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Information Support of Crisis Management

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Abstract

The increasing importance of information has begun the process of interrelated changes of the whole society in today's world. The rapid development of information and communication technologies occurs also in the problematic of crisis management. Since we live in a dynamic world, it is important to be ready to the changes that life brings, responding and adopting new technologies. One of them is crisis management information system. Information system is a tool for information support. Information systems in general are very important and indispensable part of planning, organizing, managing and controlling. This definitely applies to crisis management information system. They are therefore used in the planning of emergency measures as well as in crisis situations. Crisis management is an activity, which can help us to save life, health and property in the whole world.

Keywords: crisis management, information support, information system, rescue operation, heuristic analysis of usability, natural disaster

1. Introduction

During life, one encounters a lot of emergencies or crisis situations. The whole world is threatened by a number of emergencies, which only differs in the location of the country, its geography, the number and size of industrial enterprises, etc. The big difference is also between countries in the Mediterranean (such as the Czech Republic) and countries located by the sea (e.g. the Philippines). The countries that are located by the sea must prepare for crisis situations such as typhoons, tsunamis, etc., which are not threatening the Mediterranean countries.

As mentioned above, each country is threatened by a different emergencies and the objective of each country is to protect its population. The development of new technologies has also brought new opportunities to crisis management. To manage all emergencies or crisis

situations, information support for crisis management is used today. Lukáš defines the information support for crisis management as a process of information support, management, decision making and cognitive processes. The objective of information support is to satisfy the information needs through the information activities necessary to carry out the process. Basic information activities include information retrieval, its processing, presentation, archiving and more [1]. The law defines information activities as “the acquisition and provision of information, the representation of data information, the collection, evaluation and storage of data on mass media and the storage, retrieval, editing or modification of data, their transmission, access, exchange, sorting or combining, blocking and liquidation of data deposited on mass media” [2]. Lowe defines emergency management information system as a computer database system, which is designed to support responders during emergencies by giving them detailed, real-time information, allowing them to graphically integrate it and then transmit their decisions through the chain of incident command [3]. Lindsey defines emergency management information system which connecting all the emergency operational centers and other stakeholders for streamline information sharing and decision support for both daily routine and emergency situations response operations, supporting all phases of emergency management: mitigation, preparedness, response, and recovery. The aim is to improve the communications and information sharing among institutions involved in emergency management in order to facilitate quick and correct decisions during emergencies [4].

This support is being used in all areas of crisis management. It is used by Integrated Rescue Service (IRS) to manage the crisis more effectively and quickly. At the same time, information support for crisis management is also used in public administration, for example on regional level. Public administration institutions also need effective decision-making and assistance in crisis situations.

2. Basic concepts

The following section provides an overview of the basic concepts that are related to the area of information support for crisis management. This terminology is based on legislation, literature, and the cyber security dictionary.

2.1. Crisis management

It is a comprehensive set of management activities and procedures, approaches, views, experiences, methods and measures aimed on analyzing and evaluating security risks, planning, organizing, implementing and controlling the activities used by crisis management authorities to manage specific situations. Crisis management is an integral part of the management of the state, organization or other institution that is interested in its development. Its objective is to prevent the emergence of possible critical situations, to prepare for the managing of possible critical situations, to manage the possible critical situations within the competence of the crisis management and to fulfill the measures and tasks imposed by the higher crisis management authorities, to start the reconstruction and further development. Crisis management is

also referred to as a tool to ensure sustainable development of society, organization, territory and country [5].

2.2. Crisis management system

They are used by governments to manage emergency situations by IRS. Each country has basically the same components as the Fire Brigade, the Medical Rescue Service and the Police. In the Czech Republic, these basic components have been given the name of an IRS, which according to the law means an effective system of links, rules of cooperation and coordination of rescue and security forces, state administration and self-government, natural and legal persons in the joint execution of rescue and liquidation operations, and emergency preparedness [6].

2.3. Information

During the time of managing of an emergency or crisis situation, information has a very important role. Information is a prerequisite for effective emergency response. According to Tvrdíková, the information should have these requirements, which are also referred to as attributes of information:

- timeliness, availability, reliability of information,
- content (actuality, relevance, truthfulness, objectivity, appropriateness),
- format,
- the price and utility value of the information,
- legality [7].

According to the Cyber Security Dictionary, information is defined as “any sign expression which makes sense for the communicator and receiver.”

Lukáš included the following most important information.

- Relevance—the nature of the information should reflect the nature of its use.
- Correctness—the information should be true and reliable. They should have priority.
- Timeliness—information needs to be provided at the right time, i.e. at the time of need and use. Important decisions cannot be made without necessary information if they are not available; however, there is no point in insisting on over-rapid provisioning information that cannot be used safely.
- Timeliness—the information should reflect the actual reality.
- Completeness—all required information, not just some, should be available. Insufficient knowledge due to incomplete information is very dangerous for decision-making.
- Adequacy—the information should be reasonably detailed. Excessive detail makes review difficult and often makes it difficult to get the really needed information.

- Cost adequacy—if it takes the necessary information to obtain an unreasonable amount of time or excessive effort for the benefit it provides, it cannot be considered cost-effective [1].

2.4. Information system

Tvrđíková defines the information system as a functional unit that provides collection, processing, preservation and accessibility of information and data. It includes information sources, media, hardware and software, and equipment, technologies and procedures, standards and employees [7].

According to the Cyber Security Dictionary, information system is defined as “a functional aggregate enabling goal-oriented and systematic acquisition, processing, storage and access to information and data. It includes data and information sources, mediums, hardware, software and utilities, technologies and procedures, related standards and employees” [8].

2.5. Communication system

According to the Cyber Security Dictionary, communication system is defined as “system which provides for the transfer of information among end users. It includes end communication devices, transfer environment, system administration, handling by personnel and operational conditions and procedures. It may also include means of cryptographic protection” [8].

2.6. Information and communication technology

According to the Cyber Security Dictionary, information and communication technology are defined as “all technology dealing with processing and transfer of information, in particular computing and communication technology and software” [8].

3. Legal scope

The following chapter focuses on the legal scope for information support for crisis management, which is usually included in the law on crisis management in the selected country. This term is understood in the legal order according to the requirements of the selected country.

Crisis management in the Czech Republic experienced a great boom at the turn of the twenty-first century, in the aftermath of the catastrophic floods in 1997 in Moravia. On the basis of these floods, a lack of coordination of rescue services in managing with the crisis situation was identified.

In 2000, a package of crisis laws was issued, including Act No. 240/2000 Coll., on crisis management (Crisis Act), Act No. 239/2000 Coll., on integrated rescue system and Act No. 241/2000 Coll., on economic measures for crisis situations. At the same time, there was also Act No. 238/2000 Coll., on the Fire Rescue Service, which was amended in 2015—number 320.

The Crisis Act defines the basic concepts of crisis management, crisis situations, crisis management authorities, rights and obligations of persons in times of crisis situation. The issue of information support for crisis management is also dealt with in this Act, namely in § 26 Securing Information Systems of Crisis Management, which states:

Crisis management authorities use information systems to plan emergency measures and manage crisis situations. Introduction and usage of crisis management information systems must meet the following rules:

- a. the transmission of information to superiors, subordinates and collaborating authorities of crisis management,
- b. technical and program adaptation to function under difficult conditions,
- c. the security of retained information with the highest degree of secrecy contained in the processed dossier.

During the planning of crisis measures, crisis management authorities are responsible to comply with the principle of equivalence of written and electronic data contained in the crisis plan [9].

In Slovakia, the issue is addressed by the Act No. 387/2002 Coll., on state governance in crisis situations in time out of war and military conditions. Information support for crisis management is the same as in the Czech Republic in this law and states.

Crisis management authorities are involved in the crisis management process and use the state crisis management information system. Everyone has the right to inevitable information about upcoming measures and procedures for the protection of life, health and property in a crisis situation [10].

As can be seen in this chapter, information support for crisis management is also included in the country's legal order. Each country defines this concept in its own laws according to their requirements.

4. Information support for crisis management in selected countries

Information support for crisis management is very different in each country. This disparity is given within the country by emergencies typical for the country, by the attitude of the country to addressing emergencies and by different information policies.

The previous chapter describes the current situation of information support for crisis management in the Czech Republic. The aim of this chapter is to familiarize readers with information support for crisis management in other countries. Due to this comparison, the reader will gain broader insight into the possibilities of information support for crisis management.

4.1. United States of America

The US security and safety system has been built since the end of the Second World War. This system is considered as the most sophisticated and the most efficient in the world.

Information support for crisis management is used in the USA. This includes, in particular, the EIS/GEM InfoBook information system, which is used by the Federal Emergency Management Agency (FEMA).

4.1.1. EIS/GEM InfoBook

It is an information system for managing of crisis situations of various kinds. It is an information technology that is designed to support the prevention and solution of various crisis and emergency situations. Due to this system, users can respond appropriately to any crisis situation. It allows receiving, sending, and recording event management data with automated logging and automated reporting of the situation. It also allows recording of the necessary resources for managing the emergencies.

InfoBook provides current information in a combination with map data, data from databases, modeling and communication technologies.

The EIS/InfoBook modularity enables users to keep an immediate overview of the situation and its progress, the sources of risk in the territory or the facility, the forces and resources, their operations, and tasks, description of the territory, areas, buildings in terms of risks, equipment and other aspects. It allows processing of specific actions plans, hiding and evacuation. This system includes nine modules.

- Daily records—allow users to collect, manage and process records of emergencies and solutions.
- Plans and activities—create conditions for managing of the crisis situations—tactics and methodological solutions, emergency plans.
- Sources and resources—allow users to collect and manage data about forces and resources.
- Dangerous substances—provide data on hazardous substances, their adverse effects and the principles and procedures for reacting to their performance.
- Threat—creates tools to perform risk analysis of objects.
- Local planning—allows users to process detailed emergency plans for objects—deploy both risk and rescue resources.
- Persons—personal data management—links, qualifications, usability, training, experience.
- Response—creates the conditions for managing the response to the crisis, including the coordination of forces and resources during the intervention.

- Aftermath—allows users to keep track of damage and losses, as well as the infrastructure, transport and supply of the aftermath process [11].

This system is used by NATO, FEMA, NASA, IMB, British Petrol, and Shell Oil.

4.2. Australia

Emergency Management Australia is an Australian federal government agency tasked with solving and coordinating operations during emergencies. Emergency management includes plans, structures, and arrangements that are set up to coordinate government, voluntary and private agencies in Australia.

The Agency has four departments—the Security Coordination Unit, the Crisis Coordination Unit, the Crisis Support Unit and the Natural Disaster Recovery Unit.

Across Australia, there are a number of statutory authorities and government authorities responsible for managing and controlling emergencies such as natural disasters, technological and industrial events, or civil-political unrest.

4.2.1. Australian Inter-Service Incident Management System (AIIMS)

This system was developed in Australia in the mid-eighties. It is a robust system for managing emergencies and crisis situations. It enables smooth integration of multi-agency activities and resources to address any emergency. The system is therefore customizable and can be effectively used to manage emergencies either by one organization or by more organizations. These organizations are able to cooperate with each other and provide data.

The system operates effectively for any type of incident—natural, industrial, civilian, and many other incidents involving emergency response from organizations. In addition, the system can also be used for other events that are not considered as critical—sports and cultural events, exhibitions and conferences.

AIIMS provides a management system that facilitates the coordination of the activities of all involved agencies in addressing of any emergency. The system provides an entire framework for incident management that begins with the first response and grows with the severity of an emergency. Since the first emergency notification, many emergency management procedures have been implemented, which are predefined. The system contains a list of resources (forces and equipment) along with operational planning (**Figure 1**).

The system is based on an incident management team, which controls operations during emergencies. This team has delegated functions—a logistics office, an operating office, and a planning office. This team meets as a result of an emergency and addresses the situations and ensures the management and control of the emergency.

The advantage of this system is the possible cooperation of several organizations, due to the use of the same terminology that ensures their correct communication at all levels of emergency response. This creates a common chain of command within the incident management structure.

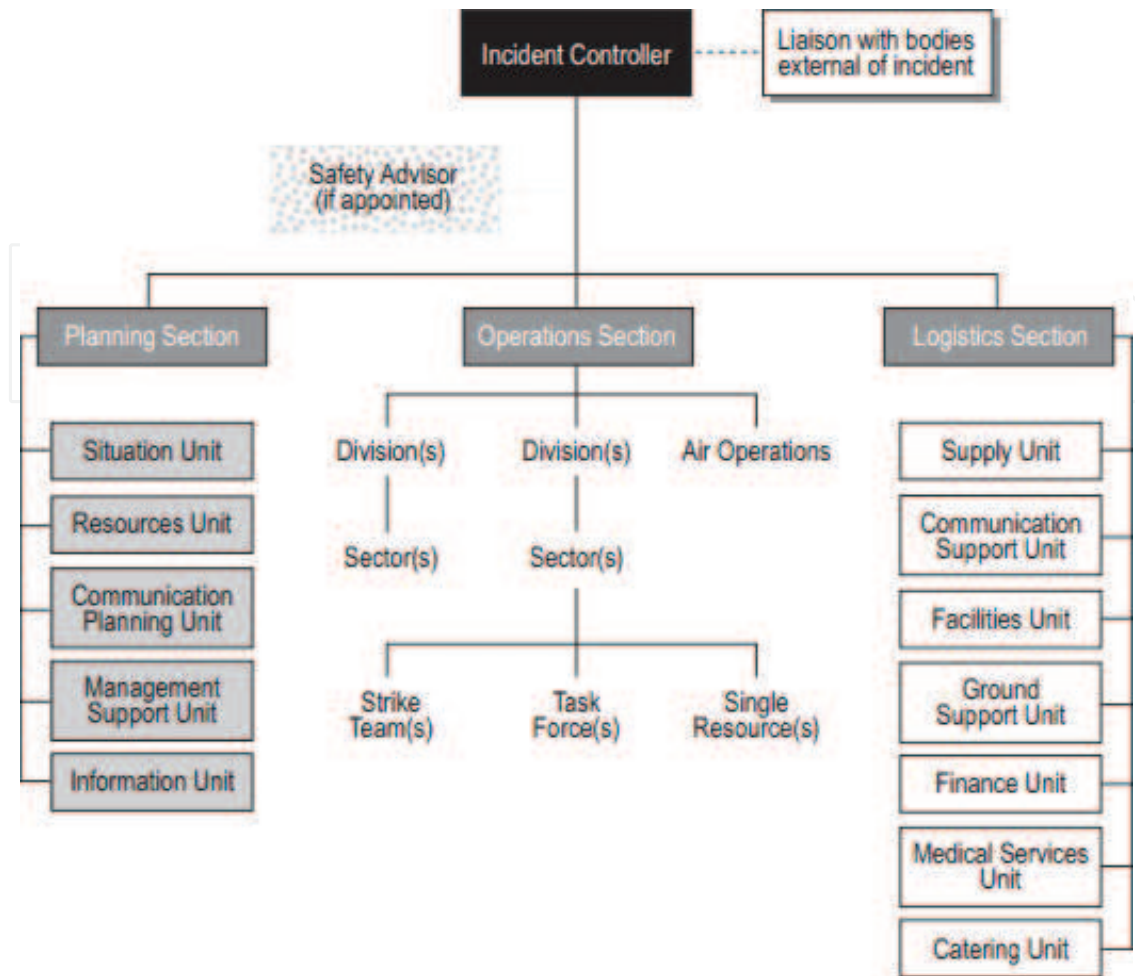


Figure 1. The structure of AIIMS [12].

Basic system incident management features include:

- defining features,
- uniform terminology,
- adaptable and scalable approach,
- defining an incident management structure,
- clearly defined roles and responsibilities,
- efficient resource management system,
- access to risk management,
- clearly defined communication flows,
- a comprehensive planning process,
- management and control system,
- a system that suits all emergencies and everyday situations.

Successful resolution and management of crisis situations, emergencies or other events are dependent on the above-mentioned features of the entire system [12].

4.3. Philippines

In the Philippines, The Crisis management system is governed by the National Disaster Risk Reduction and Management Council. This council creates crisis plans, measures and procedures in the case of a disaster and warning of residents in crisis situations.

Information support for crisis management has the highest priority due to frequent natural disasters—typhoons, floods, landslides. For crisis management, a web platform has been created, which also includes a mobile application making it possible to display actual weather, imminent crisis situations (floods, storms, landslides, volcanic activity), and basic elements of critical infrastructure (schools, health facilities, stations, fire stations, ...) [13]. In the Philippines, they are using warning system NOAH. We can therefore assume that information support for crisis management has the highest priority on the given threats.

4.4. Czech Republic

The Czech Republic addresses the information support of crisis management on several levels—state, public administration and IRS. The subsections are focused on given levels of information support.

4.4.1. Unified crisis management information system

The crisis management information system should be built as a modular system with the following characteristics of each module.

The methodology module supports planning and decision-making processes, processing crisis and type plans at a given level of public administration, including planning and choosing the optimal solution to the given situation; module should include tools supporting modeling and simulation processes, risk analysis, vulnerability analysis, processes related to education, training, etc.

GIS module including GPS and navigation system using vector, raster, altimeter data and interest spatial databases—databases of key objects, addresses, etc.—in given scales and formats compatible with spatial information standards within the public administration information system. A typical GIS application to visualize an emergency or crisis situation is to “create a record” into the map background.

Common picture module of the situation about the area of emergency or crisis situation. The module was to get a uniform overview of the emergency or crisis situation and the ongoing activities in this area. The basis of communication should be a uniform interpretation of the given situation. A common picture of the emergency or crisis situation and its ongoing activities should allow cooperative planning and solutions including targeted logistical support.

The module for supportive application should include, in particular, the alert application; evacuation; evidence of a temporary change of residence; humanitarian aid; supplies of individual protection and supplies of collective protection; transport planning; time calculations of engineer works; logistics calculations, assessment of the situation at the point of disperse of the dangerous substance; radiation, chemical and biological protection, etc.

The formalized documentation module should include tools and functions such as DMS (Document Management System) and EDI (Electronic Data Interchange). For international communication purposes (within the EU, NATO, etc.), it should have formatted documents that complies with the relevant international standards.

Key requirements of the crisis management information system. The crisis management information system should be built as a system:

- respecting international and national standards,
- respecting the requirements of efficiency and economy (using appropriate parts of existing systems, application software, databases, etc.) and complying with the principles of system integration,
- operating on a platform with different communication environments using existing communications systems or parts (e.g., the Matra system),
- respecting the required information security according to the standards,
- internally (with selected relevant problem area of systems) and externally (with other IS) interoperable; interoperability is addressed in the form of a central repository connecting all components of the system in one harmoniously operating information unit.

The reason for the failure of the project crisis management information system was mainly:

- technological demands of the entire system,
- inappropriate legislative determination,
- limited amount of data and the impossibility of its continuous update.

The above reasons led to the failure of the objectives of crisis management information system in the Czech Republic.

4.4.2. Information support of crisis management at the regional level

Based on the failure of the single crisis management information system, each municipality in the Czech Republic decided to provide its own information support for crisis management.

The Czech Republic is divided into 14 municipalities in which each municipal office has established a department of crisis management. This department is the organizational structure of the municipal office of the municipality, which ensures preparedness for management of emergencies and crisis situations (**Figure 2**).

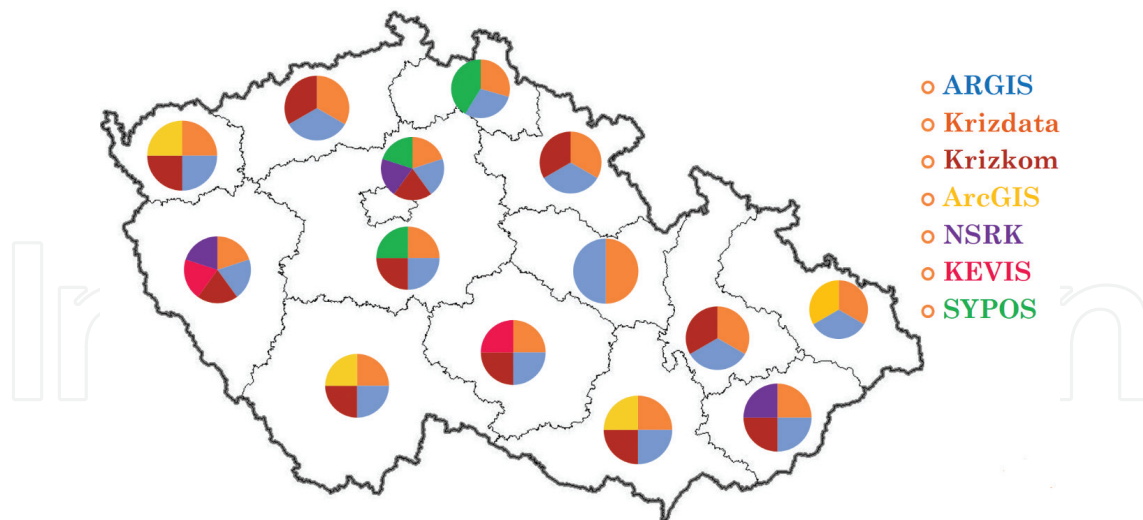


Figure 2. The map of crisis management information systems in the municipalities of the Czech Republic [own].

In the Czech Republic, many information systems to support crisis management are used. Among the most used information system belongs ARGIS, which is used by 13 municipal offices. Another major information system used by 11 municipal offices is the information system KRIZDATA.

Some municipalities have developed their own information systems to support crisis management. This small group includes the South Moravian municipality with its own portal Krizport. Another Zlín municipality that also developed its own information system called Information, Communication and Warning system (ICWS). Next is capital city Prague with its own information system Prague Crisis Management Information System. Last is Olomouc municipality, which has web application Community Cards.

Information systems do not need to be based only on computers and computer networks. Crisis management information systems therefore do not necessarily use tablets, computers, etc.; however, it may be worth using a physical recording media, namely paper. Non-computerized information systems are partly involved in providing information to support the crisis management in many municipalities. The advantage of non-computerized systems is particularly easy implementation of changes in the processing, but also in terms of reading, updating records and archiving.

Basic characteristics of own information systems:

Krizport

The main objective of this system is to transmit relevant and updated information on emergencies to the public and staff who work in the area. The portal is divided to a public section where each user have access and private section where access is permitted only for selected users. This system is operated and provided by the Fire Rescue Service of the South Moravian municipality [14]. Private section mainly contains the current information of emergency and crisis plans.

ICWS

The purpose of this system is the integration of technology and communication systems used within individual municipalities with extended competence (MEC) to the host system with a unified user interface ICWS. It provides monitoring, unified view, mutual communication and control. The system is private and only to provide the information support of crisis management in the municipality [15].

ICWS is unique in the connection of clients using optical fibers to each crisis staff in the Zlín municipality. The advantage is that the system can also be used in case of power failure and can communicate with other crisis staffs or flood commissions. ICWS is also part of the meteoradar that monitors weather and precipitation in the municipality. The system can also monitor river levels through the profiles of the watchers, and warn the population.

4.4.2.1. Prague crisis management information system

Prague Crisis Management Information System was developed for the purpose of the information support of crisis management in the capital city and it is also used by the Central Bohemian municipality. The objective of this system is to support the management of crisis and emergency. It cannot be clearly remark that the system is used only in emergency situations (such as floods), but it is also used for less serious events (such as potable water supply).

4.4.2.2. Community Cards

The Community Cards is a web application that is used in the Olomouc municipality. In general, municipal cards are used throughout the Czech Republic. The Olomouc municipality is specific because these cards have been transferred to a web application that provides information to both the Regional Office for Emergency Response and the Fire Rescue Service of the Olomouc municipality. In the event of a power failure, it is also possible to use this application in offline form. This app contains information about cities in the Olomouc municipality—contacts, forces and resources, significant objects, location risks, fire protection units, crisis management authorities, and population warnings.

4.4.3. Information support for crisis management for rescue services

As mentioned in the previous chapters, information support of crisis management is used not only at the national or the regional level. Information support is also used to support the IRS. Each IRS unit uses different information support for their own needs. This can sometimes lead to issues in cooperative dealing with emergencies or crisis situations.

4.4.3.1. Fire Rescue Service of the Czech Republic

The Fire Rescue Service of the Czech Republic uses more information systems to support decision making and effective intervention. It can be information systems of crisis management within individual region, crisis management information systems set up by the state material reserves administration, systems that can model the releases of dangerous substances (RozexAlarm, TerEx ...), ArcGIS information system, which serves in particular as a map background.

4.4.3.2. Case study on using ArcGIS by Fire Rescue Services in the Czech Republic

Fire Rescue Service of the Czech Republic operates on the map server that is configured bespoke to firefighters, joint rescue system and crisis staffs. The users have a variety of features and also a wide range of topical layers useful during the development of emergency and crisis plans or solutions to any emergency and crisis situation.

All sorts of technologies and techniques are still developing to ensure the fastest possible assistance. The geographic information system enables accurate and fast decisions aiming to save life, health, property and the environment.

Geographic information system is used by Fire Rescue Service of the Czech Republic PSAPs during the dispatch of units and equipment to the event location and also to support crisis management [16].

The main positive aspect of this system is the ability to create various data analyzes which have wide application in the area of crisis management. On the contrary, the negative aspect can be considerable financial costs of the license to use the information system (**Figure 3**).

Information system ArcGIS assists Fire Rescue Service in different areas. The system displays nearby Fire Rescue Service units (e.g. 1—professional units 5—local volunteer units) and also there were implemented details from the unified traffic information—road closures, bridges, underpasses, railway crossings and so on.

In ArcGIS, Operations and Information Centre of regional Fire Rescue Service recorded incident. Operations and Information Centre enrolled the type of incident (e.g. fire) into the system and chose the equipment that should go to the site (e.g. a fire tank truck, ladder), and Fire Rescue Service units (professional or volunteer firefighters).

After entering all above-mentioned data into the system, it will alarm Fire Rescue Service (professional and volunteer) using sirens, sending information via SMS. This will trigger alarm procedure (lights are switched, opening the door, all relevant information to the point of intervention appear on the garage monitor).

The trucks of Fire Rescue Service professional firefighters are equipped with portable technology—tablets on which the dispatch unit can find planned route and navigate to the location of the incident. The planned route takes into account the height of the truck to avoid underpasses and road closures, etc.

Once the Fire Rescue Service unit arrives at the site, commander of the intervention marks in the tablet the operational site, which was reflected on the operational center of the Fire Rescue Service, the Czech police, and Emergency Medical Services. This helps to accurately navigate IRS vehicles to the place of the event and also to inform other units about the tasks in progress. The commander designates specific areas (danger zones) that are not allowed to be crossed or zone where should IRS units intervene. For the civilian cars, the system shows detours.

Based on this case study, we can conclude that the system greatly simplifies information exchange between operating and information center and dispatch Fire Rescue Service vehicles.

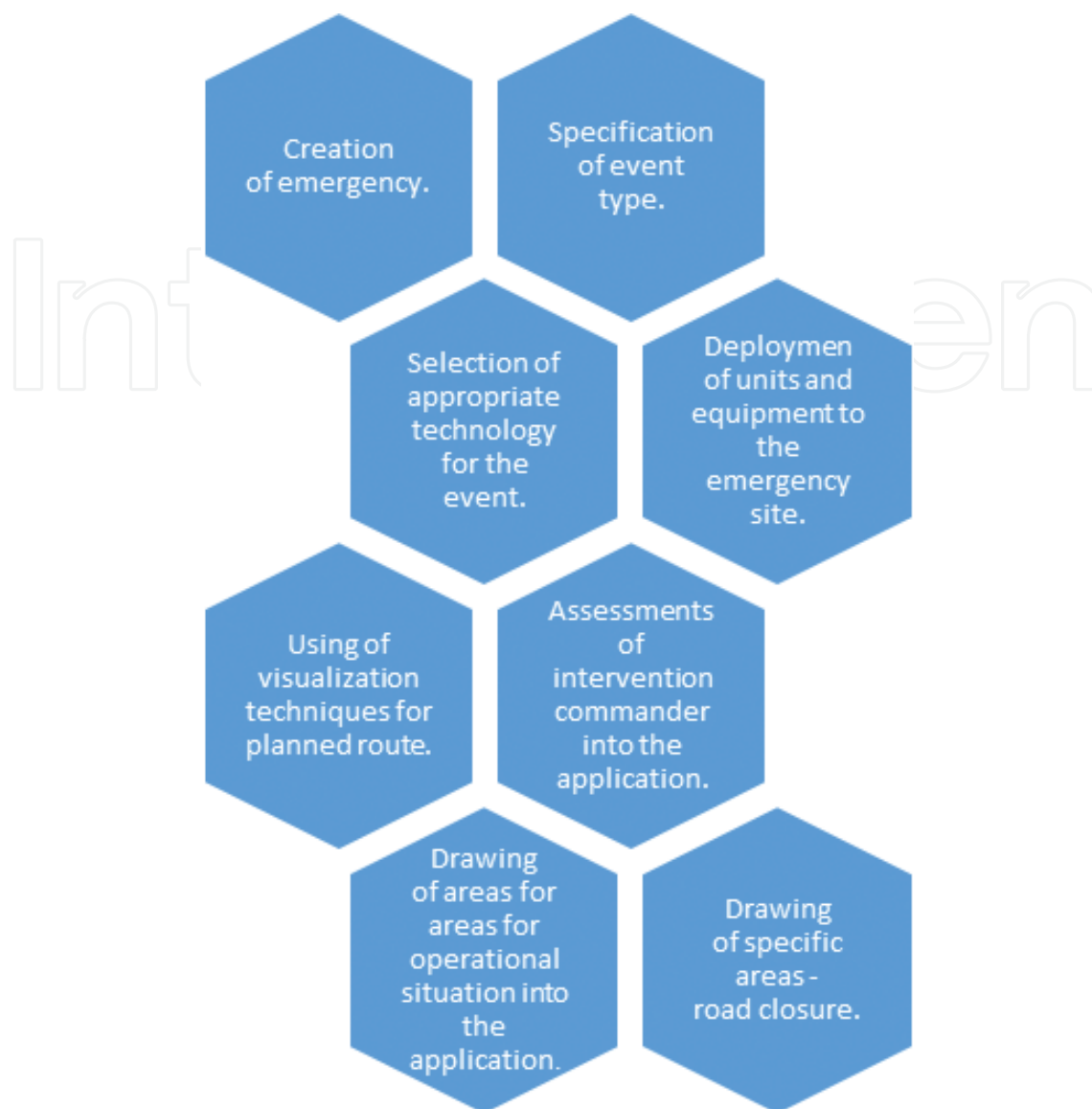


Figure 3. Visualization of operation station [own].

With this system, the Fire Rescue Service vehicles can get to the site faster and more efficiently without necessary complications that can occur on the route to the incident.

4.4.3.3. Medical Rescue Service of the Czech Republic

Medical Rescue Service of the Czech Republic uses an information system that serves as a modern tool for information support to the activities of the Medical Emergency Service. Provides support for dispatching activity, deployment of units, insurance reporting, etc. Also enables efficient collaboration and sharing of relevant information with other units of the integrated rescue system.

This system performs receiving and processing of emergency calls, deployment and controlling of units, communication with a vehicle computer, mapping and vehicle positioning, deployment logs, keeping driving books, insurance bills, warehouse management, statistics and deployment planning [17].

4.4.4. Police of the Czech Republic

The Police of the Czech Republic, as well as the previous forces of the IRS, use information support. This information support is rather used as a support for managing of events that are dealt with in police investigations. These include automated vehicle inspection systems, population, visas records, a system for detection of forged documents and the Interpol information system. These systems can also be used in managing of emergencies; however, the role of the Czech Police in a crisis situation is rather in managing traffic situations.

The information support of the forces of the IRS is adjusted to the needs of the selected rescue forces. It is clear that the Fire Rescue Service, which is usually the case for all emergencies or crisis situations, the most commonly uses information systems to manage these situations.

4.5. Comparison of crisis management information systems in the whole world

The crisis management information system may provide the following processes and capabilities:

- monitoring process—obtaining information from the environment, from production processes and from technological equipment, energy, networks (connecting, energy), social means, from public life, from legislation,
- the ability to alert and inform the population—about the imminent threat or origin crisis situations and its solutions, forms of warning (radio, television, Teletext, public information billboard, internet, news service, etc.),
- the ability to notify responsible staff—to arrive at a designated place or in areas of crisis,
- the ability to store and maintain information—about the territories and the risks that exist on it and may be a source of crisis situations,
- a system to support decision-making with the necessary information—providing information about the crisis, their characteristics, solutions, support processes, security rescue and liquidation work, logistic support,
- support for training and training programs—background for modeling, planning, teaching, research, development, exercise,
- source of optimization of institutions' activities and executive elements integrated into crisis management.

Table 1 shows the comparison of crisis management information systems in selected countries. As can be seen in **Table 1**, there are many crisis management information systems in the whole

State	Crisis management information system
Australia	Australian Inter-Service Incident Management System
Bolivia	SINAGER—SAT warning system
Colombia	SIPLAG—Integrated Planning and Control System
Czech Republic	Many systems at regional level and IRS
Ecuador	ECU 911—Application of Integrated Security Service
Indonesia	InAWARE—Indonesia All Warning and Risk Evaluation
Italy	Heat health warning systems and PRESTo warning system
Morocco	CRTS—Royal Centre for Remote Sensing
Philippines	NOAH—Nationwide Operational Assessment of Hazards
USA	EIS/GEM Infobook

Table 1. Comparison of crisis management information systems [own].

world (Europe, Asia, America, Africa). Some of them are warning systems, the next systems for integrated rescue service and unified system for government. We can the best evaluate the unified crisis management information system in USA and Australia. These systems are global and usable for the whole state. Other systems are only the part of the crisis management—warning systems (e.g. NOAH, InAWARE...).

5. Method

The crisis management information systems have a lot of the advantages and disadvantages, and therefore the heuristic analysis of usability was performed on these systems. This assessment is used for the qualitative evaluation of the systems that give us the accurate results in the connection of the strengths and weaknesses of the established system. Based on the analytical studies, we determined the staff of the Fire Rescue Services and municipal Authority of the municipalities for the analysis of the information systems. Based on the mentioned analysis, we conducted an evaluation using the following Eq. (1):

$$UIS = (R + H/2 \times H) \times 100 \quad (1)$$

where UIS = usability of the information system, R = sum of the results (acquired points), and H = amount of evaluated heuristics.

A set of the evaluation questions (70 problems) was used in the evaluation of the system, and these questions were divided according to the several indicators. These indicators can be described by the next questions.

The general—essential information from a general perspective, where it was investigated whether the system works; if the system contains only the relevant elements and information on the problem; the system can be used without help.

The usability—the usability of the system in the proper sense; the intuitiveness of the application; the ability to control in the particular conditions and adequate display on the mobile devices.

The security—a map content, which was determined by its actuality, credibility and the possibility of the system breach.

The content—the content where it was investigated whether the system includes the advertisements, the misleading elements and also regarding conciseness of the headings.

The search—the search regarding the evaluation of the results; whether the results match the searched query; whether it is viable to search by the coordinates; whether the autocomplete is accessible.

The graphics—the composition layout, typography, font color, and the suitability is evaluated as well as the esthetic impression of the unified system.

The evaluation methodology consisted of the answering of each of the assign question from the predefined plurality of the evaluation values (-1 = does not satisfy; 0 = partially satisfies; 1 = satisfies; the field is empty if the question is not relevant) [18].

6. Results

The aim of this chapter is to present the results of an analysis of the information support for crisis management in the Czech Republic. As mentioned in the previous chapter describing information support for crisis management in selected countries, the Czech Republic divides information systems to support multi-level crisis management.

Based on the above-mentioned use of heuristic usability analysis, we performed analyzes on selected crisis management information systems.

6.1. Analysis of unified crisis management information system of the Czech Republic

This chapter describes the usability of information support for crisis management in the single crisis management information system, which was only launched as pilot version between years 2008 and 2011, when it failed in a crisis situation—floods.

Table 2 shows heuristic analysis of usability of unified crisis management information system of the Czech Republic. This evaluation provides the statistics data from each of group of the indicators. As can be seen in **Table 2**, the best-evaluated indicator was “Graphic.”

Based on the analysis, it can be estimated that the system was partially usable, and if a mobile application were implemented by the system administrator, the system could still operate. The Directorate-General of the Fire Rescue Service of the Czech Republic, which has been under the auspices of this system, does not expect that the system would be reintroduced and developed in the future.

6.2. Analysis of information support for crisis management at the regional level

Information support for crisis management in public administration at the regional level is entirely diverse. Some municipalities do not use any crisis management information systems. Only the four selected municipalities have set their path to the issue of crisis management and built their crisis management information systems. For these chosen information systems a heuristic usability analysis was performed.

Table 3 presents the results of the usability the heuristic analysis of the crisis management information systems in the Czech Republic. This evaluation provides the statistics data from each of group of the indicators. As can be seen in **Table 3**, Information, communication and warning system (ICWS, Zlín) had been evaluated as the system with the highest percentage in the total score of the evaluation (92.06%). This system had been defined the search and graphic indicators as the first-rate results of the evaluation. On the other hand, the results of the heuristic analysis information system. The Community Cards had not been integrated the tool for the searching. The graphic indicator of the all systems used in **Table 3** is evaluated as the best from all indicators. The graphic indicator is important for the quick and effective orientation in the system and therefore these systems need to develop this indicator in detail. We can constate that these systems are usable and suitable for the further development.

6.3. Analysis of information support for crisis management for rescue services

As mentioned in the previous chapters, information support of crisis management is also used to support the IRS. The ArcGIS information system, which is used to support crisis management, has been selected by the primary component—Fire Rescue Service (**Table 4**).

Table 4 shows analysis of information system ArcGIS. As can be seen in **Table 4**, the best evaluated indicator is graphic. This indicator took 100%.

Based on heuristic analyzes of information systems, it has been found that the systems are focused on managing the emergencies and crisis situations, thus significantly helps decision makers.

Indicators	Number of points	Number of questions	Number of answered	Rating
General	2	12	10	60.00%
Search	3	9	7	71.43%
Graphic	8	9	9	94.44%
Content	6	9	8	87.50%
Security	4	12	12	66.67%
Usability	–1	22	20	47.50%
Total	22	73	66	71.26%

Table 2. Heuristic analysis of usability of unified crisis management information system of the Czech Republic [own].

Indicators/CMIS	ICWS, Zlín	Krizport, Brno	CMIS Prague	Community Cards, Olomouc	Total
General	91.66%	95.83%	62.50%	86.36%	84.09%
Search	100%	83.33%	92.85%	0%	69.05%
Graphic	100%	100%	83.34%	100%	95.84%
Content	87.50%	100%	81.25%	77.78%	86.63%
Security	87.50%	72.73%	85.00%	50.00%	73.81%
Usability	85.71%	91.17%	63.34%	67.50%	76.93%
Total	92.06%	90.51%	78.05%	63.61%	81.06%

Table 3. Heuristic analysis of usability of crisis management information system of municipalities [own].

Indicators	Number of points	Number of questions	Number of answered	Rating
General	1	8	8	56.25%
Search	6	8	8	87.5%
Graphic	5	7	5	100%
Content	3	8	6	75.00%
Security	2	7	6	66.67%
Usability	6	10	8	88.00%
Total	23	48	41	78.90%

Table 4. Analysis of information system ArcGIS [own].

7. Discussion

In general, information systems are very important and essential part of planning, organizing, managing or controlling. This is undoubtedly applies to crisis management information systems. They are therefore used both in planning of crisis measures and managing the crisis situations. The basis of all information systems is not only algorithms, but also data. In order for the information system to function properly, it is important that the system contains the actual data.

This chapter deals with information support for crisis management in selected countries where different types of information support are available. The US has its own information system, which is used to address the most diverse types of crisis and emergency situations. The Philippines owns a web app that is specifically designed to manage the nature disasters that are most common in this country. On the contrary, the Czech Republic is very divided in this area and the information support is divided according to individual levels, state system, public administration systems and integrated rescue system systems.

A heuristic analysis of usability was selected for the evaluation of crisis management information systems. The aim of this analysis is to evaluate any information system using six indicators. For

crisis management information systems, the analysis was modified and a quantitative assessment of the predefined 70 questions was performed.

Heuristic analysis of usability was used on 6 information systems that are used to support crisis management in the Czech Republic. There has been an evaluation of the unified information system for crisis management, which is currently not used. Furthermore, four information systems that are used in public administration at the regional level and one information system used by the Fire Rescue Service. Public administration and Fire Rescue Services have been assessed as usable and suitable for further development. Information support for crisis management in the Czech Republic should be reintroduced as a unified crisis management information system that would tackle crisis situations globally, as is the case in the US or Australia.

The main weakness of information system is that the system does not establish responsibilities and competencies for tasks in crisis management. The crisis management system should be unified and customized, so to unify and adapt to the users' needs (from population protection staff to end-users—emergency responders) who work regularly on the system and need to customize the system. The system should therefore be more user-friendly and have an intuitive interface.

8. Conclusion

The purpose of this chapter was to provide an overview of information support for crisis management that is being used in the world. The key chapter is a description of the information support for crisis management in selected countries. Four countries were selected in which information support for crisis management was described. One of the selected countries was also the Czech Republic, where the information support is further analyzed according to individual levels—state system, public administration systems and IRS systems. The heuristic analysis of usability was selected to serve as a tool for assessing crisis management information systems. In total, six information systems were evaluated.

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Conflict of interest

We have no conflict of interest.

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