DECISION SUPPORT SYSTEMS – CURRENT STATE AND DEVELOPMENT TRENDS

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In this article, we are focusing on the trends of developing the decision support systems used in military crisis management. Thus, we start by emphasizing the need to use decision support systems in crisis management, then we are to analyze the current stage of decision support systems used in crisis situations and its trends of development. Consequently, we are also going to extract some relevant conclusions related to decision support systems in crisis management.

Keywords: *DSS; crisis management; artificial intelligence; data mining.*

Crisis management overview

The concept of "crisis management" has been really difficult to define in the current security environment. When studying literature in the field, on the topic of military crisis management, we encountered definitions formulated by national governments and international organizations such as NATO, European Union, United Nations, and OSCE. Because there are many various sources, this concept is defined in rather different ways. In order to illustrate their variety two relevant definitions of crisis management are listed:

- measures to identify, acquire, and plan the use of resources needed to anticipate, prevent, and/or resolve a threat or an act of terrorism. It is predominantly a law enforcement response, normally executed under federal law. (JP 3-28)[1]
- a timely, short-term intervention by an actor, or a coalition of actors, in order to mitigate an imminent deterioration of security conditions with the help of predominantly military means[2].

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[1] http://www.military-dictionary.org/DOD-Military-Terms/crisis_management

[2] Joachim A. Koops, *Effective multilateralism in peacekeeping, capacity-building and crisis management*, in Focus, 01/2010, http://www.effectivemultilateralism.info

There are common elements to most definitions of a military crisis: (a) a threat or a deterioration of security conditions, (b) a law enforcement response by an actor, or a coalition of actors, and (c) a short decision time.

In the crisis situation, decision making is a fundamental activity for the commander. This is not simple. The commander must perform „an estimate of the situation, a clear and concise statement of the line of action intended to be followed"[3] to the successful accomplishment of the assigned mission. The crisis is often determined by the rapidly changing situation that can generate some events with dramatic consequences. The commander's role is considerable because he must know when and what to decide for it "translates early his vision of the end state into action"[4].

Consequently, successful crisis management requires:

- the commander must think creatively and strategically to solve the crisis, because most decisions are unstructured;
- a rapid identification of the problems and a correct estimation of the situation, by partial knowledge of environment factors that cause the dynamics and uncertainty and their impact;
- the generation of a set of alternative solutions and testing their feasibility using methods or rules whereby the decisional alternatives can be generated, tested and ranked for selection;
- the solution that will be implemented must be chosen depending on the outcomes obtained and the goal or objectives' criteria;
- to take bold actions and act courageously for implementing chosen solution;
- to break away from the self-protective organizational culture by taking risks and actions that may produce optimum solutions in which there would be no significant losers[5].

The military crisis is more ambiguous and unpredictable than in the past. Decision making in this dynamic environment requests commander's cognitive capabilities. This complex environment is characterized by many variables with subtle interdependencies and predicting the total outcome may be daunting.

In addition, even though individual interactions among a system's variables may be well understood by the commander, to predict how the system will react to external factors such as a policy decision is often difficult.

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[3] http://www.military-dictionary.org

[4] http://www.au.af.mil/au/awc/awcgate/army/fm101-5_mdmp.pdf

[5] Farazmand Ali (ed.), *Handbook of Crisis and Emergency Management*, New York and Basel, Marcel Dekker, Inc., 2001, p. 4.

Furthermore, lately, the developed information and communication technology has allowed the use of new techniques to collect and store data in a digital format, new methods of data modelling and analysis. All of these, exploited efficiently, help the commander to better know the real situation and make some predictions about its evolution.

In this article, we are focusing on the trends of development of decision support systems used in military crisis management. Consequently, we may start by emphasizing the need to use decision support systems in crisis management, then we will analyze the current stage of decision support systems used in crisis situations and its trends of development, and finally we are to extract some relevant conclusions related to decision support systems in crisis management.

Decision support systems for crisis management

Innovations from information and communication technology made possible the acquisition and storage of data in a huge database. Many fields, including crisis management, have become increasingly dependent on the data collection, storage and processing. However, the abundance of data collected during the crisis makes it difficult to find information and to extract knowledge required by the commander in the decision making process.

The concept of decision support systems (DSS) is extremely broad, and its definitions vary, depending on the author's point of view. According to Turban, a DSS is "an interactive, flexible, and adaptable computer-based information system, especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker's own insights"[6].

There is a substantial amount of empirical evidence that human intuitive judgment and decision making can be far from optimal, and it deteriorates even further with complexity and stress[7]. In many situations, the quality of decisions can be improved by using DSS. The DSS decision making process avoids the deficiencies of human judgment and helps the decision maker to focus on relevant information. The DSS decision making process is presented in the next figure:

[6] Turban E., *Decision support and expert systems: management support systems,* Englewood Cliffs, N.J., Prentice Hall, 1995.
[7] http://www.pitt.edu

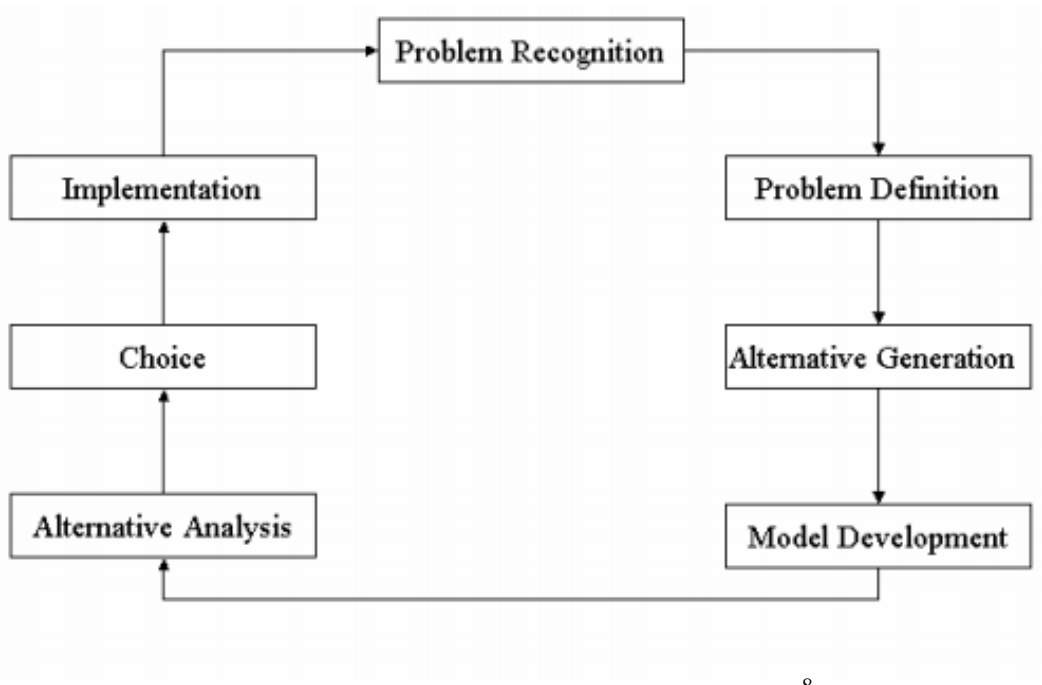

Fig. 1 *The DSS decision-making process*[8]

The current DSSs have the following characteristics:

- a set of tools and services suitable for supporting decision at any levels of planning, operating, controlling and other activities associated with the preparedness of the country, region or company to face the crisis situations;
- a web-based application designed to deliver a wide range of features to help plan and manage crisis information;
- a web-based system intended to facilitate communication and coordination within and between the various government and non-government agencies involved in responding to major incidents.
- facilities for usage of GIS technology which may bring a clear overview about situations, resources, and current status on the territory, forecasts and planned actions as well as very understandable information for the public.

These DSSs can support choice among well-defined alternatives and build on formal approaches, such as the methods of database, statistical, and decision theory. The proper application of decision-making tools increases the efficiency and effectiveness of decisions, allowing the commander to make optimal choices for technological processes and their parameters, planning military operations, logistics, or investments.

[8] Shim J. P., Warkentin Merrill, Courtney James F., Power Daniel J., Sharda Ramesh, Carlsson Christer, *Past, present, and future of decision support technology*, Decision Support Systems 33(2), 2002.

The future trends of decision support systems

More recently, DSSs have acquired new methods, often enhanced by various techniques originating from database, such as cognitive psychology, and artificial neural networks have been implemented in the form of computer programs for complex decision making. Using artificial intelligence techniques and diversification of data analysis methods, the progress of the Semantic Web, the emergence of new communication technologies and Web 2.0 are some challenges for future development of DSSS.

In the multinational crisis management, decisions are made by some members who "work together on a daily basis and have everything ready – planning, policies, processes, working practices and tools"[9].

Concerned by the growing volume of data stored in databases, researchers from the field of databases, statistics, artificial intelligence and pattern recognition, have begun to establish standard procedures to guide users in extracting useful information with the purpose of knowing the system described by those data.

The most recent DSSs are based on knowledge discovery in database and data mining concepts. Extracting relevant information from databases may cover the following aspects: descriptive modelling of the system, exploratory data analysis, predictive modelling, discovering patterns and rules, searching for content[10].

Descriptive modelling can be used in two ways: clustering and segmentation. Clustering (group analysis) is useful in pattern recognition for dividing a digital image to detect distinct regions with their edges or contained object recognition. Also, segmentation can be applied on demographic data in order to create homogeneous workgroups during the crisis. The number of groups is chosen by the decision maker.

Exploratory data analysis aims at exploring data by isolating characteristics suggestive of data and identifying potential structures and characteristics for generating hypotheses to explain the structure. These procedures are supplemented by modelling procedures and testing hypotheses. In general, these techniques are interactive and visual and rely on particular small data sets, the histograms of continuous or discrete variables, box plot diagrams, data partitions, etc.

The purpose of predictive modelling is to build a model to estimate the values of one variable knowing the values of other variables. In matters of classification, the predicted variable is categorical, while the regression

[9] http://www.nato.int/cps/en/natolive

[10] Elena Şuşnea, *Utilizarea tehnicilor data mining într-un sistem educațional de tip e-learning*, ProUniversitaria Publishing House, 2012.

variable is quantitative. The term "prediction" is used here in a general sense, without any notion of the continuous time involved. In crisis management, we can make predictions about the success or failure of an action based on certain factors, such as human resources, finance, environments factors etc.

Discovering patterns and association rules constitutes a real challenge for statisticians. They have been encountered when detecting outliers and consist in defining what behaviour is really unusual in the context of normal variability. In a multidimensional space, this can be difficult. Prior knowledge can be invaluable to an analyst's interpretation. Association rules can be successfully used in modelling various stages of crisis; thus, modelling from the first signs of crisis means beginning to build models on which the advice given by the system to be tailored and customized to the needs of the decision makers.

The search for content allows users to find patterns similar to the dataset. Datasets often contain text and images. For the text, the patterns can be a set of keywords and the user can propose discovery documents that may be relevant within a larger set of documents (e.g. Web pages). For images, the user can have such an image, an outline of a picture or a description of an image and can propose the discovery of similar images from a larger set of images. In both cases, both similarity and defining research strategy details are critical issues.

Knowledge discovery database and data mining are some laborious processes that depend on many factors, from the analyzed data, methods and techniques for extracting information to specialized skills and the ability to identify, assess and correctly operate the models and patterns extracted[11], [12].

Discussion and conclusion

In crisis management, the commander needs to know only essential information related to the crisis situation in a useable form in order to be able to make correct decisions. There are some differences between the information gathered and the information needed for prevention and action in crisis. The problem can be solved by DSS.

Some specific cognitive psychology techniques, artificial neural networks are implemented in the DSSs for helping the decision maker in a complex decision making process. The DSSs that are going to be developed in the future will try to emulate as much as possible the capabilities makers.

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[11] Tania Stoean, *Requirements over the projection of a software technology designed to train the young entrepreneurs in Romania*, The 9th International Scientific Conference eLearning and software for Education, Bucharest, 2013.

[12] Sorin Topor, Ion Calin, et al., *Despre informaţii şi sisteme informaţionale militare*, Bren Publishing House, Bucharest, 2008.

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