The Comparative Analysis of Information, Communication and Warning systems

Katerina Vichova, Martin Hromada

Abstract—This paper describes the information, communication and warning systems, which are using in the area of crisis management. For the purpose of this paper we selected system for crisis management to the three areas. Each states use different types of these systems for crisis management. The aim of this article is to describe these systems, and gives information about the using in the selected states. For each area of these systems we choose two or three state and describe them. There was used the heuristic analysis of usability, which was used for the systems in the Czech Republic.

Keywords—information system, warning, emergency management, communication, crisis.

I. INTRODUCTION

DURING life, it encounters many emergencies and crises. The whole world is threatened by many emergencies. The most common disasters are natural disasters [1]. Inhabitants live in an environment which is permanently exposed to a diversity of more or less dangerous situations, generated by numerous factors. Extreme natural phenomena such as: storms, floods, drought, landslides, earthquakes and others, in addition to technological accidents (severe pollution, for example) and conflicting situations, may influence directly the life of every person and that of society as a whole [2]. These emergencies differ according to the location of the country, its geography, the number and size of industrial enterprises, and others. The enormous difference is also cause by geographical location of the states. States located in Central Europe (e.g., the Czech Republic) are threatened different emergency than states found by the sea (e.g., the Philippines). The countries that are located by the sea must be prepared for crises such as typhoons, tsunamis, hurricane and others. Hurricane Sandy was the second costliest hurricane in United States history [3]. Natural disasters are among humanity's most costly, deadly, and dreaded occurrences [4]. However, nobody knows when another extraordinary event or crisis will strike. This issue deals with security futurology. The security futurology is the science of the future, which deals with the theory, study and creation of variants of possible developments in the security situation [5].

In today's era of data deluge, information fusion has increasing applications in myriad of domains like disaster relief [6]. The aim of each state is to protect its population. New technologies also present new opportunities for crisis management. The crisis management information systems (CMIS) are used to address all emergencies or crises today. The term crisis communication is associated with emergency management and the need to inform and alert the public about an event. In this case, crisis communication might refer to the community leaders' efforts to inform the public [7].

Each state characterizes the CMIS itself. The Czech Republic specifies the CMIS as a system for acquisition and providing information, presenting information, collecting, evaluating, and storing data, retrieving, disseminating, accessing, exchanging, sorting or combining, blocking and disposing of data [8]. Information support is a process (a set of information activities) supporting information management, decision making and cognitive processes [9].

Slovakia uses information systems to plan emergency measures and manage crises. Use of CMISs must comply with the following rules:

(a) the transmission of information to superiors, subordinates and collaborating authorities of crisis management,

(b) technical and program adaptation to function in emergencies,

(c) the security of the retained information with the highest degree of secrecy contained in the processed dossier [10].

The United States of America characterize an 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 [11].

The CMISs are used at all levels crisis management. Firstly, they are used by Joint Rescue Service. They use them to manage the crisis more efficiently and speedily. Next, CMISs are also used in public administration which needs effective decision-making and assistance in crisis. Finally, they can be used at the state level. There are some significant differences

K. V. Author is a phd student at Tomas Bata University in Zlín (Faculty of Applied Informatics, Department of Security Engineering, Nad Stráněmi 4511, 760 05 Zlín, Czech Republic) phone number: +420 737 800 427, email: kvichova@utb.cz

M. H. Author is a associate proffesor at Tomas Bata University in Zlín (Faculty of Applied Informatics, Department of Security Engineering, Nad Stráněmi 4511, 760 05 Zlín, Czech Republic), email: hromada@utb.cz

among countries in the ways how the CMISs are applied, and these differences have been little discussed so far.

This paper describes and analyzes different systems, which are used in the crisis management. We have split systems to the categories information system, communication systems and warning systems.

II. INFORMATION SYSTEMS

First type of the crisis systems are information systems. These systems are characteristic with the sharing information in times of crisis. Typical state, which uses information system of the crisis management is the Czech Republic and Slovakia.

The Czech Republic has CMISs at two levels: state and public administration. The aim of the Czech Republic was to create a unified system for crisis management in 2004. This system should create a tool for qualified decisions, planning support, and decision-making processes. The system should respect national and international standards. The intention has not been met, and the system is not developer yet at this time. The reason for the failure of the project CMIS was mainly:

    a)   technological demands of the entire system,

    b)   inappropriate legislative determination,

    c)   limited amount of data and the impossibility of its continuous update.

The above reasons led to the failure of the objectives of CMIS in the Czech Republic.

The Czech Republic is divided into 14 regions. Each regional office has established a department of crisis management. This department is the organizational structure of the regional office of the region. Each region ensures preparedness of management of emergencies and crisis.

This small group includes four regions. Firstly, it is the South Moravian region with crisis portal KRIZPORT. Secondly, it is the Zlin region, which developed its Information, Communication and Warning System. Thirdly, it is capital city Prague with CMIS of the capital city Prague. Finally, it is the Olomouc region with application Community Cards (CC). In the next part of this paper, we will analyze these systems.

The second mentioned state, which use information system in the area of crisis management is Slovakia.

For the managing of crisis, the Unified Information System for Economic Mobilization (UIS EM) is used in Slovakia. This system is used by all central state administration bodies, including Slovak Television and Slovak Radio and other thousands of entities, including all local government authorities and municipalities. The Ministry of Economy of the Slovak Republic is the coordinator of the use of the system throughout Slovakia. Each entity using UIS EM has a programming tool that is tailored to its needs [12].

The task was to create a shared online communication platform to facilitate data collection and follow-up planning, to introduce a single content form of planning documentation, to enable independent work with all the essential information in electronic and written form, to informally support the processes of economic mobilization and crisis management or emergency incidents [12].

UIS EM is based on an extensive information base built to support the decision-making process of state administration bodies in dealing with crisis or to provide the needs of the armed forces of coalition partners on the territory of Slovakia. This information base is also used during the prevention period during the preparation of crisis response measures.

Significant information - identifying, legal, structural, personnel, financial, planning, etc. - of the entity, as well as details on the tools and resources the entity intends to use in performing its tasks in crisis, is reported. The system fundamentally monitors the needs of the population and the armed forces, the resources - people, energy, state material reserves, the production capacity of companies, etc.

UIS EM consists of a set of technical and program resources, methodological guidelines, economic mobilization entities used for the processing, evaluation, and transmission of data on economic mobilization, and collection and sorting of information for the decision-making of state bodies, local authorities and other economic mobilization bodies. For stakeholders, the structure, content, and binding of individual data for individual groups of tracking information and the regularity of their transmission are binding and coordinated.

Since 2009, UIS EM has been gradually developing as an internet-based system with their protection called EPSIS. The system is only available to economic mobilization entities.

The EPSIS solution is implemented with an applied three-layer architecture, which has three layers. It is a presentation layer or a thin client that forms the highest, presentation layer that serves to retrieve output data from the user and to present the results of user requirements. Typically, there are various presentation layers in the system for different types of devices (PC, mobile phone, tablet) and different platforms (Windows, MacOS, Android). Additionally, it is an application layer or application server, which is an intermediate application layer that implements all the calculations and operations between the data layer and the user. The last one is a data layer or a data server, the lowest data layer that does not just store and capture data, but also provides some data operations such as aggregation, pre-processing of selected data, integrity.

The advantage of the EPSIS and UIS EM program is online traffic over the Internet - monitoring and processing of data is performed in real time at different levels of management, access to information between economic mobilization entities is realized at both the departmental and the cross-sectional level through the set access authorization. Besides, the system offers a better opportunity to register registered users and control their entry into the system; economic mobilization entities can be notified via SMS and e-mail messages and send them bulk messages in selected areas, and data can be used directly in the field - laptop and mobile connections are needed. Other benefits of the system include the creation of press releases and documents and the insertion of external files, data can be linked to map data and exported to a local

computer, available codebooks and registers can be used, the user can use data for other purposes such as economic mobilization in accordance with the legislation in force [13].

III. COMMUNICATION SYSTEMS

Second part of the crisis systems are communication systems. The aim of these systems is to communicate through to CMIS. These type of the systems are used in the USA and Australia.

The United States of America have CMIS at the state level-EIS / GEM InfoBook. It is a system for managing crisis situations of various kinds. Thanks to this system, users can respond appropriately to any crisis. It allows receiving, sending, and recording event management data with automatic logging and automated reporting of the situation. It also allows recording of the necessary resources for managing the emergencies. The EIS / InfoBook modularity enables users to keep a quick 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 region, areas, buildings regarding risks, equipment, and other aspects [14]. It allows processing of specific actions plans, hiding, and evacuation.

The second state using this type of the crisis system is Australia. Australia has a CMIS at the state level too. It is Australian Inter-Sevice Incident Management System (AIIMS). This system was developed in Australia in the mid-eighties. It is a robust system for managing emergencies and crisis. The system is therefore customizable and can be used effectively to manage emergencies.

The system operates efficiently for any incident - natural, industrial, civilian, and many other incidents involving the emergency response from organizations. Also, the system can be used for other events that are not considered as critical – sports and cultural events, exhibitions and conferences.

This system provides firstly a management system that coordinates the activities of all involved agencies in addressing of an emergency, secondly, an entire framework for incident management that begins with the first response and grows with the severity of a crisis. The system contains a list of resources (forces and equipment) along with operational planning [15].

Based on the complexity of the emergency or crisis in the Australia these system includes different units and specialist resources. There are these main units - situation unit; resources unit; communication planning unit; management support unit; information unit; technical advice.

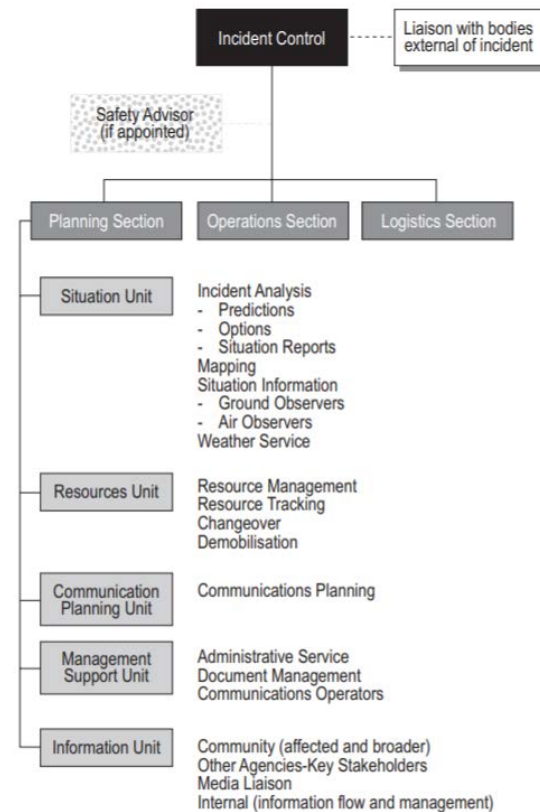The following figure shows a detailed description of the functions of each unit.

Fig. 1 Decription of the functions AIIMS [15]

A vast number of crisis management systems have been analyzed in the Czech Republic. One of them is the KISDIS system. This system serves as a communication system for dealing with a crisis. This system sends predefined contact groups instructions in the form of short messages. The advantage is that the dispatcher may not be physically present at the dispatcher's workplace. This group may be a crisis crew, a task force, or a security council. Furthermore, this communication system alerts new tasks, informs you about the missed assignment, task tracking. [16].
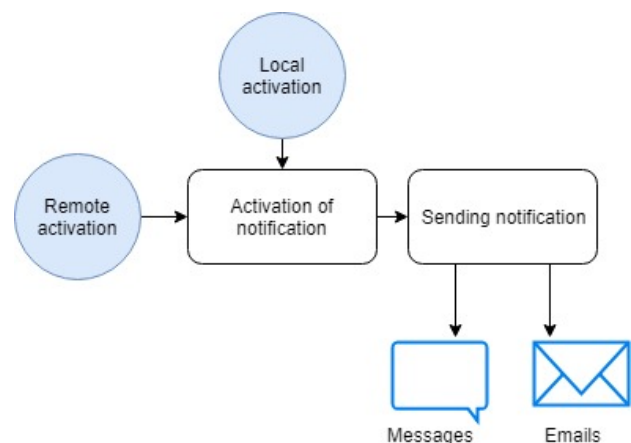

Fig. 2 Way of communication KISDIS [16]

The figure shows the way of notifying predefined groups and managers and how to forward information.

IV. WARNING SYSTEMS

The last category of the system, which are using in the are of crisis management are warning systems. The aim of these systems is to warn if inhabitants in times of crisis – typhoons, floods, landslides, tsunami and others. These systems are using Philippines and for example the USA. One of the system which are using in the Czech Republic is warning too.

The National Disaster Risk Reductional and Management Council is governed in the Philippines. This council creates crisis plans, measures, and procedures in case of a disaster and warning of residents in crisis.

Information support for crisis management has the highest priority due to frequent natural disasters - typhoons, floods, landslides. Philippines use warning system NOAH. It is a web platform which makes it possible to display actual weather, following crisis situations (floods, storms, landslides, volcanic activity), and essential elements of critical infrastructure (schools, health facilities, stations, fire stations). We can, therefore, assume that information support for crisis management has the highest priority during response to the given threats.
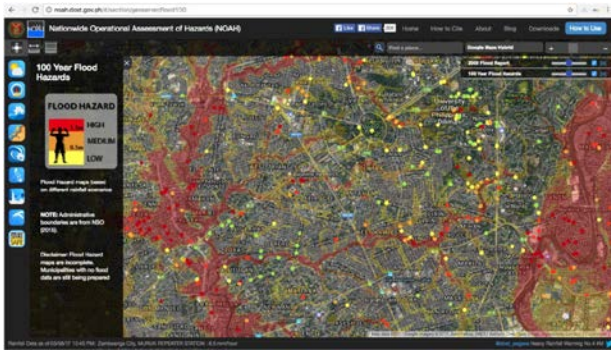

Fig. 3 Warning system NOAH – Flood Hazard [17]

Second example of the warning system is National Warning System (NAWAS). It is a comprehensive party line network of telephone circuits connecting state and Federal warning points throughout the United States. Each state has its plan for the use of NAWAS during weather emergencies. It is used to disseminate warning information concerning natural and technological disasters to approximately 2200 warning points throughout the continental United States, Alaska, Hawaii and the Virgin Islands. This information includes acts of terrorism including Weapons of Mass Destruction after aircraft incidents/accidents, earthquakes, floods, hurricanes, nuclear incidents/accidents, severe thunderstorms, tornadoes, tsunamis and winter storms/blizzards. NAWAS allows issuance of warnings to all stations nationwide or to selected stations as dictated by the situation [18].

The last mentioned system, which is used for the warning in the Czech Republic is Information, Communication and Warning System (ICWS). One part of this system is to warn inhabitants and other municipalities in times of emergency and crisis. 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.

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.

V. METHODOLOGY

The CMISs have many advantages and disadvantages, and therefore the heuristic analysis of their usability was performed. This assessment is used for the qualitative evaluation of the systems. 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. We conducted an evaluation using the following equation:

$$UIS = ((R + H) / 2 \text{ x } H) \text{ x } 100 \% \tag{1}$$

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

A set of the evaluation questions (70 problems) was used, and these issues were divided according to several indicators. These indicators fall into six categories.

The general indicator describes the essential information from a broad perspective where this information was investigated. The next part of this indicator determines whether the system works and if we can use the system without help (user´s guide). The last part solves whether the system contains only the relevant elements and information about the problem.

The second indicator is named usability. The usability finds out whether the system has the intuitiveness of the application. The next part determines the abilities firstly to control the system/application in particular conditions (in the car of Fire Rescue Service) and secondly to be adequately displayed on the mobile devices.

The third indicator is named security; it solves credibility and the possibility of the system breach. The second part of this indicator ascertains of the content of the map as actual.

The fourth indicator deals with the content of the system. This indicator solves whether the system includes any advertisements and the misleading elements.

The fifth indicator looks into the search part of the system. It observes whether the results match the searched query.

Finally, we evaluate the graphics indicator. This indicator solves the composition layout, typography, font color, and

their suitability is evaluated as well as the aesthetic impression of the system [19].

The goal of the appraisal is to get feedback on the selected crisis management information system. Each item gained the following value:

-1 = does not meet,

0 = partially meets,

1 = satisfies,

the field is empty if the question is not relevant.

VI. Results

This chapter aims to present the results of an evaluation of the information support for crisis management in the Czech Republic. The Czech Republic divides the information support of the crisis management to two types - state level and regional level.

An analysis of these systems has been performed. The method described in the previous chapter was used for this evaluation.

The analysis of the crisis management information system in the Czech Republic - state level

This part describes the usability of the unified CMIS of the Czech Republic. This system was only launched as a pilot version between 2008 and 2011, and it failed when it was used in a crisis during floods in Prague in 2011.

TABLE I. EVALUATION OF UNIFIED CMIS

Indicators	Points	Questions	Answers	Total
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%
Utility	-1	22	20	47.50%
Total	22	73	66	71.26%

Table 1 shows the data from the heuristic analysis of the usability of the unified crisis management information system of the Czech Republic. As can be seen, the best-evaluated category was "Graphic" which gained 95 percent. On the other hand, the category "Utility" gained only 47.5 percent. According to the evaluation, we can say that the system was partially usable. The system was under the auspices the Directorate-General of the Fire Rescue Service of the Czech Republic. This institution does not expect that the system would be reintroduced and developed in the future.

The analysis of the crisis management information systems - regional level

The information support for the crisis management in the public administration at the regional level is very diverse. Some municipalities do not use any CMISs. Only four selected regions have their CMISs, and the heuristic usability analysis was performed for them.

TABLE I. EVALUATION OF CMIS IN THE CZECH REPUBLIC

Indicators	ICWS Zlín	Kriz-port Brno	CMIS Prague	CC 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%
Utility	85.71	91.17	63.34	67.50	76.93%
Total	92.06	90.51	78.05	63.61	81.06%

Table 2 presents the results of the usability the heuristic analysis of the CMISs of municipalities. This evaluation provides the statistics data from each group of the category. As can be seen, Information, Communication and Warning system (ICWS, Zlín) was evaluated as the best one (92.06 percent). The search and graphic indicators of Zlin's system were evaluated as the first-rate. On the other hand, the CC did not integrate the tool "Search".

The graphic indicator of all systems used in Table 2 is evaluated as the best one. This indicator is necessary for the quick and active orientation in the system. As a result, it must be highly developed. We can conclude that these systems are usable and suitable for the further development.

VII. Discussion

The This paper dealt with the comparative analysis of information, communication and warning system which are used in the area of crisis management in the whole world. In each area was selected two or three states, which are using the selected type of the system for crisis management. In general, information systems are an significant and essential part of planning, organizing, managing and controlling of information. That also applies to CMISs. They are used in the preparation for and handling of the crisis situations.

Each country has its own and unique CMIS. The United States of America have a unified information system. This system is used for handling diverse types of crises and emergency situations. The same kind of the system is in Australia. The Philippines use a web application to alert the inhabitants about the crisis. On the contrary, the Czech Republic has various CMISs which are divided according to two levels – country level and regional level.

A heuristic analysis of usability was selected for their evaluation. The aim of this analysis is to evaluate any information system using six indicators. The analysis was adjusted for CMISs and it contained seventy predefined questions. It was used in five CMISs. Firstly, a unified CMIS has been evaluated. Secondly, four information systems, which are used at regional levels, have been evaluated. The systems

at the regional level were used and evaluated as usable. We propose to introduce a unified CMIS again.

The main weakness of the systems for crisis management is that the system does not determine responsibilities and competencies for the tasks in crisis management.

The first step is to unify the CMISs. Furthermore, the whole crisis management system should be customized for users as required by them. The system should, therefore, be more user-friendly and have an intuitive interface.

We propose a new module for these systems, which will evaluate crisis preparedness of the hospital in times of power outage.

VIII. CONCLUSION

The aim of the paper was the comparative analysis of information, communication and warning systems, which are used in crisis management. These systems serve for more effective and faster sharing of information between crisis managers and citizens alike. In this article, these systems were divided into three areas, with examples of countries using them. At the end of the paper, these systems were evaluated and a new module designed.

ACKNOWLEDGMENT

REFERENCES

[1] 18 U.S.C. 793 "Gathering, transmitting or losing defense information" [Online]. Available: http://uscode.house.gov/download/pls/18C37.txt

[2] M. CIOCA, L.-I. CIOCA. "Decision Support Systems used in Disaster Management". In Chiang Jao. Decision Support Systems. IntechOpen, 2010, pp. 371 - 390.

[3] E. S. BLAKE, et al.. "Tropical Cyclone Report, Hurricane Sandy". 2013.

[4] P. BLAKIE, et al. "At Risk: Natural Hazards, People's Vulnerability, and Disasters". In Journal of Homeland Security and Emergency Management, Vol. 2, No. 2, 2005, pp. 1 - 5.

[5] J. VALOUCH, H. URBANCOKOVA. "Methodology of Future Security Studies". In SECURWARE 2016: The Tenth International Conference on Emerging Security Information, Systems and Technologies, 2016, pp. 69 - 71.

[6] T. GREGORY. "An incremental graph-partitioning algorithm for entity resolution". In Information Fusion, 49, 2019.

[7] B. REYNOLDS. "Crisis emergency risk communication". U. S. Department of Health and Human Services. 2014, pp. 1 - 462.

[8] Czech Republic. Law No. 240 from the year 2000 about Crisis Management.

[9] L. LUKAS. "Information management in the security components". Prague. 2008, p. 214.

[10] Slovakia. Law No. 387 from the year 2002 about Managing the State in Crisis Situations in Times of War and Military Situations.

[11] W. J. LOWE. "GIS application design for an Emergency Management Information System". [online]. Available: http://www.giswebsite.com/lkc/refs/er/sld001.htm

[12] EPIS, UIS EM. [online]. Available: https://www.jishmsr.sk/info/

[13] J. REKTORIK. "Crisis Management in Public Administration: Theory and Practice". Ed. 1. Praha: Ekopress, 2004. P. 249.

[14] M. DROZDEK, K. JELSOVSKA. "Information Support of Crisis Management". Opava, 2013

[15] The Australian Inter-service Incident Management System. 3rd edition. [online]. 2014. Available: https://www.afac.com.au

[16] Z. DVORAKK, et al. "Vzdálené řízení krizových situací KISDIS". Prague: ANAKAN, 2015, p. 103.

[17] Nationwide Operational Assessment of Hazards (NOAH). [online]. 2018. Available: http://noah.up.edu.ph/#/

[18] National Warning System (NAWAS). [online]. 2017. Available: http://disasterpreparednesscourse.com/disaster-preparedness-topics/hazards-and-disasters/national-warning-system-nawas/

[19] R. NETEK. "Rich Internet Application for Support of Decision-making Processess of Integrated Rescue System". Olomouc, 2015, p. 161.

Katerina Vichova, is a doctoral student at Tomas Bata University in Zlín, Faculty of Applied Informatics, Department of Security Engineering a she is a student at the student program engineering informatics. The field of the interest is the interconnection of crisis management and informatics. She was studying at Tomas Bata University in Zlín, Faculty of Logistics and Crisis Management where she completed the bachelor degree. Next she was studying at Faculty of Applied Informatics where she completed the title of the engineer. In 2016 she started as a doctoral student at the faculty, which is mentioned in the first part. She is the author of some publication, which was presented at Bali, Cyprus, Mallorca and others. The research from the area of Information Support of Crisis Management was published as a part of the book Crisis Management – Theory and Practice.