An introduction in the design of decision support systems mixed with soft computing, for extreme risk management (DSS-ERM)

PRELIPCEAN GABRIELA
“Stefan cel Mare” University of Suceava
13 Universitatii Street, 720229 - Suceava, Romania
E-mail: gprelipcean@yahoo.com

BOSCOIANU MIRCEA
Faculty of Aeronautical Management
Air Force Academy “Henri Coanda” Brasov
Brasov, Romania, e-mail: mircea_boscoianu@yahoo.co.uk

Abstract: The recent financial crisis, the growth of the impact and frequency of extreme risk events (natural hazards, terrorism, technological accidents), but also the interest to optimize the interventions in critical situations are motivations for a new framework for analysis of all the events that implies extreme risk patterns. In a highly uncertain and highly dynamic environment this types of applications assist strategic decision makers in a flexible, adaptive and robust manner. Modern technologies permits new concepts, better adapted to support critical decisions, not only in economy and finance but also in military and law enforcement applications, in turbulent periods, or in extreme risk events.

The interest is to develop an integrated framework capable to support emergency decisions via a better understanding of the dynamics of extreme events and a better detection and management of emerging and critical situations that imply risk and uncertainty. In this case, the focus is on the characteristics of genericity and adaptability of the framework in order to build a modular, flexible, adaptive, robust and efficient system that does not depend on a particular case and it is equipped with the capability to be easy extended in a creative manner.

Keywords: decision maker, decision support system for extreme risk management (DSS-ERM), crisis

1 Introduction
The severe growth of the number and the impact of extreme events (natural hazards, terrorism, technological accidents, and economic/financial crises) but also the complexity of interventions have motivated the scientific community to find new efficient solutions for the emergency response. Decision makers in extreme risk environments should respond in a new different manner because modern crisis management requires urgent developments toward better, more elaborated and appropriate means for extreme risks. Extreme risk management needs to ensure a better interoperability of different emergency services (police, fire chief, health sector, civil protection) to provide the appropriate information (of course, after data fusion and data filtering) at the right place in the critical moments. The new global environment is very complex, and the dynamics of changing is difficult to understand. Decision making in critical or special situations is very complex because the systems are complex, the dynamics is difficult to understand, and adaptability is essential. Even the technologies to cope with the crisis and high risk events have developed considerably there are some underlying problems that complicate high risk prevention and multiple crisis response: an inadequate communication between different actors and different levels; the relative inadequate data fusion, selection, filtering and standardization impacted information database; the difficulty to update information about the development of the extreme risk (victims damages, rescue team technologies, in the case of natural/man-made hazards, or specific information in the case of financial crushes and crises); the access to existing databases and action plans it is relatively slow.

In the modern literature are presented a lot of applications, procedures and activities capable to anticipate, prepare for, prevent, reduce different types of risks/losses associated to...
different type of crises, but there are only few integrated frameworks to deal directly with the extreme event. In this case, the decision makers need a huge technical assistance to support decision making process before, during and after extreme events.

All these applications are based on a huge quantity of data, a dynamic or real time selection between alternatives and the implementation of the final solution should be define with precision, but also with adaptability and creativity. Other aspects are related to the possibilities to integrate and to mix different types of models, methods and techniques/decision tools and to understand the limits of acceptability. DSS is one of the most efficient technologies in the treatment of extreme risk and crisis, because it offers adaptability, robustness and is easy to use in a modular-adaptive framework. Soft computing techniques could be used together with DSS/IDSS not only as a mathematical ingredient, because its efficiency is given by a better capability of selection, a higher speed of analysis, and also on adding the advantages of adaptability, flexibility, modularity.

2 Emerging techniques to understand extreme risk management

Extreme risks are high impact high uncertainty, low probability emergency events with high negative impact/losses due to uncertainty spread to different levels; in the case of financial events appear also the contagion phenomenon. Extreme events demand immediate action because of serious threats to the environment; contagion brings a new dynamics in recent financial events. The urgent need for action is to respond hints that the time interval is very short. Managers should act in time but with surgical precision because crisis represents critical turning points with decisive changes. Extreme risk and multiple crises could be describes as the manifestation of an unexpected risk that develops very quickly in to an emergency/disaster situation. An emergency/disaster situation contains also surprise and response elements. Emergency response represents the synthesis of knowledge based on experience, procedures and activities to anticipate, prepare for, prevent, reduce or overcome all the risks associated with extreme events. The interest is to offer framework easy to use but efficient in reducing the negative consequences.

The decisional support system (DSS) concept, launched before PCs was focused on the use of interactive computing in unstructured/ quasi-structured decision making activities. After Michael S. Scott Morton first definition, Sprague (1980) observed that this is limited to solve unstructured problems and proposed an extension capable to include every system. Druzdel and Flynn (2002) define DSS as an interactive system based on computer, capable to assist the user in selection activities; in this concept DSS provide data based management and refined the conventional access to information and the capability of find function via a support in building rational models. The decisional support system (DSS) concept, related to an interactive, flexible and adaptable system developed for an intelligent decision making support offers a better information management for a better coordination of activities. DSS was used with success in management and the evolution was always linked to the dynamics of informatic systems, databases and expert systems. The new IT application has influenced has decisive influence DSS, with application that spread in all domains of activities. The main objectives of DSS are related to a better adaptability of decision making and the build of a preliminar study for decision making in teh case where is not posible an efficient planning of such activities.

The characteristic elements of a dedicated DSS are: addressing unusual problems and assist in improving the quality of decisions to resolve them; DSS is a productivity enhancement tool for decision-making activity of the expert who holds an active control system; construction and development cause an evolutionary DSS-makers, system developers that are influencing each other in a process that does not end at a specified time; DSS has a data integrator and is adapted to the particularities of the individual application and user, limited to just one method or information technology; DSS may have several stages of completion, from the core of system to application systems; DSS can be addressed according to its stage of development and more users (decision makers, analysts, developers of tools).
DSS is a technology capable to improve the ability of managers in decision making to better understand the risks and the dynamics of the extreme events within the constraints of cognitive, time, budget/liquidity limits. The purposes of a DSS-ERM is to offer a better support for decision makers, allowing better intelligence design, or selection via a better understanding of the whole problem and its dynamics, a better managing knowledge via efficient solutions for non structured decisions. The main characteristics of a special purpose DSS-ERM are the following:
- a structured knowledge that describes specific aspects of the decision makers environment, how to accomplish different tasks;
- it incorporates the ability to acquire and maintain a „complete” knowledge and its dynamics;
- it incorporates the ability to select any desired subset of stored knowledge and to present the global knowledge in different customized ways/reports;
- it offers a direct interaction with the user (decision maker) with adaptability and creative flexibility to the situation and users.

DSS-ERM should offer an intensive level of use in decision making process both in the case of a crisis and before/after the crisis. This ability is based on the dynamic analysis of the current situation and „similar” past situation. The output of using this instrument could be represented by direct effects (a better decision capability, better efficiency, better objectivity in decision making process, less errors and ambiguities in communication, a good stimulus to adopt excellence and the news style of work, a better use of creativity and innovation) and indirect effects (creation of new skills and new jobs, more efficient, better competitive, better adaptability of the structure to critical situations).

3 Basic features in the design of a dedicated architecture for DSS-ERM
The system should be built and implemented in a flexible and evolutionary philosophy. It should be considered good knowledge of different applications that implies extreme risks, a good identification of the task linked to the capabilities of decision makers, a capability to refresh data/knowledge bases, a good knowledge and selection of adequate methods for the design. This system is modular and should be evolved. The flexibility will add good capability to modify in an efficient manner and the better adaptability to the treatment of new risks/events.

Decision makers that deal with crisis situations need intelligent instruments like software tools capable to deal with the questions related to the global perspective thinking, the response to unpredictability of human reaction under stress, the impact of communication systems failure. In crisis management, the interest is to integrate different types of risk, the interactions between these risks at different levels to provide a dynamic complete picture that take into account all possible hazards and the phases of related planning including mitigation, preparedness, response, recovery after extreme event with the aim to express a structured solution. Automation, networking, systems integration and intelligent decision support improve the performance of complex decision, such typical for crisis management. The use of vague concepts is important in the context of uncertainty/ imprecise information and artificial methods (knowledge bases, fuzzy logic, multi-agent systems, natural language, genetic algorithms, neural networks) could develop emerging capabilities that mimic human characteristics (approximate reasoning, intuition, just plain common-sense). The main features of a dedicated DSS for crisis management are: real time data, efficient response, a user friendly interface to support decision makers that work in difficult conditions, a good quality of information, data recovery capabilities.

In the concept of Intelligent Decision Support Systems (IDSS) (Gadomski, 1998; Guerlain, Brown, 2000; Turban, 2004) are developed effective smart systems for problem solving and decision-making (Turban, 2004; Dahr, Stein 1997) that deal with complex, imprecise and non-structured situations. IDSS are dynamic because they develop and implement more effective and productive support systems. The need for IDSS arrives from the growing need for relevant/ effective DSS to deal with a dynamic, uncertain, complex management environment, the need to build context-tailored, not general purpose systems, the
increased acceptance that intelligent technologies can improve decision quality and work productivity. This type of DSS should be real-time, distributed, robust, fault tolerant. Assistance is provided by taking into account the elements or subsystems of high uncertain/vague information, under constantly changing dynamic and stochastic scenarios. The main generic capabilities are related to the independence from specific database management systems, the data fusion capability, the level of integration of resources management, the accuracy of the graphical interface, the way to detailed the in time information, the use of post-action verification procedures and an efficient access to the technical documentation and history.

The contingency management tool (CMT) is a distributed system based on fuzzy logic, knowledge based systems and distributed systems concepts that provide decisional support for a global picture of critical situations. The main advantages of using an intelligent decision support tool for contingency management, as the CMT, are: reduction of the global risk, an overall increase of efficiency and reliability, a global view of the recognized picture based on a better quality of information, DSS for human resources in real-time in critical situations, DSS for training and experimentation. The use of soft computing techniques is welcome because it results a better capability of selection, a higher speed of analysis, and also on adding the advantages of adaptability, flexibility, modularity.

Fuzzy set theory (Zadeh, 1965) is a generalization of the conventional set theory that provides a strict mathematical framework to deal with the uncertainty inherent to phenomena whose information is vague/imprecise and allows its study with some precision and accuracy. Fuzzy logic allows expressing knowledge with linguistic concepts (Ross, 2004, Zimmermann, 1996) and provides a good way to express imprecision that is inherent in the vagueness of such concepts (Jackson, 1999, Ross, 2004). Expert Systems (Turban, 2004) proceeds knowledge intensive tasks to perform inference for determining a priority list of which subsystems should be fixed and in what sequence. In crisis management it is difficult to decide which systems should be fixed first. Expert Systems allow different reasoning processes such as the fuzzy multi-criteria. The advantage of using cooperation supported by communication networks enables the separation of data, the transparent access, the sharing of computational power, decentralized decision processes, thereby enabling the increase of robustness, redundancy and efficient resource usage.

There are a lot of efficient applications of CMT: DSS for management of actions in crisis context, DSS for management of equipment repair priorities under disaster/emergency situations, DSS for in time advice on the selection of resources for increase reliability and prevention of failures/incidents, human resource training for contingency situations. Any critical facility subject to extreme events is a possible candidate for using the CMT. The application for risk management responds to a hierarchical and distributed decision making process that offers a specific infrastructure (libraries, knowledge bases, databases, inference engine) and a set of generic templates that reduce the time to market a customized application. CMT collects and compiles input information on the status of the subsystems and the dynamics of risks (Sousa, 2006).

4 Conclusions

There is an emerging interest for different applications of DSS in critical decision making and in extreme risk management. The nature of DSS tools have changed significantly and modern DSSs are equipped with a variety of tools such as graphics, visual interactive modeling, artificial intelligence techniques, fuzzy sets, genetic algorithms, that adds new capabilities to DSS. The interest is to demonstrate the efficiency of using DSS in an extended list of applications, including the post event management of natural hazards, terrorism, technological accidents, but also financial crises and even multiple crises. All these problems are treated in a multidisciplinary, modular, scalable, flexible, adaptive, and robust framework.

DSS-ERM support real time decisions based on a high number of parameters and criteria, where knowledge is expressed using vague and
uncertain concepts, difficult to assess for human knowledge. Fuzzy logic is an appropriate framework to support the capability to represent human knowledge in both crisp and fuzzy formats. An innovative solution is to introduce the contingency management tool (CMT), a knowledge-based system tool. To cope with the need of decentralised decision-making requires the development of an inherently distributed system. DSS build with CMT enables the following features: the support decision under critical situations reducing the risk of questionable decisions; risk reduction through preventive actions; increased level of response supported by better training; it overcomes critical cases when experts are not available; give the information availability for an effective support to decision makers with a global perspective, in real time. The use of CMT in extreme risk management responds efficiently to a hierarchical and distributed decision making process that offers a specific infrastructure (libraries, knowledge bases, databases, and inference engine) and a set of generic templates that reduce the time to market a customized application. DSS-ERM framework should be design in a friendly manner so that users can input new data/task easily. DSS-ERM should be flexible so that new risks and impact functions can be easily incorporated by users and it should incorporate also financial-economic modules. In this philosophy, DSS-ERM could improve decision making process in extreme risk management with impact on the global efficiency in multiple crises management.

References:


