phase.

Figure 1. *UAVOcheck application interface*

Source: *Shutterstock.*

Regulations regarding civilian UAVs should be assessed not only through the lens of aviation safety, but also in the context of a country's resilience to asymmetric threats. The Shahed case demonstrates that a national security culture in the drone era must be:

- Systemic,
- Multi-level,
- Integrated across civil and military boundaries,
- Based on technological prevention.

In this context, existing regulations constitute a normative foundation, but they require supplementation with instruments that strengthen the state's ability to identify, monitor, and mitigate risks associated with the uncontrolled use of UAV technology. Conflict experiences, therefore, constitute not only evidence of a threat but also an impetus to redefine the scope of national security culture amidst the dynamic development of unmanned systems.

From a national security perspective, existing regulations serve as a stabilizing and ordering mechanism, but their effectiveness in building a security culture depends on several factors: the effectiveness of enforcement, the level of digitization of supervisory systems, database integration, and interinstitutional cooperation. The degree of internalization of norms by users is also crucial – a security culture does not stem solely from legal coercion, but from acceptance of the values underlying the regulations.

In this context, it can be concluded that the current regulations constitute a solid normative foundation for shaping a security culture in the UAV sector, but their preventive potential has not been fully utilized. Expanding the regulatory system to include solutions covering the sales and distribution of technology could strengthen the proactive dimension of national security, shifting the focus from control to preventive action.

In summary, the impact of current regulations on national security culture should be assessed as significant, yet it requires further refinement towards legal, technological, and organizational integration. Only a synergistic combination of legal standards, digital tools, and educational activities can ensure a sustainable improvement in safety culture amid the growing operational use of unmanned aerial vehicles.

4.3 Practical Application of New Technologies as Supporting Tools

Analyzing the opportunities and threats arising from the use of drones should be grounded in a systems perspective. Unmanned aerial vehicles are part of a broader technological ecosystem encompassing artificial intelligence, autonomous systems, and digital airspace management systems. Raising the level of national security therefore requires:

- Integrating technology with ethical and legal norms,
- Continuously improving response procedures,
- Developing institutional competencies,
- Building the security system's resilience to hybrid threats.

In most legal systems, control focuses on the use of drones, while the sale phase is primarily commercial in nature, not preventive. However, the distribution of technology is the first point of contact between the user and the state security

system. Lack of buyer verification can lead to:

- Anonymous purchase of advanced aircraft systems,
- Lack of knowledge of applicable regulations,
- Limited operator traceability.

A pilot study using surveys and a qualitative study, such as the expert interview described earlier, confirmed the need to implement control tools at the sales stage. Based on the obtained results, a utilitarian and graphical evaluation was conducted in consultation with a UX Design specialist – User Experience Designer. The aim is to increase customer satisfaction with digital products by improving their functionality and usability, providing an easy-to-use product, and ensuring the desired customer-product interactions.

The research sought confirmation of the usefulness of this tool and specific responses from aviation security experts. Individual product elements, from the application name to the customer data reading system, were developed based on expert-level discussions to achieve ease of use while maximizing the tool's functionality.

The guiding principle of the developed sales control tool was to enable efficient exchange of information regarding the verification of drone buyer registration in the Civil Aviation Authority system, their authorizations, and the assignment of a specific device to a given operator (buyer). In this context, the concept of the UAVOcheck sales application aligns with the direction of preventive action advocated by experts.

A mechanism for buyer verification and confirmation of regulatory awareness at the sales stage can reduce anonymity and increase user accountability, which is a crucial component of a national security culture. Building a security culture with drones therefore requires a shift in emphasis from reactive measures to preventative solutions encompassing the entire technology lifecycle, including the sales stage.

Integrating the tools of the developed UAVOcheck application concept with the surveillance system can be a real element in strengthening national resilience and reducing vulnerabilities resulting from the growing availability of unmanned technologies. The most significant benefits of the sales app include:

- Lightning-fast verification of the drone buyer,
- Seamless verification of the user and their authorizations at the seller level,
- Real-time exchange of information between the Civil Aviation Authority and drone distribution,
- The app is compatible with Android/iOS software – it can be operated on devices such as mobile phones and tablets, allowing for unlimited use.

Within the app, the seller would be required to read the UAV operator's number or a QR code confirming authorization, which would then assign the purchased drone to the verified user. Figure 1 shows the active app's windows in sequence to illustrate the interface characteristics and available options.

Figure 1. *UAVOcheck application interface*

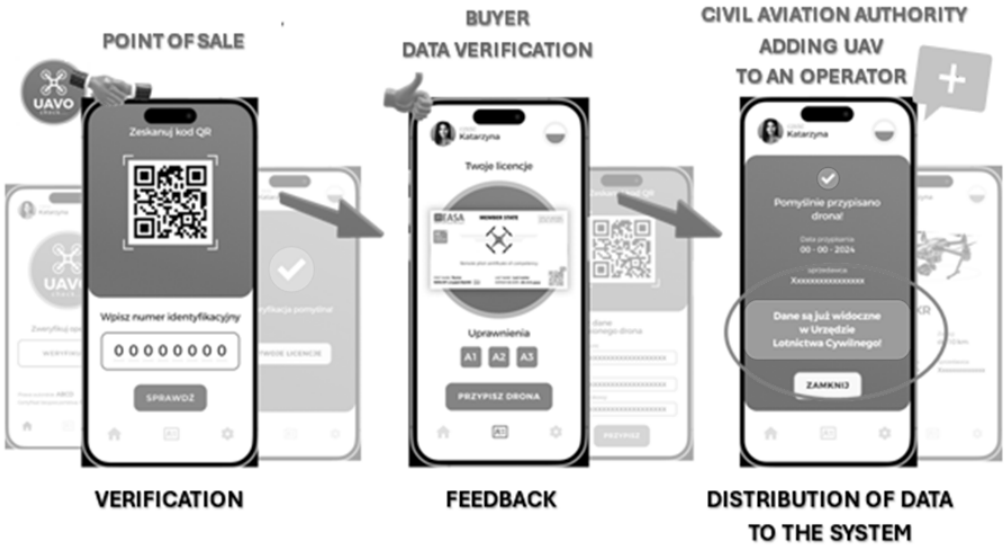
Source: *Authors' own research.*

In turn, the presented graphic (Figure 2) illustrates a scenario for successfully verifying a buyer's registration and authorizations. The application operates interactively within the website.

The graphics in Figure 2 describe the step-by-step process of adding a drone to a registered buyer (in the Civil Aviation Authority system). In the first step, the seller reads the user's QR code – this code is obtained through the operator's registration in the Civil Aviation Authority system. In the event of technical issues (e.g., not having a code), an alternative solution is to manually enter the operator's identification number.

After completing the described operation, information regarding the buyer's authorizations appears in the application window. This allows you to verify whether the user is authorized to operate the purchased device.

Figure 2. *UAVOcheck functional algorithm*



Source: *Authors' own research.*

In the next step you are directed to a page that allows you to read the QR code of the purchased device – at this point, the process of correctly adding the drone, along with real-time information distribution to the Civil Aviation Authority, is complete. Data stored in this way in the Civil Aviation Authority system allows for obtaining full information regarding the airspace of the UAV system held by a specific user.

This solution would significantly facilitate the enforcement of sanctions for improper use of UAVs by operators and would also solve the problem of identifying the drone user in the event of loss of control/range.

The UAVOcheck application integrates the following functions:

- Identification – identity and authorization verification,
- Educational – raising regulatory awareness
- Preventive – limiting anonymity and potential abuse,
- Systemic – enabling collaboration with supervisory institutions.

From a security science perspective, this solution is an example of a practical implementation of the "security by design" concept, transferred to the field of dual-use civilian technology. Thus, the article contributes both to the theory of security culture and to research on the resilience of national security systems in the face of ongoing technological advancement.

The novelty of this study lies not only in identifying the opportunities and threats arising from the use of unmanned aerial vehicles, but above all in proposing a systemic model that can mitigate asymmetric risks by influencing them at the

earliest stage of the technology lifecycle. In this approach, national security is treated as a dynamic process requiring the integration of legal, organizational, and digital instruments.

5. Conclusions and Recommendations

Unmanned aerial vehicles (UAVs) are not merely a technological tool, but a transformative factor in the operation of the state's security system. Their impact on national security culture is ambivalent – they can both strengthen state capabilities and generate new areas of vulnerability.

The key challenge, therefore, is not merely implementing technology, but shaping a conscious, responsible, and systemically integrated security culture capable of adapting to the dynamic development of the technological environment.

The development of UAVs is influencing the perception of airspace as a security domain. Its partial commercialization is occurring, requiring a redefinition of oversight and accountability mechanisms. Drones enhance:

- Reconnaissance capabilities,
- The effectiveness of rescue operations,
- Monitoring critical infrastructure,
- Crisis response.

At the same time, they generate:

- The risk of airspace violations,
- The ability to conduct reconnaissance operations against the state,
- Terrorist and sabotage threats,
- Difficulties in identifying operators.

The ambivalent nature of this technology means that its impact on safety culture depends on the level of regulation, user awareness, and system solutions.
Based on our own research (expert interviews with industry representatives), we formulated conclusions and recommendations for strengthening the safe use of UAVs.

Table 3. *UAV operational capability – expert conclusions and recommendations*

Subject area	Conclusions and recommendations
Legal regulations, legislation	Digitalization of processes is a necessary condition for the proper autonomy and automation of the UAV system development process.
	It is assumed that e-identification will enable the identification of individual drones by serial number, user, and serial data.
	Regarding the popularization of UAVs, there has been a sharp decline in public trust due to the conflict in Ukraine. The issue of anonymity in the case of using a drone as an attack (or defense) tool was emphasized.

	The implementation of sales control, including tools in this field, should take place at the EU level.
	In the open category, the practice of UAV operators is declarative.
	Systematic work in airspace situation monitoring is required, as well as keeping up with technology and current knowledge of the applied design solutions (propulsion systems, application spectrum).
	The perception of UAVs will be determined by the implementation of the U-Space concept. Proper organization of UAV movements and the creation of a well-functioning system within UAM (Urban Air Mobility) will reduce the need to treat UAVs as a potential threat.
	Under the EASA concept, 2035 is expected to be a breakthrough in the field of passenger transport by drones – the project's feasibility is primarily a matter of public acceptance and building trust within society. Currently, the most limiting factor for this type of UAV is battery autonomy, which is why models cooperating with electric propulsion and the use of energy storage technology are being considered.
Airspace control	UAV operations cannot be assessed one-dimensionally – as a threat. Certain threats can be identified in the area of UAV operations, including inadequate operator training. UAV operations have become a part of aviation.
	There are no procedures for protecting aviation/airport safety, which UAVs are a part of. UAVs can pose a threat to the proper operation of airports/safety of air traffic by violating the boundaries of MCTR zones.
	Applicable regulations are continually adapted to the needs resulting from the dynamically growing activity of UAVs.
	An analysis of ATM/CNS reports indicates that the main cause of threats to air traffic from unmanned technology is the low awareness of UAV operators and a lack of compliance with applicable regulations.
	Anonymous undesirable activities, even those performed unconsciously, such as skipping check-in, should be monitored and eliminated.
Training design	Despite its many advantages, the future of combining drones with artificial intelligence may pose some significant challenges. Data security and privacy, control over autonomous drones, and legal regulations are just some of the aspects requiring consideration.
	Public awareness still requires education and preventative measures.
	Systematic updates to training programs, examination systems, and operator verification are required. Sales-level control should be the foundation for the safe operation of UAVs in airspace. These are an intermediate, absolutely fundamental step towards standardizing operator behavior, especially for FPV drones.
	The implementation of effective counter-drone systems, building on proven systems (e.g., the HAWK 1700), is essential.
Practical flight performance	There should be greater supervision over the activities of UAVs in airspace.
	Risk generation can be primarily caused by inadequate operator training and a lack of awareness of the risks. Online exams and training are incredibly simple, and some people complete the tests without preparation, relying on online instructional videos.
	Increasing the emphasis on implementing anti-collision systems for drones is a topic that should be further developed given the constantly growing demand for UAVs.
	Despite numerous applications that streamline operators' operations and are primarily aimed at air safety (e.g., check-in or DroneMap), many operators do not use tools that allow them to check current information on airspace availability in each area.
	In crisis situations (search/rescue), the time it takes to establish an operational zone should be reduced – this requires a change in PANSA procedures.

	A good solution would be to implement effective counter-drone systems in urban areas.
	Risk analysis and assessment are not conducted properly – information regarding behavior that violates procedures should be publicized in the form of alerts, with simultaneous tightening of sanctions against irresponsible operators.
	The idea of app-based sales control sounds promising. It is recommended to patent the app's name and the project's intended purpose.
	The use of drones at airports (airport security, passenger air traffic) is not a primary benefit. The presence of surveillance drones in the airport zone is not a necessary concept due to the presence of cameras, SOL, and existing procedures.
	The security concept in Poland will follow the same path as in the US – there is a need to implement Remote ID to eliminate the anonymity of airspace users. The incidents that led to the law evolving in a specific direction were the result of a lack of individual accountability.
	We lack effective protection and countermeasures, such as the US-developed C-RAM (Centurion Counter-Rocket, Artillery, and Mortar) system.
	A merger of military and civilian aviation is undesirable. A strict ban on drones over training grounds (Zone D) should be reinforced by neutralization restrictions.
	At low altitudes, UAV detection becomes problematic. Any solution to raise awareness is desirable: applications, marketing prevention, increased sanctions, etc.

Source: *Authors' own research.*

Achieving success in the harmonious development of unmanned technologies while maintaining the desired aviation safety indicators requires cooperation at the level of scientific and research institutions. This is the only correct direction for developing responses to real challenges and needs.

Analyzing the directions of unmanned aircraft use, preventative solutions were identified, the implementation of which could impact not only aviation safety but also the broader dimension of national security. It was indicated that effective management of UAV operations, enhanced by control instruments at the technology access and user verification stages, strengthens the state's resilience to asymmetric threats and limits the potential for instrumentalization of the civilian market for destabilizing purposes.

Preventive actions understood in this way are consistent with a systemic approach to national security culture, which treats airspace as a component of the nation's critical infrastructure. Maintaining the desired level of aviation security becomes a component of a broader strategy to protect the sovereignty, integrity of airspace, and the institutional stability of the state amid the growing operational use of unmanned technologies.

Improving national security culture in the face of an intensifying offensive systems such as the Shahed-136 requires a shift from a narrowly defined operational approach to a systems model integrating normative, technological, organizational, and social components. Integration of detection and response systems within a unified airspace management model is essential.

Conflict experience indicates that the effectiveness of countering UAV threats depends on the speed of target identification, information exchange, and civil-military coordination. A national security culture should therefore be based on interoperability between services, developed crisis response procedures, and constantly updated risk analyses.

It is essential to develop the resilience of critical infrastructure to attacks using unmanned aerial systems. This means not only investing in technical measures (counter-drone systems, physical security) but also implementing organizational standards that address hybrid threat scenarios. In this perspective, a national security culture is manifested in institutions' ability to anticipate, adapt, and minimize the impact of potential attacks.

Attacks using loitering munitions have demonstrated that relatively low-cost means of destruction can have significant strategic consequences, including destabilization of energy systems, disruption of administrative operations, and psychological impact. Building a security culture should therefore also encompass educational programs, inter-ministerial exercise scenarios, and information campaigns that increase public cognitive resilience.

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