



Designing a multimedia platform for emergency management

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Abstract

Purpose – The purpose of this paper is to describe research, the objective of which was the development of models, methodologies, and tools for the realization of the multimedia platform for emergency management in technological systems.

Design/methodology/approach – This objective was achieved through the operationalization of the following major tasks: the theoretical research on the specific characteristics of emergency management system structure and processes; definition of educational structures, processes, and subjects for emergency management; development of models and software tools for the analysis of emergency development; development of information (web) services to support the collaborative decision making.

Findings – A model of multimedia platform for emergency management in technological systems has been developed, which defines emergency services with appropriate information infrastructure, the structure and characteristics of the interoperability system and their mutual communication.

Research limitations/implications – Further research should result in: the concrete structure and processes of virtual organisation for emergency management in technological systems; software for the support of collaborative decision making; models for emergency management education and training based on multimedia technologies. The limitations are primarily related to model implementation, since there are no suitable emergency databases.

Practical implications – The platform can be used by: industrial companies, companies that provide building maintenance, public services, insurance companies, educational institutions, local authorities (by an adequate upgrade of models and software).

Originality/value – This paper presents the information flow identified in emergency management and the structure of a multimedia platform which, by creating favourable environment for collaborative decision making, enables effective and efficient emergency management in technological systems, as well as emergency management education and training.

Keywords Multimedia systems, Computer applications, Emergency measures, Education, Training

Paper type Research paper

Introduction

Rapid technological development over the last several decades has brought about the emergence of complex systems. They are often characterised by indeterminacy in terms of defining their scope and aims, as well as in terms of the ways and conditions in which they are used. Decision making in these systems is more complex, and the consequences of wrong decisions far more serious and expensive.

One of the main problems related to complex systems is that of risk management, which involves the problem of emergency management. Emergencies are caused by events which disrupt the normal functioning of services and companies and threaten people's lives, the environment and the stability (sustainment) of local, national and global development. The analysis of emergency services' reactions to emergencies (accidents, catastrophes, natural disasters) in Serbia, as well as in the world, indicates shortcomings both in reacting organization and methodology in emergencies.



Therefore, it is necessary to develop systems for the support of decision making, for education and for emergency management training. The development of these systems should be based on information technologies that will enable their their adequate, efficient and effective functioning.

The facts mentioned above were the basis for defining the project “Multimedia platform for emergency management in technological systems”. The project is carried out by the Faculty of Electronic Engineering and the Faculty of Occupational Safety, University of Nis, in co-operation with the Palilula municipality and “Inkoplan” company, and is financed by the Ministry of Science and Environmental Protection of the Republic of Serbia.

Multimedia platform makes it possible to integrate different media (data, text, picture and sound), and multimedia systems are not primarily defined by their data structures but by the nature of their communication. Multimedia information can be the trigger for cognitive constructions. Multimedia provide the following modalities: co-occurrence of a number of processes, simultaneous displaying of different media, interactivity for the purpose of collaborative work (group decision making), which is extremely useful in emergency management.

Complex relationships between risk, accident, emergency and sustainable development are a great challenge for knowledge identification, distribution, transfer and application as well as for the creation of new information and knowledge about emergency management for the purpose of sustainable development. The authors' attention is directed to the possibilities for mutual connecting, work coordination and emergency management participation opened up by knowledge and information for various social entities.

About emergency management

To understand the basic emergency processes and information flow that can be carried out by multimedia platform, it is necessary to define the key terms, processes and specific characteristics of emergency management systems.

Emergency is:

- any unplanned event that can cause death or serious injuries to employees, customers or the public, shut down your business or disrupt operation, cause physical or environmental damage, or threaten the facility's financial standing or public image (Wahle and Beaty, 1993);
- disruption of normal life and work of people in the building or on a certain territory, caused by catastrophes, natural disasters or ecological accidents, epidemics etc, which leads to or may lead to human and material losses (Arhipova and Kulba, 1998); or
- situation whereby normal living and working conditions of people in the building, on a certain territory or aquatory are disrupted, people's lives and health threatened, their property damaged and environment threatened (Menshikov and Shvirajev, 2003).

In order to eliminate, control or minimise the causes and potential effects of emergencies, emergencies must be managed.

A typical process of emergency management involves the following stages: planning, mitigation, preparedness, response and recovery. It is presented in Figure 1 (Stojmenov *et al.*, 2005b).

Planning for emergencies is the adoption and implementation of procedures to identify foreseeable emergencies by systems analysis and to prepare, test and review emergency plans to respond to such emergencies (DAU, 2001).

Planning procedure in complex systems involves:

- planning in normal conditions (strategic planning); and
- planning in extreme conditions (operative planning).

Strategic planning defines preventive measures and it is carried out primarily through logistics processes (regulation, protection, maintenance, inspection, education). Operative planning defines actual activities in case of emergency occurrence and development. It is a real-time planning, and it is carried out in case of insufficient and unspecific information and lack of time.

Mitigation of risk includes any activities that actually eliminate or reduce the probability of occurrence of a disaster.

Preparedness activities are necessary to the extent that mitigation measures have not, or cannot, prevent disasters.

Response to emergency is realised in accordance with the strategic plan of reaction to an actual emergency as well as with the current emergency development.

Recovery is achieved by applying measures for re-establishing the normal functioning of the elements whose functions were disrupted during the emergency.

Emergency management systems are management systems aimed at emergency planning, control and reduction. The main aim of emergency management system is maintaining the quality of the system being managed in the conditions of emergency, and the criteria are minimum loss (human and material), minimum investments in realising preventive measures and minimum time for operative measure realisation. These aims and criteria are quite different from those defined in quality management systems (Savic *et al.*, 2005).

Emergency management requires management systems with specific characteristics, which make them quite different from traditional management systems: they have a number of operation modes; their structure is changeable; they



Figure 1.
Phases in an emergency
management system

contain many pieces of information which rapidly replace one another and which are imprecise and insufficient for quality decision making; the aims should be achieved in the conditions of limited material, human and especially time resources (Stankovic *et al.*, 2002). These characteristics unambiguously point to the fact that the development of emergency management systems must be based on systems analysis and information technologies. These systems are also characterised by a specific working environment of decision makers (which is dynamic and loaded with information), which often causes a high level of stress and working load as well as a higher probability of oversight and misinterpretation of available information.

Organizational mechanisms in emergency management systems have to be able to recognise new problems, come up with and realise new solutions (decisions), provide the possibility of maximum concentration of resources, unite the existing resources and mobilise forces to recover the system as quickly as possible. This requires a structure based on the principle of elasticity (the possibility of choice of operational measures different from measures of immediate-reaction strategy for an actual emergency) and the principle of adaptability (the possibility of structure change in accordance with the current development of emergency).

In case of emergency, information represents the basis for decision making. It is considered as a service whose quality directly or indirectly influences decision quality. Due to the fact that decision making in emergency management systems is complex and that half-structured or non-structured problems should be solved, the value of timely information is immense. Information about the possibilities of emergency occurrence and tendencies of its development is obtained through environment conditions monitoring, forecast and analysis. This means that at the moment when complete information is obtained, there is time deficit for decision realisation. This leads to an evident paradox: while expecting credible and sufficient information, the system undergoes losses due to unexpected changes and, lacking sufficient information, it cannot realise measures intended to solve the problem that has arisen (Arhipova and Kulba, 1998).

Together with solving urgent operative tasks, emergency management system performs the functions of strategic planning and management. The necessity to develop a long-term strategy for preventing the consequences of emergency and recovering the system represents an essentially new task in management systems and requires a different management organization. Emergency occurrence and development are caused by unpredictable and unexpected circumstances. That is why they cannot always be analysed and solved by relying on prior experience.

The specific characteristics mentioned above unambiguously imply that the development of emergency management system has to be based on systems analysis and information technologies. This, together with the problem of lack of time for decision making in operative management process, makes it necessary to develop programme platforms that will enable: data collecting and analysis, formation of emergency development scenarios, creating a model for operative problem solving, interactive formation of operative plans, operative correction and control of strategic plans, assessment of the effectiveness and efficiency of emergency planning and management, as well as knowledge management (Savic and Stankovic, 2005).

Emergency management in the educational discourse

Current events in various parts of the world confirm that no country, regardless of its level of technological, economic, and social development, can neglect numerous accident risks and dangers and other forms of devastating effect on humans, natural and material resources, and environment in general. The emergencies which occurred during the last decades raised a number of questions about the issue of human safety and environmental protection (e.g. accident in Seveso, 1976; Bhopal, 1984; fire at "Sandoz", Switzerland, 1986, etc.). As the results of different researches show, human (internal, subjective) factor is dominant (as compared to material, organisational, and other factors) as the cause of risk events and emergencies. Therefore, the struggle against human factor dominance, through educating and informing, has occupied a significant, strategically justified and one might say central, place in emergency management system.

Until today, the environment has never been bound by fate to the general tendency that safety, peace, stability, and sustainable development should be established in the world. On the other hand, it is quite obvious that there is not, nor will there be, national and globally sustainable development, welfare, and stability, unless there is a development of the risk management system in working and living environment, and within it, the emergency management system. Accordingly, the basic intention, which has a paradigmatic significance, refers to preventive measures and activities, among which education for emergency management has an invaluable role in the realisation of objectives and tasks of sustainable development education.

Within that context, the authors observe interdependence between emergency management and sustainable development and innovation in the implementation and content of educating and informing the public. Changes which occur in the world and time we live in ("society of risk") must necessarily follow the changes in contents, structure, nature, and ways of learning and educating ("society of learning"). In addition, the analysis, study, and assessment of risk in working and living environment represent a precondition for emergency management and incorporation into sustainable development education; if risk is not thoroughly investigated, studied, or even not known, all efforts to relate it to education will remain nothing but an abstract conception and will become a pedagogical myth.

In modern conditions, knowledge (to predict, prevent and manage or eliminate risk, or to minimise emergency effects on humans and the environment) and sustainable development are connected and mutually conditioned. Accordingly, learning and education for emergency management represent a constituent part of a complex and all-enveloping conception of sustainable development education. Confirmation of this statement can be found in numerous international documents, strategic plans, and recommendations pertaining to sustainable development strategy and promotion of sustainable development education.

Moreover, knowledge which affects development of awareness, conscientiousness, morality, responsibility, and value, of occupational and technical culture, ecological culture, and the culture of protection ("safety culture"), is perceived and designated as the basic "resource" of a society's sustainable development. The quality of this human capital is significantly determined by learning and education. For the educational system to be efficient as a whole, it is necessary to promote a systems, rather than partial, approach. Seen from the aspect of emergency management education, the

analysis of practice and experience of different countries testifies to partial and sporadic approaches to this issue. Accordingly, one cannot speak of a horizontal and vertical connection of certain parts of the educational system, nor of its connection with other systems of social development. It is particularly noticeable that there is no participation, cooperation, connection, coordination of work, and involvement of different members of the informal educational subsystem in this field (companies, services, e.g. civil protection services, fire brigades, the police, the military, etc., agencies, organisations, local self-government, etc.). These are the reasons why partial changes in education should be conceived while taking into consideration the functioning of the whole system, so that attention must be given to demands of both local and global sustainable development. Since changes in education and social context are connected, educational development is optimised by a strategy which considers development strategies of other systems of national development and social development in general, founded on knowledge and learning (“learning societies”) for sustainable development.

In the recent years, seen from an international perspective, numerous institutes, centres, etc. have been opened, publishing expert materials, organising education, developing recommendations with the purpose of preventing accidents and preparing the whole society for an adequate reaction in case of emergency. Recommendations and directives of different international organisations are also aimed at this goal: World Health Organisation, EU (e.g. the Seveso Directive), OECD, UN (e.g. UNEP program for response to technological accidents, APELL – Awareness and Preparedness for Emergencies at Local Level) etc.

From a global perspective, recommendations pertain to both formal education and informal qualification and training of the population. Formal education includes implementation of safety-related content, protection of working and living environment, and sustainable development on all levels and in all segments of formal educational system. With regard to their basic educational aim, objectives and tasks of formal education can be seen and defined as being general, pertaining to the development of ecological awareness and responsibility, culture of work, and culture of protection (“safety culture”) in general, i.e. pertaining to forming attitudes, values, and behavioural manners in compliance with the demands of sustainable development; they can also be seen and defined as special (professional), oriented more on direct acquaintance of an individual with risks and hazards in a particular professional activity and in the environment, with the possibilities of preventive action, and forms of safety and behaving safety (Nikolic, 2003; Nikolic and Savic, 2003).

Learning and acquiring knowledge pertaining to safety, protection and sustainable development of the environment in the formal educational system actually represents a necessary basis of permanent education and learning in this field. In addition, what is especially important is the organisation of different forms of educating and informing, qualification and training of employees in industry and other activities for safe behaviour and adequate response in case of emergencies. Qualification is an important factor of preparedness, which implies possession of specific knowledge, skills, and habits, i.e. application of such knowledge for the purpose of safe work and safe behaviour and, if an accident does occur (in case of emergency), providing safety to oneself and others. Employee qualification has to be permanent and innovative – content suited to employees’ needs in the labour process and existing risks in the

immediate and broader surroundings. Training pertains to practising acquired practical knowledge and skills, i.e. practising procedures and verification of an action plan in emergencies. In the phase of previous planning, it is necessary to repeat drills, simulations, etc. in order to enable maximum functioning under heavy stress (in case of accident) and provide efficient joint action and coordination of different subjects, actors, and social factors in response to accident.

Nevertheless, experience and practice of Serbian companies indicate an unsatisfactory treatment of education, qualification, and training of employees in this field. Apart from that, the focus of the qualification and training program is on occupational safety content, with only a symbolic inclusion of content pertaining to critical processes and programs for accident risk management (measures and activities) and interventions in case of emergencies. All this indicates the lack of acknowledgement of the particularities of certain peace-time risks and hazards and a need for adopting special and specific knowledge and activities, in accordance with the assessment of endangerment of concrete environments.

At the same time, organization of various forms of informal educational and informative work with local population takes priority when raising awareness and preparedness in case of danger and emergencies on the local level is concerned. Regardless of whether emergencies originated as a result of industrial, commercial, or other operations, natural disasters of great and catastrophic proportions, etc., one cannot dispute the significance of the program for qualifying, informing, and preparing the population, with the purpose of:

- creating and/or raising the awareness of the community about risks and hazards in the local environment, as well as about measures taken to protect the community from those hazards; and
- becoming acquainted with plans and types of response and behaviour in emergencies.

Since emergency management, among other things, implies preparations for removing any possibility of an accident or at least a timely response if an emergency does occur, the program for educating and preparing the population implies contents which pertain to prevention, as well as to preparedness and response to emergency.

In addition, the process of preparing and informing the population should include the whole community in order to ensure maximum preparedness in case of emergency. In that respect, what is most often suggested is the so-called “joint educational programs” which involve different actors in response to emergency: companies, local management, local community, healthcare institutions (emergency medical services, healthcare institutes, stationary health institutions, etc.), services for emergency technical interventions, departments within the Ministry of Environmental Protection, departments within the Ministry of Internal Affairs, civil defense departments, fire brigades and rescue services, monitoring and notification services, mass media, etc.

In conditions of transition and numerous transformational processes in Serbia, it is of paramount importance to prevent risk events and possible emergencies, the consequences of which would additionally burden the economy and endanger stable social development. Existence of a large number of potential accident sites (poor material conditions, obsolete and worn equipment, non-functioning security and technical systems, obsolete technological processes, technological errors, sabotage,

etc.) stresses the significance of establishing and developing methodologies and models for recording, monitoring, and managing emergencies. These models are based on information technologies which provide the necessary data and information base, forming a complex system for emergency management. The generated knowledge system and its permanent innovation provide the necessary preconditions for creating programmes and forming innovative approaches to the education/training of the employees (e.g. the application of the knowledge management concept) or to the preparation of the local self-government and population for appropriate reactions in case of emergencies. Thus, the social function of emergency management surpasses its function related only to loss and consequence minimization, and acquires the connotation of preventive character aimed at the benefit of the community. Since a number of researchers point out that the contemporary approach to emergency management is characterised by a focus on the management component rather than emergency component (Britton, 2002), multimedia platform for emergency management is certain to offer important possibilities and solutions.

Multimedia platform for emergency management in technological systems

The research object of the project "Multimedia platform for emergency management in technological systems" comprises: structures, processes, regulation, and legislature in emergency management systems; modern technologies and methodologies for diagnostics, supervision, development prediction, and visualization of emergencies in technological systems; information (web) services to support collaborative decision making; educational, processes, models, and subjects for emergency management education, as well as technologies for emergency management education and training, based on multimedia platform.

The research objective is the development of models, methodologies, and tools for the realization of multimedia platform for emergency management in technological systems.

This objective was achieved through the operationalization of the following tasks:

- Comparative analysis of the existing methodologies, models, and technologies for recording and monitoring emergencies.
- Development of methodologies, methods, and models for emergency management.
- Definition of emergency management system structure and processes.
- Development of methodologies, methods, models, and software tools for the analysis of emergency development.
- Development of models and ontologies necessary for acquiring and accumulating knowledge of the domain and integration with surrounding information systems.
- Development of information (web) services to support collaborative decision making.
- Definition of educational structures, processes, and subjects for emergency management.
- Development of models for emergency management education and training, based on multimedia technologies.

- Verification of suggested models and information services for emergency management based on the example of public services and companies at the local self-government level.

One result of the research, which is relevant for the overall perspective of the educational function, is the outline model of information flow in an emergency management system (Figure 2).

The model comprises subjects/services for response to emergency with appropriate information infrastructure, the interoperability system and their mutual communication.

Subjects for response to emergency can be found among the following organizations, specified primarily according to the activities they perform:

- Ministry of Science and Environmental Protection: Head Office for Environmental Protection.
- Ministry of Internal Affairs: Head Office for Fire Protection and Rescue Services, fire brigades, traffic police.
- Ministry of Health: Emergency Medicine Services, health protection institutes, Mobile Eco-toxicological Unit Belgrade.
- Ministry of Defense: Head Office for Civil Defense, ABHO Centre Krusevac, notification centers.

Interoperability system is the basic module of the model and it enables a transparent approach to data coming from different sources. Generally, the notion of interoperability refers to the ability of two systems to inter-exchange information (Goodchild *et al.*, 1997). In the process of emergency management, such ability is of paramount importance, concerning the fact that all subjects for response to emergency

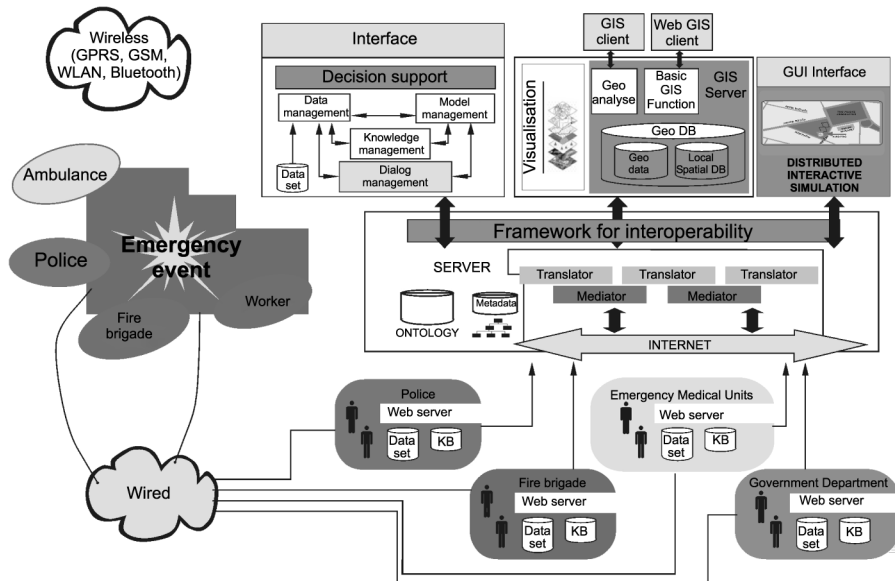


Figure 2.
Conceptual model of
information flow in
emergency management
system

possess their own information systems and that access to other subjects' data is necessary for efficient quality-decision making within one subject. Nevertheless, this can lead to an enormous amount of information in the system. For this problem to be resolved, adequate informational and communicational infrastructure has to be built. It is also necessary to apply efficient methods of storing, accessing, searching, and properly using a large amount of knowledge and information.

Application of the system for interoperability is developed in a way which makes data representation completely separate from data storage. System can be dynamically connected to information sources but can also dynamically change the user interface according to user privileges.

This module is based on the results of the GeoNis project, the implementation of which provided the infrastructural platform and software tools for the realisation of interoperability of GIS applications on the local self-government level (Stojmenov and Djordjevic-Kajan, 2003; Stojmenov *et al.*, 2005a).

In the domain of GIS application, research pertains to a timely and accurate display of spatial data on emergencies in a given geographical space (through a digital geographic map). GIS provides tools for spatial analysis of emergencies and a display of risk factors from the same geographical space. Integration of multimedia technologies into GIS will provide more efficient mechanisms for displaying emergencies.

Besides efficient management of data and databases, it was also necessary to find a means to properly interpret information and make decisions. The term "management" implies decision making. Proper decision making tends to choose the best, or at least a sufficiently good, alternative course of action with timely and accurate information. The task becomes quite demanding in the case of an ever-changing environment, in which information is incomplete and inaccurate and in which the number of alternative choices can be rather big and the effects of a decision can be far-reaching but also difficult to predict. Likewise, the price of a wrong decision can be very high.

Decision making in emergency management is mostly done in a group (a group/team handles all decisions or tasks pertaining to decision making). Group decision making improves the decision-making process by (Turban *et al.*, 2002):

- supporting participants during parallel data processing and production of ideas;
- enabling larger groups with more exhaustive information, knowledge, and qualifications to participate in forming decisions;
- enabling a group to use structured or non-structured procedures and methods;
- offering quick and easy access to information from the surroundings;
- allowing non-sequential computer discussion;
- giving instant anonymous voting results;
- providing planning process structure;
- enabling simultaneous interaction of several users; and
- recording automatically all information passing through the system for future analysis (developing organizational memory).

The basic structure of the module designed for decision-making support, besides databases and models, contains subsystems for dialogue management, data and model

management, and knowledge management. The subsystem for dialogue management forms a user interface for communication with the system. The subsystem for model management enables application of case analysis models at any given moment. Its basic features are: quick and simple creation of new models, ability to access and integrate model blocks, creation of a model catalogue and its maintenance for other users, ability to connect different models with databases, and efficient and effective database management. The subsystem for knowledge management provides management, stores and forwards knowledge, which in turn provides knowledge distribution, organizational learning and intelligence.

Being that emergency management is based on semi-structured or non-structured data or situations, it cannot be optimized with standard models but can be simulated instead. Simulation is one of the most frequently used tools for creating models of emergency development scenarios and for management optimization. The system for visual interactive simulation enables efficient visualization of information by displaying information which is necessary for the situation at hand and corresponding user tasks. It provides intuitive and knowledge-based components of visualization, which enables decision makers to quickly become aware of the situation at hand and to decide efficiently when pressed for time. The system is so developed as to be independent of the user interface and to have the ability of filtering information and forming user priorities.

A significant part of the research will pertain to the application of technologies based on ontologies for semantic integration of information. Intelligent integration of heterogeneous information sources based on semantics (represented by ontologies) represents the key factor for realizing and utilizing the platform for integral emergency management. Semantic integration enables high flexibility of information services, as well as an effective interaction and information exchange.

Connecting distant, functionally and structurally different services, for the purpose of achieving the common management aim, this platform basically represents a virtual organization for emergency management.

Multimedia platform for emergency management provides recording, following and evaluating of emergency development, assessing risk level, making pre-analysis and taking preventive steps for the purpose of preventing or minimizing losses and consequences. Providing a complex system of information and knowledge for emergency management, the platform opens up possibilities of efficient and thorough planning of response and, accordingly, planning of organizational forms and programming educational and training contents for all the members of the community to behave adequately in case of emergency. Also, creating new knowledge and information is especially important as a precondition for permanent training and professional improvement of the members of services responsible for emergency management. Thus, different possibilities and solution efficiency, provided by a developed platform, are especially valued by the community of the local self-government.

The platform, that is, the designed software, can be used by:

- Industrial companies (for emergency management).
- Companies that provide building maintenance (through integration with intelligent buildings software packages).

- Public companies (for accident and natural disasters management).
- Insurance companies (for private property insurance, agricultural insurance and insurance of dangerous material transportation).
- Local authorities (for creating infrastructure on local community level for emergency management, by an adequate upgrade of models and software).

Identification, distribution, exchange, integration of information and data lead to development of knowledge, awareness, culture of security and responsibility of all the members and institutions of the community to take preventive and operative measures competently and permanently in order to prevent emergencies, reduce their frequency and scope as well as the effects they might have on man and the environment.

Conclusion

Even though a number of tasks necessary for the realisation of a multimedia platform for emergency management have been carried out successfully, further research should provide: concrete structure and processes of virtual organisation for emergency management in technological systems; software for the support of collaborative decision making in emergency management; models and technologies for emergency management education and training based on multimedia platform. The suggested models and information services (software) will be verified through use in public services and companies in the Palilula municipality in Nis. After verification, a suitable enlargement of the platform is planned, so that it could be used at the level of local self-government.

References

- Arhipova, N.I. and Kulba, V.V. (1998), "Emergency management", Russian State University, Moscow.
- Britton, N.R. (2002), "A new emergency management for a new millennium?", *The Australian Journal for Emergency Management*, Vol. 16 No. 4, pp. 44-54.
- DAU (2001), *Systems Engineering Fundamentals: Supplementary Text Prepared by the Defense Acquisition University Press, Fort Belvoir, VA*, available at: www.dau.mil/pubs/pdf/SEF_Guide
- Goodchild, M., Egenhofer, M.J. and Fegeas, R. (1997), *Interoperating Geographic Information Systems: Report of a Specialist Meeting under Auspices of the Varenius Project*, US National Center for Geographic Information and Analysis, Santa Barbara, CA, available at: www.ncgia.ucsb.edu/varenius/varenius.html
- Menshikov, B.B. and Shvirajev, A.A. (2003), "Hazards, chemical objects and technological risk", Lomonosov University, Moscow.
- Nikolic, V. (2003), *Education and Environmental Protection*, Foundation Andrejevic, Belgrade.
- Nikolic, V. and Savić, S. (2003), "Safe work education and professional risk management", *Proceedings of the National Conference with International Participation: "Risk of Fire, Explosion, Damage and Burglary in Insurance and Organization of Protection Systems"*, Danube Group – Belgrade, Belgrade.
- Savic, S. and Stankovic, M. (2005), "Planning in emergency management system", *Proceedings of the 8th International Conference on Dependability and Quality Management: DQM-2005, Research Centre DQM, Cacak, Serbia*, pp. 196-201.

- Savic, S., Stankovic, M. and Andjelkovic, B. (2005), "Preventive engineering – systems risk engineering", *Research and Design for Economy*, Vol. III No. 9, pp. 17-28.
- Stankovic, M., Savic, S. and Andjilkovic, B. (2002), *Systems Analysis and Risk Theory*, Protection Press, Belgrade.
- Stojmenov, L. and Djordjevic-Kajan, S. (2003), "Realization of GIS semantic interoperability in local community environment", *Proceedings of 6th AGILE Conference on Geographic Information Science: AGILE 2003, Lyon, France*, pp. 73-80.
- Stojmenov, L., Predic, B., Mihajlovic, V. and Stankovic, M. (2005a), "GIS interoperability platform for emergency management in local community environment", in Toppen, F. and Painho, M. (Eds), *Proceedings of AGILE 2005*, pp. 635-40.
- Stojmenov, L., Predic, B., Stanimirovic, A. and Stankovic, M. (2005b), "Emergency management in local community environment using geographic information systems", *Proceedings of the 8th International Conference on Dependability and Quality Management: DQM-2005, Research Centre DQM, Cacak, Serbia*, pp. 63-74.
- Turban, E., Mclean, E. and Wetherbe, J. (2002), *Information Technology for Management*, John Wiley & Sons Inc., New York, NY.
- Wahle, T. and Beatty, G. (1993), "Emergency management guide for business & industry: a step-by-step approach to planning, response and recovery for companies of all sizes", Federal Emergency Managemet Agency (FEMA), Washington, DC, available at: www.fema.gov/business/guide/toc.shtml

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