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USE OF ARTIFICIAL INTELLIGENCE IN CIVILIAN PROTECTION

Abstract

In recent years, the number of threats in our environment has been steadily increasing. Observable climate change, increasingly frequent natural disasters, technical failures, and armed conflicts pose new challenges for humanity. a response to these challenges lies in the use of modern technologies that enable effective civilian protection. One of the key solutions is the growing application of artificial intelligence as a tool supporting threat forecasting and aiding decision-making processes in crisis situations. Artificial intelligence is an important component of contemporary video surveillance systems, drones, and other devices, enhancing their operational efficiency and enabling autonomous functioning. On the one hand, it offers opportunities for effective threat prevention and mitigation; on the other, it raises concerns related to legal frameworks and ethical standards.

Keywords

Public safety and order, civilian protection, civil defense, artificial intelligence, threat forecasting, CCTV.

Introduction

The use of new technologies in civilian protection is becoming increasingly widespread and crucial in the face of contemporary challenges such as rapid climate change, pandemics, and armed conflicts. Modern technological solutions—including artificial intelligence (AI), geographic information systems (GIS), drones, advanced communication technologies, and video surveillance systems—play a key role in crisis management and public health protection. Their implementation significantly improves and accelerates decision-making processes while also offering new possibilities for enhancing safety. These technologies considerably reduce the time between the emergence of a threat and the adoption of appropriate decisions and responses. Additionally, they help maintain a relatively high level of safety for personnel directly involved in civilian protection activities. The versatility of modern technological solutions is also noteworthy. The same tools can be applied across various scenarios and incidents during the execution of civilian protection tasks[1]. The application of modern technologies in civilian protection and civil defense is gaining particular importance in light of the long-anticipated legal regulation—the Act on Civilian Protection and Civil Defense of December 5, 2024[2].

Technologies that not long ago remained at the conceptual stage now constitute an integral part of crisis management systems. Among them, artificial intelligence (AI) occupies a prominent place, with applications in threat forecasting, decision-making support, operational planning, and the execution of rescue operations. Given the increasing complexity of modern threats, analyzing both the capabilities and potential risks associated with technologies—particularly AI—from the perspective of security studies is not only justified but essential for better understanding their developmental trajectories.

Methodological Assumptions and Research Methods

The primary aim of this publication is to present the potential applications of modern technologies in the field of civilian protection. Particular attention is given to artificial intelligence as a tool that supports threat forecasting and aids decision-making processes in crisis management. This aim led to the formulation of the following research problem: *What are the capabilities of artificial intelligence-based technologies in the domain of civilian protection? To what extent does artificial intelligence support threat prediction and decision-making in crisis management?* a qualitative analysis of the available literature played a key role in the research process. Special emphasis was placed on the review of foreign-language publications that present experiences and solutions related to the use of artificial intelligence in civilian protection. The

1 P. Gromek, *Nowe technologie w ochronie ludności w Polsce. Rozwiązania dotyczące projektu SILVANUS. Część 2 – Twarde technologie i rozwiązania służące angażowaniu społecznemu*, „Zeszyty Naukowe Pro Publico Bono" 2024, nr 1(1), p. 178-179.

2 Act of 5 December 2024 on Civil Protection and Civil Defence (Journal of Laws of 2024, item 1907).

analysis incorporated synthesis, content analysis, and comparative analysis of various concepts for applying artificial intelligence.

Artificial Intelligence – Concept and Categories

The term *artificial intelligence* does not yet have a legally binding definition in Polish law. Literature often assumes, perhaps implicitly, that the term is commonly understood, though proposed definitions vary significantly[3]. According to T. Zalewski, the most frequently cited definition of AI stems directly from the Turing Test[4]. In this view, artificial intelligence is the ability of a machine to imitate or replicate human intelligence[5]. Zalewski also proposes his own definition, suggesting that AI is a system capable of performing tasks that require learning and consideration of new circumstances in solving specific problems, which—depending on configuration—can operate autonomously and interact with its environment[6].

Diverse definitions of AI are also found in international documents issued by the European Union, the Council of Europe, and UNESCO. M. Świerczyński and Z. Więcowski emphasize the fundamental importance of adopting a unified legal definition at the international level[7]. They point out that AI, as a scientific discipline, encompasses various approaches and techniques, such as:

- machine learning;
- machine reasoning, which includes planning, action programming, knowledge representation and reasoning, search, and optimization;
- robotics, which involves control, perception, sensors, and actuators, as well as the integration of all other techniques into cyber-physical systems.

The authors note that no standard definition of AI exists even within the scientific community, and it is most commonly referred to in relation to human intelligence. They examine European legislative acts defining AI, highlighting that these often serve as aspirational lists of goals, limitations, and caveats, while also identifying new areas where AI may serve as a problem-solving tool.

A notable example is the definition proposed in the European Parliament's resolution of 20 October 2020, which contains recommendations to the European Commission on the ethical framework for artificial intelligence, robotics, and related technologies (2020/2012(INL)).

3 T. Zalewski, *Definicja sztucznej inteligencji*, [in:] *Prawo sztucznej inteligencji*, L. Lai, M. Świerczyński (ed.), Warszawa 2020.

4 The Turing Test is a practical examination designed to attribute intelligence to a machine. The test was proposed by the British computer scientist Alan Turing. His work led to the formulation of the concept of a "learning machine." According to Turing's assumption, a machine capable of conversing with humans without arousing suspicion that it is a machine would win the "imitation game" and could be considered "intelligent." See: J. C. Lennox *2084 Sztuczna inteligencja i przyszłość ludzkości*, Warszawa 2023.

5 See: Ibid, p. 2.

6 T. Zalewski, *Definicja sztucznej inteligencji*, [in:] *Prawo sztucznej inteligencji*, L. Lai, M. Świerczyński (ed.), Warszawa 2020, p.2.

7 M. Świerczyński, Z. Wieckowski, *Sztuczna Inteligencja w prawie międzynarodowym. Rekomendacje wybranych rozwiązań,* Warszawa 2021, p. 35.

In that resolution, AI is defined as: *a system based on software or embedded hardware that exhibits intelligent behavior through, among other things, the collection, processing, analysis, and interpretation of data about its environment, and that takes actions—at least to some degree autonomously—in order to achieve specific goals*[8].

At the level of the Council of Europe, AI has been defined as a set of scientific methods, theories, and techniques aimed at replicating human cognitive abilities through machines[9].

In reviewing definitions, M. Świerczyński and Z. Więcowski identify several common features of AI:

- perception of the environment, including real-world complexity;
- information processing through data collection and interpretation;
- decision-making, including reasoning and learning;
- action-taking, including adaptability and responsiveness to environmental changes, while maintaining a certain level of autonomy;
- goal-oriented behavior[10].

A crucial element of modern AI systems is machine learning. Like AI itself, machine learning has been subject to numerous definitions. It is best understood as one method for achieving artificial intelligence[11]. Machine learning is defined as a subfield of AI that focuses on adaptive computational methods such as artificial neural networks and genetic algorithms[12]. Learning systems are closely linked to two other AI areas: automated reasoning and heuristic search. Automated reasoning is the oldest branch of AI and is based on formal logic, aiming to develop effective algorithms for deduction. Heuristic search focuses on efficiently exploring large problem spaces, primarily for problem-solving and strategic games[13]. Machine learning enables computers to "learn" rather than merely execute pre-programmed instructions. This method applies statistical techniques to enhance machine performance by generating new mathematical algorithms from large datasets without explicit programming. As a result, machine learning generates forecasts and recommendations based on patterns identified in training data, rather than following static algorithms like traditional computers[14].

The most advanced approach to AI development is *Artificial General Intelligence* (AGI), also referred to as *strong AI*. AGI aims to enable machines to perform any

8 https://sip.lex.pl/akty-prawne/dzienniki-UE/rezolucja-parlamentu-europejskiego-z-dnia-20-pazdziernika-2020-r-zawierajace-69483184 (access: 22.03.2025).

9 The definition is the result of work the European Commission for the Efficiency of Justice (CEPEJ) see: *European Ethical Charter on the use of artificjial intelligence in judicial systems,*.

10 M. Świerczyński, Z. Więckowski *Sztuczna Inteligencja w prawie międzynarodowym. Rekomendacje wybranych rozwiązań,* Warszawa 2021, p. 40.

11 See: Ibid, p. 43.

12 *Encyclopedia of Artificial Intelligence* red. J.R.R. Dopico, J. Dorado de la Calle, A.P.Sierra, Hershey 2009, p.666.

13 P. Cichosz, *Systemy uczące się*. Wydawnictwa Naukowo-Techniczne, Warszawa 2007, p.50.

14 *Artificial Intelligence and Data Protection: Delivering Sustainable AI Accountability in Practice, First Report: October 2018 Artificial Intelligence and Data Protection in Tension,* https://www.informationpolicycentre.com/uploads/5/7/1/0/57104281/cipl_second_report__artificial_intelligence_and_data_protection_hard_issues_and_practical_solutions__27_february_2020_.pdf, p. 4-5 (access: 23.02.2025).

intellectual task that a human can. a more illustrative way to describe AGI is to envision it as a machine capable of simulating human-level or even superior intelligence—also referred to as *superintelligence*[15]. All existing AI systems fall under the category of *narrow AI*, designed for specific tasks. At present, no systems exist that can be classified as AGI. It remains unclear whether such systems will ever be developed[16]. Nonetheless, claims about the emergence of AI systems that could rival the human mind occasionally surface in public discourse[17].

AI and Threat Forecasting

One of the key applications of artificial intelligence in civilian protection is threat monitoring and early warning. AI algorithms are capable of analyzing vast datasets from diverse sources—such as satellites, meteorological sensors, and social media—to predict the occurrence of natural disasters like floods, hurricanes, or wildfires. Such technologies could also be effectively implemented in Poland, where extreme weather and climate-related events have been observed over the past several years. Particular attention should be paid to increasingly frequent strong winds and high temperatures—phenomena that were previously rare in the region[18]. According to reports by the United Nations Climate Change Task Force, these occurrences are a direct result of global warming and broader climate change processes[19].

A notable example of AI in threat forecasting is the use of systems that analyze meteorological and historical data to predict the likelihood of flooding in specific regions. These tools enable early warning for residents and facilitate the implementation of appropriate preventive measures. In 2018, a team of scientists from Lawrence Berkeley National Laboratory (Berkeley Lab) received the Gordon Bell Prize[20] for developing a deep learning model capable of extracting indicators of extreme weather events from climate data. According to the method's description, AI supported by high-performance computing can effectively predict and mitigate the impacts of climate change[21]. Neural network-based models have proven particularly

15 J. C. Lennox *2084 Sztuczna inteligencja i przyszłość ludzkości,* Warszawa 2023, p. 36-37.

16 P. Księżak, s. Wojtczak, *Prawa Asimova, czyli science fiction jako fundament nowego prawa cywilnego*, „Forum Prawnicze" 2020 nr 4, p. 59.

17 M. Rotkiewicz, *Trzy litery, które wstrząsną światem*, „Polityka", nr 7, p. 61.

18 W. Krasiński, Unmanned Aircraft Systems in Crisis Management in Poland after 2007, „Safety and Defence Scientific and Technical Journal" 2020, Vol 6, No 2, p. 46-47.

19 Raport IPCC: Summary for policymakers in Polish. Communication 05/2021 of the Interdisciplinary Advisory Team for the Climate Crisis at the President of the Polish Academy of Sciences. https://bip.pan.pl/artykul/215/823/6-raport-ipcc-podsumowanie-dla-decydentow-po-polsku(access: 11.01.2025).

20 The Gordon Bell Prize is awarded annually in recognition of outstanding achievements in the field of large-scale computing. The purpose of the prize is to track progress in parallel computing over time, with particular emphasis on innovations in the application of high-performance computing used in science, engineering, and large-scale data analysis. The founder of the prize is Gordon Bell, a pioneer in high-performance parallel computing., https://awards.acm.org/bell (access: 11.01.2025).

21 W. Karasiński, *Sztuczna Inteligencja w ochronie ludności w Polsce – możliwości i perspektywy wykorzystania,* „Doctrina. Studia społeczno-polityczne" 2024, Tom 21 nr 21, p. 29.

effective in this context. Literature cites a model that achieved 99.9% accuracy in forecasting earthquake-related casualties, highlighting the potential of neural networks to analyze massive datasets and generate precise predictions for high-risk areas. These technologies not only support the planning of emergency operations but also improve evacuation processes, significantly reducing both casualties and material losses[22].

A practical example of AI in hazard forecasting is found in the work of the National Institute of Water and Atmospheric Research (NIWA) in New Zealand, led by N. Fadaeff. Given the country's frequent flooding events, the project aimed to develop a machine learning-based tool to replace traditional flood modeling techniques. While conventional physical flood models required up to 24 hours to process, the AI-enhanced system can generate reliable flood maps within 1–2 minutes. This significant reduction in processing time has a direct impact on the speed and accuracy of responses by residents in flood-prone areas[23].

Another application of AI in flood forecasting is discussed in *Nature*, where researchers demonstrated that AI-based models can improve forecast accuracy, particularly in regions where traditional methods are less effective. These AI systems can issue warnings up to five days in advance[24]. They are capable of detecting both extreme events and threats in ungauged basins. One such model has been integrated into an operational early warning system that provides free, real-time flood forecasts for over 80 countries. The model was tested against the Global Flood Awareness System (GloFAS), a leading global flood prediction platform. The AI model performed equally well—or better—than GloFAS in both short- and long-term scenarios, especially when forecasting extreme weather events[25].

AI has also been applied in flood forecasting research on the Ba River in Vietnam. In this case, researchers combined hydrodynamic models with AI to assess flood risk. Techniques such as decision trees[26] and AdaBoost[27] were used to develop flood vulnerability maps. The study successfully demonstrated the integration of machine learning, hydraulic modeling, and the Analytical Hierarchy Process (AHP) method

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22 R. Chaparro, H. Rincon, O. Betancourt, A. Melo Sierra, M. Gomez., J. Penuela, *Artificial intelligence for the prediction of health emergencies and disasters,* "Disaster and Emergency Medicine Journal" 2024, 9(4), p. 255.

23 *Forecasting floods in a fraction of the time with AI*
https://niwa.co.nz/news/forecasting-floods-fraction-time-ai (access: 18.03.2025).

24 G. Nearing, D. Cohen, V. Dube, et al. *Global prediction of extreme floods in ungauged watersheds.* Nature 627, 2024 s.559–563, https://doi.org/10.1038/s41586-024-07145-1 (access: 17.04.2025).

25 See:Ibid.

26 The decision tree technique is a method used in machine learning and artificial intelligence to make decisions or classify data based on their features (attributes). a decision tree is a structure resembling a flowchart, consisting of nodes, branches, and leaves. Source: D. Nelson, Czym jest drzewo decyzyjne? https://www.unite.ai/pl/what-is-a-decision-tree/ (access: 12.04.2025).

27 The AdaBoost (Adaptive Boosting) technique is a machine learning algorithm that builds a strong classifier by combining multiple weak classifiers. It operates iteratively, training successive weak models and increasing the weight of training examples that were misclassified by previous models in each iteration. This allows subsequent classifiers to focus more on difficult-to-classify cases. Source: J. Wołoszyn, *Wykorzystanie techniki AdaBoost w modelach opartych na regresji z wykorzystaniem sztucznej inteligencji.* Dydaktyka informatyki. 2019, (14), p. 162–169.

for risk assessment. The results continue to inform flood risk evaluation in the region and contribute to the development of effective mitigation strategies[28].

Beyond flood forecasting, AI is increasingly used in predicting the locations and intensities of hurricanes. Research conducted by the University of Miami's Rosenstiel School of Marine, Atmospheric, and Earth Science has shown that AI can effectively forecast a wide range of extreme events—from hurricanes and heatwaves to rainfall and droughts. AI models can predict events within minutes, whereas traditional methods require hours. In studies funded by the U.S. National Oceanic and Atmospheric Administration (NOAA), researchers analyzed radar data collected by so-called "hurricane hunter" aircraft. Machine learning techniques enabled the classification of this data to determine whether it represented meteorological phenomena or irrelevant oceanic or radar artifacts. While manual analysis of such data could take hours, AI systems complete the task within minutes[29]. a notable success of such implementation is a European AI-based model that accurately predicted the development of Hurricane *Francine* nearly ten days before it struck the southern coast of Louisiana—significantly earlier than traditional forecasting models[30].

Another area of active research is AI's use in earthquake forecasting. Preliminary results offer promise that this technology may help mitigate the impact of earthquakes on human lives and infrastructure. a team of scientists from the University of Texas at Austin developed an algorithm that predicted 70% of earthquakes a week before they occurred during a seven-month study in China. The model detected statistical patterns in real-time by analyzing seismic data based on historical events. It successfully predicted 14 earthquakes within approximately 200 miles of the epicenter, with nearly accurate estimates of their magnitudes. Researchers noted that this success was due to a relatively simple machine learning approach. The AI system was provided with statistical features based on the team's knowledge of earthquake physics and was trained on a five-year database of seismic records[31].

Importantly, AI integrates data from multiple sources—such as satellite imagery and real-time monitoring—enabling more precise forecasting of natural hazards and assessment of their potential consequences. Through the analysis of such data, new threats can be identified, and their evolution can be tracked, particularly in the context of changing weather conditions. Risk assessment systems supported by AI combine meteorological forecasts with localized environmental data, providing crucial support for preventive measures. The integration of monitoring technologies

28 Nguyen Huu Duy; Le Tuan Pham; Nguyen Xuan Linh; Tran Van Truong; Dinh Kha Dang; Truong Quang Hai; Quang-Thanh Bui *Flood risk assessment using machine learning, hydrodynamic modelling, and the analytic hierarchy process* Journal of Hydroinformatics 26 (8): 1852–1882. https://doi.org/10.2166/hydro.2024.033 (access: 17.05.2025).

29 R. C. Jones Jr. *a powerful, new tool in hurricane forecasting*, https://news.miami.edu/stories/2024/09/a-powerful-new-tool-in-hurricane-forecasting.html (access: 18.03.2025).

30 Ch. Scragg, *How artificial intelligence is storming the world of meteorology,* https://www.foxweather.com/weather-news/how-artificial-intelligence-storming-world-meteorology (access: 19.03.2025).

31 AI-Driven Earthquake Forecasting Shows Promise in Trials, https://news.utexas.edu/2023/10/05/ai-driven-earthquake-forecasting-shows-promise-in-trials/ (access: 18.03.2025).

with AI makes it possible to issue alerts to local communities before threats reach critical levels[32].

Decision Support in Crisis Situations

In the face of threats, the speed and effectiveness of decision-making are often critical to the successful de-escalation of a crisis. Traditional crisis management systems can struggle with processing and analyzing large volumes of information. Artificial intelligence is revolutionizing this process, with one of the most promising technologies being Retrieval-Augmented Generation (RAG), which combines generative language models with advanced information retrieval mechanisms[33]. This innovative approach merges search methodologies with generative models to enhance applications across various fields. RAG uses external data sources to improve the accuracy and relevance of generated responses. In the context of crisis management—especially during natural disasters—it can significantly enhance the decision-making process by providing timely and relevant information. Real-time data retrieval enables rapid access to critical information, supporting better situational awareness and more effective operational planning—both essential elements of successful crisis management[34]. The implementation of RAG in crisis management systems increases the precision of information disseminated to the public and aid organizations[35]. By synthesizing data from multiple sources—including weather forecasts, population maps, and infrastructure status—RAG systems can provide decision-makers with a comprehensive picture of the evolving situation[36]. The processes involved in RAG promote creative problem-solving akin to metacognition. This capability enables systems not only to generate responses but also to critically evaluate their outputs against retrieved data, thereby improving the overall factual accuracy of the information delivered[37].

Integrating artificial intelligence with crisis management systems enables the automation of decision-making processes, which is vital for fast and effective crisis response. a key component of this integration is the consolidation of data from sources

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32 P. Zaskórski P., Żbik, *Monitorowanie zagrożeń z wykorzystaniem systemów informacji geograficznej*, „Studia Bezpieczeństwa Narodowego" 2016, 9(1), p. 397-413.

33 S. Malik, H. Kharel, D.S.Dahiya, H. Ali, H. Blaney, A.D. Singh, … & B.P. Mohan. *Assessing chatgpt4 with and without retrieval augmented generation in anticoagulation management for gastrointestinal procedures.* Annals of Gastroenterology. 2024. https://doi.org/10.20524/aog.2024.0907 (access:18.05.2025), G. Barbarossa, S.N.A.K. Putri, K. Rahayu, A. Siddiq, M. Maulana, N.A. Ferawati, *Hexa-helix approach for smart disaster governance framework in developing cities, case study: slawi urban area, tegal regency.* IOP Conference Series: Earth and Environmental Science, 1264(1), 012029, (access:18.05.2025).

34 Y. Xia, Y. Huang, Q. Qiu, X. Zhang, L. Miao, Y. Chen, *a question and answering service of typhoon disasters based on the t5 large language model,* "ISPRS International Journal of Geo-Information" 2024, 13(5).

35 P. Li, Y. Lai, *Augmenting large language models with reverse proxy style retrieval augmented generation for higher factual accuracy,* https://doi.org/10.31219/osf.io/ma6cq (access: 19.05.2025).

36 Z. Bouzidi, M. Amad, A. Boudries, *Enhancing warning, situational awareness, assessment and education in managing emergency: case study of Covid-19,* "SN Computer Science" 2022, 3(6).

37 Y. Hou, Z. Liu, J.S. Jin, J. Nie, Z. Dou, Z. *Metacognitive retrieval-augmented large language models. Proceedings of the ACM Web Conference 2024,* 1453-1463, https://doi.org/10.1145/3589334.3645481 (access:19.05.2025).

such as Geographic Information Systems (GIS), satellite imagery, and demographic information. This leads to a more complex and integrated picture of the situation, allowing for more precise decision-making. GIS—short for *Geographic Information System*—was introduced in the 1960s by Canadian geographer Roger Tomlinson. It originated as a Canadian innovation considered one of the first systems to introduce a new approach to acquiring, storing, and analyzing spatial data. In a narrow sense, GIS refers to a system used for collecting, storing, updating, managing, analyzing, and disseminating geographic data that is spatially referenced to the Earth's surface. In a broader sense, the term encompasses an entire system of information flow and usage, including technical tools (such as hardware and software), methodologies, databases, procedures, and the human and financial resources necessary for its operation. GIS is also a scientific discipline concerned with geographic information and GIS-related methods and techniques—commonly referred to as geomatics or geoinformatics[38].

Crisis management systems enhanced with AI algorithms can analyze spatial data, enabling detailed mapping of threats and forecasting their potential progression. This greatly increases the effectiveness of preventive and emergency response efforts[39]. The integration of AI with GIS can revolutionize crisis management by allowing for more precise analyses and efficient responses to disasters and natural hazards. As a result, GIS systems become even more reliable and capable in large-scale data analysis and decision-making during disaster scenarios. AI algorithms enhance GIS capabilities by automating data processing, pattern recognition, and predictive modeling. During a disaster, an AI-supported system can assist in response efforts and disaster recovery operations. AI algorithms can analyze data in real time, allowing emergency services to identify critical areas such as damaged infrastructure, population density, and resource distribution. This information supports the efficient allocation of resources and coordinated rescue efforts. Furthermore, AI can assist in damage assessment by comparing pre-disaster GIS data with post-event imagery—automatically analyzing the extent and severity of damage to buildings, roads, and other infrastructure, and helping authorities prioritize recovery actions[40].

AI is also proving valuable in supporting law enforcement decision-making and the execution of operational tasks. AI-based tools increase operational efficiency and enable effective analysis of large datasets. For instance, applications can assist in determining the necessary personnel and resources for specific tasks, such as optimizing the number and deployment of police officers, positioning resources, and identifying optimal service planning strategies[41].

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38 E. Bielecka, *System Informacji geograficzne. Teoria i zastosowania,* Warszawa 2006, p. 1-2.

39 A.E. Gunes, J.P. Kovel, *Using GIS in Emergency Management Operations.* Journal of Urban Planning and Development, 126(3), 2000, p. 136–149. https://doi.org/10.1061/(ASCE)0733-9488(2000)126:3(136) (access:17.03.2025).

40 P. Emami, A. Marzban, *Synergia sztucznej inteligencji (AI) i systemów informacji geograficznej (GIS) w celu lepszego zarządzania klęskami żywiołowymi: szanse i wyzwania.* Medycyna katastrof i gotowość w zakresie zdrowia publicznego, 17. 2023. https://doi.org/10.1017/dmp.2023.174 (access:18.04.2025).

41 N. Malec *Sztuczna inteligencja a bezpieczeństwo państwa*, „Prawo i Bezpieczeństwo" 2024, Issue No: 11/2024, p. 29.

Another advanced solution that supports crisis management through enhanced situational awareness—leveraging elements of artificial intelligence—is the Internet of Things (IoT). This concept is based on the idea that various devices can be interconnected to collect and exchange sensor data. These may include electronic devices, vehicles, buildings, cameras, and other objects. While a wireless network and appropriate technologies are essential for connectivity, AI unlocks the full potential of the data generated. Currently, devices communicate using various, often incompatible protocols. AI has the potential to streamline and harmonize this complex network of communications, effectively serving as an integrating force[42].

Several key factors influence the effective application of artificial intelligence in crisis management systems:

- awareness and recognition of AI's potential to enhance decision-making, reduce response time, and deliver critical information during crises;
- availability of advanced AI technologies, such as machine learning and natural language processing;
- organizational readiness, including willingness to invest in AI infrastructure and analytical capabilities;
- a supportive legal environment and appropriate consideration of privacy and ethical issues associated with AI use[43].

An intriguing concept in crisis management is the use of AI-powered chatbots for communication and information management. These tools, based on AI and natural language processing, can improve communication with the public, deliver real-time updates, and collect data from populations affected by crises[44]. This discussion may be summarized with the findings of research conducted in China aimed at assessing the effectiveness of AI-supported crisis management systems. One of the core research questions was: *How do AI-based technologies impact public safety outcomes?* The study was based on a public safety and crisis management optimization model implemented in Chinese cities. The model consisted of five key components:

- a public safety management structure;
- AI-based data collection and analysis;
- crisis forecasting and early warning systems;
- AI-supported decision-making;
- public safety response mechanisms.

These components were integrated into a comprehensive AI-based public safety and crisis management system. In the decision-making component, AI was used to support the decision-making processes related to public safety and crisis response. AI-driven decision support systems can analyze multiple scenarios, predict possible outcomes, and recommend optimal courses of action based on predefined objectives

42 A.S.A.R Aladawi, A.N.A. Ahmad, *a study of factors influencing the adoption of artificial intelligence in crisis management,* "International Journal of Sustainable Construction Engineering and Technology" 2023, 14(5).

43 See: Ibid, p. 419.

44 See: A. Stranjik, D. Kozlevac, I. Turčić, *Artificial Intelligence in crisis management. Crisis Management Days.* 2024. https://ojs.vvg.hr/index.php/DKU/article/view/471 (access: 15.04.2025).

and constraints. The study concluded that public safety management structure, AI-powered data collection and analysis, AI-supported decision-making, and response mechanisms all had a positive and significant impact on improving public safety in a broad sense[45].

Artificial Intelligence in Video Surveillance and Drones

Video surveillance systems are increasingly incorporating elements of artificial intelligence, enhancing their effectiveness and significantly expanding their capabilities. As noted in scholarly literature, journalistic reports, and oversight body findings, the Polish legal system has not yet developed a formal legal definition of video surveillance[46]. One of the commonly cited definitions refers to video surveillance (English: *Closed Circuit Television – CCTV*, German: *Videoüberwachung*) as a system that enables remote monitoring of events captured by anywhere from a single to several hundred cameras simultaneously. The system consists of cameras transmitting images to a receiving center, where personnel can observe recorded events on monitors[47]. Another definition, adopted by the Polish Committee for Standardization (PKN) based on the International Electrotechnical Commission (IEC), introduces the term *Video Surveillance Systems (VSS)*[48]. In recent years, VSS has been used interchangeably with CCTV[49]. Both terms refer to a type of industrial television system—an electronic monitoring system that uses video cameras, connected in a "closed circuit," to capture, collect, record, and transmit visual information about events occurring in a specified area and timeframe[50].

Contemporary developments in video surveillance systems are advancing in two primary directions. On one hand, these systems are increasingly equipped with software based on algorithms capable of active, automated image analysis. On the other, public discourse more frequently references the ability of surveillance cameras to automatically recognize individuals' identities. While the former direction is largely uncontroversial, the implementation of identity recognition systems has sparked resistance from various stakeholders, particularly concerning legal grounds and ethical implications. Despite these concerns, facial recognition technology is developing rapidly in the security sector. Modern computers have proven capable of recognizing human faces more quickly and accurately than humans themselves[51].

45 Li, G.; Wang, J.; Wang, X. *Construction and Path of Urban Public Safety Governance and Crisis Management Optimization Model Integrating Artificial Intelligence Technology.* Sustainability 2023, *15*,7487. https://doi.org/10.3390/su15097487 (access: 11.05.2025).

46 G. Matuszek, *Monitoring wizyjny – ujęcie prawne i technologiczne. Współczesność i perspektywy,* „Zeszyty Naukowe SGSP" 2020, nr 73/1/2020, p. 296.

47 G. Matuszek, *Monitoring miejski jako narzędzie bezpieczeństwa i porządku publicznego*, Dąbrowa Górnicza 2025, p. 56.

48 G. Matuszek, *Monitoring wizyjny – ujęcie prawne i technologiczne…*, p. 298.

49 Prepared on the basis of the Standard PN-EN 62676-1-1, https://czytelnia.pkn.pl/#/reading- room/PN-EN%2062676-1-1:2014-06E/~/PN-EN%2062676-1-1_2014-06E_ KOLOR.pdf/1 (access: 8.04. 2025).

50 G. Matuszek, *Monitoring miejski jako narzędzie……*p. 56.

51 See: Ibid, p. 247.

Another critical direction in CCTV evolution is automated video analytics. It is increasingly evident that a single operator—or even a small monitoring team—is no longer capable of effectively observing and responding to events captured by dozens or hundreds of cameras. For this reason, recent years have seen a growing emphasis on automation, including the integration of artificial intelligence in video surveillance systems. This development should be distinguished from "smart building" applications, which simply allow users to access and control the system from any location via smartphone. In professional surveillance systems, AI components are employed to shorten response times to detected threats and reduce the number of personnel required to operate the system. These tasks are facilitated by systems equipped with appropriate image analysis algorithms. Real-time image monitoring enables immediate intervention, thereby reducing the need for large security teams. The new functionality of these so-called "intelligent" monitoring systems is based on algorithms and software capable of configuring the system to respond to various predefined scenarios—such as detecting a person lying on the ground, unauthorized access to restricted zones, or illegal parking. These scenarios are not limited to optical image analysis; increasingly, advanced solutions are being developed to detect temperature changes, gas emissions, and water levels[52].

Considering the potential of AI, growing attention is being given to its use in drones, which are becoming increasingly common tools in civil protection. The literature lacks a single, standardized definition of "unmanned aerial system." In this context, there is a diversity of terminology, e.g., Unmanned Air Vehicle – UAV, Unmanned Aircraft System – UAS, Remotely Piloted Aircraft – RPA, Unmanned Vehicle System – UVS[53]. The term "drone," although widely adopted in colloquial language, is contested by some aviation professionals and legislative bodies due to its imprecise and non-technical connotations. It is thought to originate from the distinctive buzzing sound made by early unmanned aircraft, reminiscent of a female bee[54].

Unmanned aerial vehicles (UAVs) can effectively perform a variety of tasks in civil protection and crisis management. Examples of applications include:

- monitoring threats for wide-area reconnaissance and early warning systems;
- search and rescue operations;
- assessing the extent and impact of natural disasters and industrial accidents;
- transporting emergency supplies such as medical equipment, blood, medications, or vaccines.

AI can enable autonomous operation of UAVs. Military sources distinguish ten levels of UAV autonomy, which are being gradually implemented, with the final level involving fully autonomous swarms. These levels include:

- remote control;

52 See: Ibid, p. 248.

53A. Fellner, *Determinanty operacyjnego zastosowania RPAS* [in;] *Wykorzystanie bezzałogowych platform powietrznych w operacjach na rzecz bezpieczeństwa publicznego,* M. Feltynowski (ed.), Józefów 2019, p. 76.

54 W. Leśnikowski, *Drony w służbie ochrony infrastruktury krytycznej na wojnie z COVID-19*, Toruń 2021, p. 41.

– real-time control;
– adaptation to failures and flight conditions;
– onboard route re-planning;
– group coordination (achieved in 2015);
– group tactical re-planning;
– group tactical objectives;
– shared control;
– group strategic objectives;
– fully autonomous swarms (expected by 2025)[55].

An example of autonomous UAV operation was the "Spiderweb" operation, carried out by Ukraine's Security Service (SBU) on June 1, 2025. In this mission, AI was used to control combat drones that launched attacks on Russian airbases. These drones combined AI-driven autonomy with human operator oversight, allowing them to continue missions even if the control signal was lost. In such cases, the drones would switch to a pre-programmed route and autonomously approach their targets, activating their warheads automatically. AI also enabled autonomous target recognition using advanced computer vision and machine learning algorithms. These systems allowed drones to analyze live camera footage in real time, identifying and classifying targets based on visual features—without the need for constant operator control[56]. The course of the "Spiderweb" operation confirms that drones can autonomously perform civil protection tasks, even in the absence of operator communication.

Conclusion

Devices, applications, and systems utilizing artificial intelligence are becoming integral components of the modern environment. While they raise certain concerns, they also offer humanity novel and previously inaccessible capabilities. One of the most prominent and impactful domains for AI implementation is civil protection, which spans a wide spectrum of crisis situations—including natural disasters, technological failures, and military threats. AI-equipped tools allow for the prediction of potential disaster locations and impacts, and significantly support the decision-making process, especially in scenarios involving vast volumes of data. AI's role in video surveillance systems and UAVs is particularly noteworthy, as it enables autonomous operations. These capabilities contribute not only to threat avoidance but also to rapid and effective crisis response, which is essential for minimizing and mitigating damage. Moreover, AI-enhanced systems significantly reduce the risk to human personnel involved in emergency response operations. All the examples cited in this study clearly confirm the value and necessity of further developing AI-based

55 See: Ibid, p. 44.

56 *Rzeź rosyjskich lotnisk. Nagranie z operacji Pajęczyna*, https://polskieradio24.pl/artykul/3533329,rzez-rosyjskich-lotnisk-nagranie-z-operacji-pajeczyna (access: 10.06.2025).

systems for the purpose of effective civil protection. Any concerns related to their deployment should be addressed through the implementation of appropriate legal, procedural, and organizational frameworks.

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