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## New Technologies in Crisis Management

### Abstract

*Objective:* Modern technologies are increasingly important in managing a public organisation. This also applies to the very sensitive area of crisis management, the effectiveness of which directly affects the health and lives of citizens. This article aims to analyse the literature on the subject of the use of modern technologies in crisis management.

*Research Design & Methods:* The article uses literature review as a research method.

*Findings:* The analysis of the obtained results indicates that the use of modern technologies in crisis management is a current research topic. At the same time, the application layer shows the potential of using modern technologies.

*Implications/Recommendations:* Future research should focus on determining the acceptance of modern technology in the organisation. At the same time, it seems important to analyse the conditions for the optional implementation of modern solutions in the organisation.

*Article classification:* theoretical/review paper

*Keywords:* emergency management, public management, new technology, ICTs

*JEL classification:* H7

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## Introduction

The example of Poland was chosen, because the Supreme Audit Office (NIK, 2017) points to many years of neglect, resulting in disregard for the importance of preparing plans, procedures, and structures in the event of threats. Due to the fact that the financial resources of local governments are very limited, local government authorities refrain from creating departments responsible for crisis management and place such units e.g. in the promotion departments of a commune or a poviát (NIK, 2017, p. 10). Additionally, the lack of regulations specifying the competencies of people employed in the structures of crisis management centres results in poor substantive preparation of employees, in particular at the district and municipal levels (NIK, 2017, p. 11). According to NIK (2017, p. 9), actions should be taken to regulate crisis management issues, because currently many actions are improvised, based only on *ad hoc* decisions, which may significantly reduce their effectiveness. Preparation for action, also using new technology, is crucial and makes it possible to take control of the crisis more efficiently.

The crisis management process is beginning to be of paramount importance, especially when there is a loss of control over the course and development of events, and the decision-making process is disrupted (Ziarko & Walas-Trębacz, 2010). The civilisation progress can cause the occurrence of various undesirable situations, such as industrial failures, construction disasters, traffic accidents, public order disturbances, or terrorist acts. In addition to natural threats, which have been intensifying recently, they can be a potential source of a crisis situation that negatively affects the level of human security (Wróblewski, 2014).

Crisis responders, to manage them efficiently, should take into account the following issues (Council Regulation (EEC) No 793/93 of 23 March 1993):

- time of action (especially as a reaction to a crisis situation);
- uncertainty;
- difficulties in estimating the effects of actions;
- action in a state of danger;
- the lack or excess of contradictory information (so-called information chaos);
- a shortened decision-making process.

Inter-organisational trust and appropriate cooperation between these entities are also important (Marciniak, 2023). According to Witkowski and Marcinkowski (2022), the main benefit of cooperation is synergy, i.e. additional effects that are greater than the sum of the effects of activities carried out individually. In order to achieve additional synergistic effects of interaction, it is necessary to shape the relationship between individual links based on trust and the proportional sharing of risks and benefits between them (Witkowski & Marcinkowski, 2022).

Also, the local community should trust crisis management entities and believe that in the face of a threat they will be able to provide them with aid, medical services, and necessary transport. As Bengtsson and Brommesson (2022) note, trust can be shaped by personal experience or by information about the performance and/or ability of a particular agent, but it is a subjective phenomenon based on perception, i.e. an attitude towards another agent. Therefore, interpersonal as well as organisational and institutional relationships can be treated as psychological contracts which, unlike formal contracts, are subjective in the sense that one party's understanding of a contract may not be shared by the other (Bengtsson & Brommesson, 2022). Moreover, Choi and Wehde (2020) conducted research that indicates that community trust in emergency management bodies may influence their response to tornado warnings. Thus, the risk associated with disasters can

be significantly reduced if residents are well-prepared, follow the recommendations of local authorities, and trust them.

An important element supporting activities in crisis management is modern technologies that help to achieve the agility and transparency of activities. Currently, it is impossible to imagine management processes without information collection and processing technology, i.e. database technology. A database is a collection of related data. By data, in this case, we mean known facts that can be recorded and have a specific meaning (Elmasri & Navathe, 2019). Other innovative technological solutions, such as drones, are also being introduced internationally. Many major disasters damage transport infrastructure and leave people without access to adequate means of transport and essential medicines and supplies. Such situations generate the development of drone-based delivery systems to improve logistics operations in crisis management (Rejeb et al., 2021). Not limited to the existing road networks, drones can deliver urgently needed assistance packages in a short period of time (Ghelichi et al., 2022).

Public organisations are increasingly willing to use technological solutions that improve their operations. In this view, the purpose of this article is to analyse the possibilities of using modern technologies in the area of crisis management. To achieve this goal, literature review was used as a research method.

## **Material and methods as well as goals and research methods**

This article aims to analyse the literature on the subject of the use of modern technologies in crisis management. The used research method is critical literature review. The critical literature review is used at the initial stage of research, when the researched area is not precisely defined and the descriptions in scientific publications are scattered (Mays et al., 2001). As Tricco, Lillie, Zarin, O'Brien, Colquhoun, Levac, and Straus (2018, p. 1) point out, it is a type of knowledge synthesis carried out in such a way as to record research material about the topic and identify the main concepts, theories, sources, and knowledge gaps. The advantage of analysing and criticising literature in the context of researching projects in crisis management is the collection of knowledge dispersed in many legal acts, publications, and books.

The databases that are mainly used include: BazHum, CEJSH, Web of Science, and Scopus. The main keywords were: “emergency management”, “crisis management”, “disaster management”, “threats in crisis management”, “hazards in crisis management”, “threats in disaster management”, “hazards in emergency management”, “crisis management system”, “technologies in crisis management”, “technologies in emergency management”, and “technologies in disaster management”.

## **Literature review**

### *A typology of threats – international and national approach*

Due to the unlimited types of crises, Hamidovic (2012) proposes two main categories: industrial and natural crises. Natural crises arise from acts of nature, and industrial crises are situations where organised industrial activity causes serious damage to human life, property, and the environment. Economic damage caused by disasters generates direct and indirect costs. Direct costs are costs related to physical damage to infrastructure, crops, farms, livestock, as well

as social infrastructure such as hospitals, schools, homes, bridges, etc. Costs related to the loss or damage to tangible items usually contribute to direct costs. Indirect costs are costs related to the disruption of the flow of goods and services in the supply chain. Additionally, disruptions to services such as telecommunications or water supply can have a huge economic impact. Indirect costs also include the cost of medical expenses (Shaw & Krishnamurthy, 2009).

Among natural disasters, water causes the greatest statistical loss of human property. This is because people have always tried to settle in areas with good water availability. As a result, thousands of objects, villages, and towns appeared in the river valleys and floodplains, and over the millennia these towns became densely built-up, which is conducive to the occurrence of floods. It should be noted that practically every year there are floods on a regional and local scale, causing significant losses. Extreme phenomena related to water, i.e. droughts and floods, are a fairly common problem in Poland. The catastrophic flood in Poland in July 1997 caused 55 fatalities and material losses estimated at 12.8 billion PLN. In turn, in the dramatic flood in May and June 2010, 20 people died and material losses amounted to 10 billion PLN (Żmudzka, 2004). The lack of water also causes serious losses. This applies primarily to agriculture, where the variability of thermal and precipitation conditions leads to a decrease in yields (Żmudzka, 2004).

Flooding has a number of consequences. The main effects of the flood include (Ciekanowski, 2011): the loss of human and animal life; flooded roads, railways, bridges, arable land, sewage treatment plants, septic tanks, as well as municipal and industrial waste dumps; destroyed and damaged engineering and technical facilities, e.g. flood embankments; release of pathogenic bacteria and epidemiological risk such as salmonellosis, typhoid fever, bacillary dysentery, tetanus, hepatitis A, diarrhoea, staph poisoning (dead animals, cemeteries); emission of significant amounts of chemical substances and heavy metals, plant protection products, fertilisers, petroleum products, toxic chemicals, and many others into the atmosphere; significant material, health, and moral losses. The effects of the flood are very extensive and multi-faceted, and carry a number of natural, economic, and social consequences.

In general, in Poland, the most common cause of natural disasters involves extreme weather-related phenomena (frost, heat waves, droughts, forest fires, gales, storms, heavy rains, floods, hailstorms, heavy snowfall, landslides, snow and mud avalanches, fog, rime, ice, and lightning strikes). There are also seismic hazards in Poland, as evidenced not only by numerous micro-tremors in mining areas, but also by stronger tremors observed on 21 September 2004 in the north-eastern border of the Republic of Poland, with the epicentre in the Kaliningrad region (Kundzewicz & Matczak, 2010).

In addition to threats caused by natural factors, dangerous industrial events occur in Poland. The Chief Inspectorate for Environmental Protection, as of 2018, lists 255 plants with increased risk (ZZR) and 184 plants with a high risk of a serious industrial accident (Main Inspectorate for Environmental Protection, 2018). In addition, not only increased and high-risk plants can cause a serious accident, but also non-Seves plants, to which they belong (Centralny Instytut Ochrony Pracy, 2019), i.e. plants that have not been included in the ZZR category due to the relatively lower number of substances than established in the qualification criteria (the so-called „sub-threshold” quantities), and plants with large amounts of substances classified as corrosive, including acids and alkalis, harmful, irritating and other, not included in the qualification criteria.

Threats arising from transport incidents also constitute an important part of the existing dangers related to industrial and commercial activities in Poland (Michalik & Gajek, 2008). The reasons for such events may be different, e.g. human error, poor technical condition of the vehicle or

emergency equipment, poor technical condition of roads, the lack of monitoring. Water transport turned out to be the safest of all (Bęczkowska, 2015).

In the world, the nature of threats is slightly different from that in Poland, but currently, the high mobility of societies creates circumstances to participate in many unforeseen events outside the country. The World Economic Forum (2022) lists the most important threats in the world:

- climate crisis;
- social crisis;
- growing number of cyberattacks;
- uneven global economic recovery;
- chronic and antibiotic resistant diseases.

The threats of climate change and cybercrime are frequently discussed in the media. Global warming is progressing dynamically and, as a result, many small island countries (e.g. Kiribati, the Maldives, Tuvalu) are threatened by sea level rise, which inevitably accompanies warming. Countries that are located at higher latitudes stand to gain from the consequences of climate change, while most developing countries will lose out. A new type of “climate” refugees will emerge (Kundzewicz & Juda-Rezler, 2010). Today, many scientists point out that due to global environmental changes, the Earth could enter a new geological epoch dominated by humanity – Anthropocene. It is the first epoch that has been distinguished during its duration, and not after its end, based on geological research (Lewis & Maslin, 2015). Conflicts over natural resources are also a problem, as researchers Szyjko (2012) and Marczuk (2014) point out, and in some parts of the world there is already competition for water.

Cybercrime and computer crime, although they do not belong to the catalogue of Polish statutory expressions in the current legal state, are listed among the greatest threats related to crime in the world. It is estimated that the total value of global losses incurred as a result of cybercrime is 388 billion USD annually and is even comparable to the value of the entire drug market (Wasilewski, 2017). Studies indicate that almost a billion people fall victim to illegal activities on the Internet every year. It has been calculated that there are about 14 victims of this type of unlawful activity per second (Wasilewski, 2017).

In the face of countless threats, both natural and civilisational, each country should take care of a well-organised crisis management system, i.e. having appropriate solutions, procedures, and resources to prevent crisis situations and react immediately in the event of their occurrence.

### *The crisis management system in Poland*

Crisis management can include military and non-military measures to address the full spectrum of crises – before, during, and after conflicts. Operations use the right combination of political and military tools in order to manage crises in an increasingly complex security environment (The North Atlantic Treaty Organisation, 2022). Khorram-Manesh (2017) states that crisis management is taking immediate and appropriate actions in the face of a threat under time pressure as well as the lack of appropriate and accurate information. Such activities should be planned. The lack of strategic crisis management plans may lead to a serious crisis and, consequently, to the destruction of the state system.

The current crisis management system in Poland is relatively young and has been operating for 16 years with the entry into force of the Crisis Management Act of 26 April 2007 (Kamiński, 2016). The main purpose of introducing the Crisis Management Act was to establish a system

of procedures for public administration bodies, owing to which it will be possible to make specific decisions in the event of crisis events (Kamiński, 2016). In the initial period of the occurrence of a given event, the threat may not meet the conditions for introducing any of the states of emergency (the state of natural disaster, the state of emergency, or martial law). Therefore, it would be justified at this stage to implement special mechanisms that would ensure the effective monitoring of threats, their elimination, or at least significant limitations (Kamiński, 2016). The legislative motive for crisis management was to supplement the already existing national security management system with the principles of preparing state structures in the scope not regulated in states of emergency (Kamiński, 2016).

The system in Poland is multidimensional and consists of the following components (Government Centre for Security):

1) crisis management bodies:

- national level: Council of Ministers, Prime Minister;
- ministerial level: Minister in charge of the government administration department, Head of the central authority;
- voivodeship level: Voivode;
- district level: district organisation;
- commune level: commune head, mayor, president of the city;

2) consultative and advisory bodies:

- national level: Government Crisis Management Team;
- departmental level: Crisis Management Team (ministry, central office);
- voivodeship level: Voivodeship Crisis Management Team;
- district level: District Crisis Management Team;
- municipal level: Municipal Crisis Management Team;

3) 24-hour crisis management centres:

- national level: Government Centre for Security;
- departmental level: Crisis Management Centre (ministry, central office);
- voivodeship level: Voivodeship Crisis Management Centre;
- district level: District Crisis Management Centre;
- commune level: Commune Crisis Management Team, Commune (municipal) Crisis Management Centres, or an organisational unit of the Commune (city) Office competent for crisis management.

The crisis management system was developed because of a catalogue of rules determining its organisation, including (Lidwa, Krzeszowski & Więcek, 2010): the principle of the primacy of the territorial system; a one-person management principle for governance and accountability; the principle of adequacy of the level of management; the principle of universal response, meaning the involvement of institutions and entities operating in the area affected by the threat; and the principle of single responsibility of the management bodies. The crisis management system focuses on the principle of the primacy of the territorial system, i.e. the main burden of decisions and responsibility lies with the authority acting at a given level of the territorial division of the country where the crisis has occurred (Wróblewski et al., 2014).

Nejgebauer's research (2022) indicates that the quality of decisions made in crisis management can be enhanced owing to modern technologies. According to Gudzbeler and Nepalski (2015), the improvement of communication and the effectiveness of actions can be achieved owing to an integrated simulation platform for crisis management entities. Studies by Durugbo and colleagues

(2022) also highlight the role of innovation in relation to digital, integrated and adapted public services, initiatives, and systems. However, Polish entities building the crisis management system do not have the appropriate equipment and systems that would increase the scope of control, cooperation, communication, as well as the quality of decisions being made. Although the TELDAT organisation has prepared a crisis management system ‘Jaśmin’, which could strengthen actions during crisis management in Poland, it is not used in response to the existing crisis situations (see: [www.teldat.com](http://www.teldat.com)).

### *The use of modern technologies in the area of crisis management*

Modern technologies related to the 4<sup>th</sup> Industrial Revolution have significantly changed the functioning of not only private but also public organisations. The use of modern technologies in the implementation of public sector tasks has become inevitable to better meet the growing expectations of stakeholders, also in the area of crisis management. The use of modern technologies in crisis management seems particularly important from the point of view of the importance of tasks performed by crisis management and the negative effects of the materialisation of risks covered by crisis management. For this reason, it was considered reasonable to extend the research interest of the authors to the possibilities of using modern technologies in crisis management. The aim of the conducted research was to determine what technologies are used in crisis management. Literature review was used as the research method (Zdonek et al., 2016; Lenart-Gansinieć, 2021). The used keywords were as follows: ICT, emergency management, crisis management, new technology. The focus was on full-text scientific articles in English or Polish available in the following databases of scientific publications: EBSQO, Scopus, ProQuest, Web of Science, Google Scholar.

As the analysed literature on the subject indicates, technological progress has significantly changed the way of crisis management in all its stages, from identifying, monitoring, responding to crises, towards removing the effects of crises. Modern technologies are increasingly playing a key role in crisis management, providing tools and platforms for effective communication, data collection, analysis, and decision-making.

One of the most important technologies in the socioeconomic functioning of society and organisations is currently information and communication technologies (ICTs) such as social media platforms, mobile applications, crisis mapping tools, virtual cooperation platforms, shared databases, and communication channels. ICTs facilitate the rapid dissemination of information during a crisis, enabling real-time communication between crisis management teams, emergency services, government agencies, and the public, helping to coordinate response efforts, provide updates, and gather situational awareness (Wociechowicz et al., 2012; Hu & Kapucu, 2014; Abgarowicz et al., 2015; Chaturvedi et al., 2015; Rysz, 2017; Reuter et al., 2018; Saroj & Pal, 2020; Fazeli et al., 2021; Kaur et al., 2022). ICTs have also greatly improved the effectiveness of emergency notification systems, which can be via SMS, mobile apps, social media, and broadcasting systems, which significantly improves the speed at which important information such as evacuation orders, safety guidelines, and updates during a crisis is disseminated. These systems help reach large numbers of people quickly and increase public safety. Gjørseter, Radianti, and Chen (2021) also point out that when building crisis management systems, the special needs of digitally-excluded people, e.g. the elderly or the disabled, should be considered so that they do not remain outside the system and thus without the possibility of receiving assistance due to the lack

of digital skills. ICT tools primarily increase situational awareness, improve coordination, and provide a synchronised response between the various stakeholders involved in crisis management (Łachacz, 2022). However, as pointed out by Jennings and colleagues (2017), the use of modern ICT technologies is supported by the existence of independent IT departments in units responsible for crisis management, both in operational management, risk communication, and social media.

The use of modern technologies also allows the mapping and visualisation of crisis situations, which provides a comprehensive picture of the situation. Geographic information systems (GIS) and satellite imagery can be used to map the affected areas, identify critical infrastructure, and track response efforts (Pietryka, 2021). The GIS technology combines spatial data and mapping tools to provide a visual representation of emergencies. It aids in mapping affected areas, identifying critical infrastructure, assessing resource allocation, monitoring the movement of emergency personnel, as well as assessing risks (Rezvani et al., 2023). GIS also assists with situational awareness and decision-making by providing a comprehensive overview of an emergency situation.

ICTs also play a vital role in the post-crisis recovery phase (Mohan & Mittal, 2020). They enable the collection and analysis of data related to damage, loss assessment, and reconstruction needs. ICT tools support the coordination of aid distribution, the tracking of recovery progress, and the involvement of affected communities. In addition, technologies such as cloud computing and data backup help ensure the resilience of critical information and systems in the face of future crises.

The literature on the subject also points to the possibility of using modern technologies such as Big Data, the Internet of Things, artificial intelligence, or virtual reality in crisis management (Pietryka, 2021; Mehraeen et al., 2020). Big Data analytics can help identify patterns, trends, and anomalies, enabling more accurate risk assessment, resource allocation, and decision-making during a crisis, and has the potential to increase engagement in prevention (Al-Ma'aitah, 2020; Drosio & Stanek, 2017; Iglesias et al., 2020). In turn, the Internet of Things (IoT) – i.e. sensors embedded in infrastructure, buildings, and equipment – can provide real-time data on various parameters such as temperature, humidity, air quality, and structural integrity (Ogórek & Zaskórski, 2018). This data can improve the monitoring and early detection of emergencies, enabling timely interventions and preventive actions. AI algorithms can analyse large amounts of data, identify patterns, and make predictions in real time (Dugdale et al., 2019). They can help crisis managers assess the severity of the situation, anticipate future developments, and optimise resource allocation for effective response and recovery.

## Discussion

Nowadays, the word ‘crisis’ is one of the most frequently used terms, because it is part of our everyday life. Individual citizens, families, institutions, organisations, the state, and the world are going through a crisis. The life of every human being is characterised by constant changes as a result of critical events, because we live in an uncertain environment, where, apart from positive values, there are also negative ones that cause a state of internal imbalance, crises, and crisis situations (Otwinowski, 2010).

Therefore, one of the priority functions of the modern state is to guarantee citizens the basic conditions of protection against possible and real dangers related to the occurrence of natural disasters and other similar events caused by forces of nature, technical failures, or military actions (Sobolewski, 2021).



It is important that all crisis management entities are ready to act, because the diversity and complexity of modern reality leads to more and more frequent events that disrupt the security of citizens. To protect them, crisis management entities need to undertake planning and executive actions in the face of a threat in order to ensure the highest quality of distributed assistance.

Regarding modern technology, an interesting area of future research may be the analysis of conditions for the implementation of new technologies in crisis management or, more broadly, in the public sector. As pointed out by Jennings and colleagues (2017), one of the important conditions is the individual attitude of employees of public organisations to new technologies. It directs research attention towards the concept of the Unified Theory of Acceptance and Use of Technology (UTAUT), which assumes the existence of four determinants influencing the intention to use a new technology. These are: performance expectancy, effort expectancy, social influence, and facilitating conditions (Soltysik-Piorunkiewicz & Zdonek, 2015; Venkatesh et al., 2003; Venkatesh, 2022). Performance expectations is the belief that the use of a given technology will help to achieve benefits or higher performance in accomplishing important tasks. Effort expectancy is the degree of difficulty in using a given technology. Social influence is the degree of a person's belief that people important to them would also use the technology. Facilitating conditions means the degree to which a person is convinced that an appropriate technical and organisational infrastructure exists to provide support during a difficulty with using technology. These determinants influence users' intentions to use modern technology.

## Conclusions

The aim of this study was to assess the current state and effectiveness of crisis management in Poland, with a focus on the use of modern technologies. The empirical findings revealed significant deficiencies in preparedness and response mechanisms due to insufficient financial resources and poorly-defined regulations. These deficiencies often result in improvised and *ad hoc* responses that compromise the effectiveness of crisis management. The research highlights the importance of trust, inter-organisational cooperation, and the use of advanced technologies such as GIS, drones, and ICTs in improving emergency response capabilities. The results suggest that the integration of modern technologies significantly improves data collection, situational awareness, and coordination between crisis management actors.

At the application level, the conducted research points to the need for increased investment in modern technologies in order to improve situational awareness and operational efficiency during crises. At the same time, regular training programmes for crisis management personnel should be introduced to improve their technical skills and ensure that they are well-prepared to use advanced tools and technologies.

Due to the character of the used methodology, one of the limitations of this research is the risk that the results may quickly become outdated. Technological progress is currently so rapid that the publication processes of scientific articles cannot fully reflect the timeliness or dynamics of the use of modern technologies in crisis management. This calls for further research using multiple approaches to examine, among other things, the impact of emerging technologies on the effectiveness and efficiency of crisis management. An interesting line of research might also be to examine the factors influencing the adoption of modern technologies in public sector crisis management, using a framework such as the Unified Theory of Acceptance and Use of Technology (UTAUT). A research line focusing on citizen participation in crisis management

through ICTs would also be of interest. By addressing these areas, future research can provide more comprehensive insights into optimising emergency management practices and policies to ensure better preparedness and response to both natural and human-made disasters.

## Acknowledgements:

Article funded by the research project “Digital Economy: A model approach to supporting the inclusion of cyber-excluded older people in the use of social services provided in a post-pandemic world by public management entities with the use”. Head: Prof. Dr. Aldona Frączkiewicz-Wronka. Project funded by the University of Economics in Katowice (the ‘Beyond Barriers’ competition).

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**Funding**

This research received no external funding.

**Research Ethics Committee**

Not applicable.

**Conflicts of Interest**

The authors declare no conflict of interest.

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**Data Availability Statement**

All data will be available and shared upon request.