Design of a Decision Support System in Disaster Management

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ABSTRACT

When a disaster occurs, complexity, turbulence and often uncertainty about crucial information and organization make coordination and decisions difficult. Managers faced with emergencies have several ways to take decision :
- from predefined plans associated to identified emergencies,
- from acquired knowledge linking observation to danger evaluation and related startegies,
- instantly, from no experience at all,
- from experience of past disasters and case studies.

Disaster management is complex because each organization has its own regulations, practices and culture, and because managers are not aware of all the knowledge and experience of colleagues from other organizations.

To improve efficiency, organizations such as the International Red Cross are designing and implementing global information systems and databases, to make possible an efficient sharing of information and to make available this experience in disaster management.

This study has been started to propose a decision support system; the goal is to help any disaster manager by exploiting all the experience of disaster management which is available, using Artificial Intelligence techniques to assess similarities between disasters and to benefit from disasters experienced in the past.

INTRODUCTION

Organizations today are looking for ways to obtain systematic information. The globalization of markets has created a need for instant and accurate information available worldwide. This globalization does not exclude crucial information needed in time of disasters. International organizations such as the International Federation of Red Cross and Red Crescent Societies are looking for ways to take an advantageous position in this exchange of world information networks. This last organization is presently putting in place its own telecommunications and information resource facilities in order to take appropriate advantage of this new environment (Federation, 1994). Organizations faced with disasters need tools to exchange and treat information in a more systematic way. The development of decision support systems is a way to complement this approach by improving the use of information.

In a recent research, we demonstrated the importance of communication networks in interorganizational exchanges of resources during disasters (Therrien, 1993). The results of this research showed the difficulties of coordinating and exchanging resources in a turbulent environment for decision makers. Also, some observations led us to believe that the management style of decision makers influences the management of disasters and how decision are made (Therrien, 1994). This paper is a preliminary step for the development of an efficient decision support system that would take into consideration managerial effects of decision makers faced with a disaster.

CONCEPTUAL BACKGROUND

When disasters strike, complexity, turbulence and sometimes uncertainty in the organizational environment make the coordination of the relief effort difficult (Denis, 1993). Decision support systems can now help decision makers manage disasters more efficiently. It can be said that these systems do not always consider uncertainty in the organizational environment. Also, organizations are not always structured with efficient systems that could help the coordination of events.

Efficiency of organizational and interorganizational decision processes in a complex environment could be increased by a decision support system. During disasters, some decisions are made without always considering the effects of these decisions. Also, some decisions are made considering future impacts but one manager cannot always take them all into consideration. It is always after an event that issues of efficiency and effectiveness resurface. Decision makers are often

looking for ways to increase their efficiency in the management of disasters. They search for ways to obtain information and means of communication that would make them more efficient in their decision making. But they also take into account past events where they have learned from these experiences.

Decision processes used in the management of a disaster are different from the ones used in "normal" times. Uncertainty in the organizational environment makes the development of proactive strategies difficult. But decision support systems give three alternatives to overcome the limitations of information transactions for decision makers (Comfort, 1993). First, they create networks for exchanges, facilitating communications and focusing their attention on one problem at a time. Secondly, they create a synthetic representation of the information, simplifying the complexity, the speed and exactitude of information. Finally, these systems create more extended data bases of different organizational environments. Vital information of these environments is concentrated, permitting managers to take more informed decisions. These three alternatives give means to managers to reduce their decision making time. In no way could such a system replace managers, or could it increase the efficiency of an organization. These decision support systems give managing methods of organizational problems.

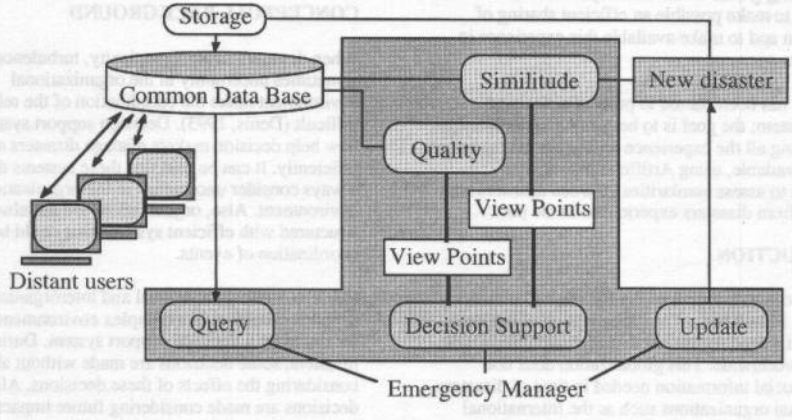
The following description shows the successive development steps of a decision support system that will take into account qualitative managerial data and help transforming it into systematic information to propose decision support.

OBJECT OF THIS STUDY

The system we propose to develop will organize the experience in disaster management, by giving access to decision makers to raw information (by a data base) and to a decision support tool that uses this experience in order to be able to face a new event (disaster).

We propose to use an artificial intelligence method, called Case-based Reasoning (CBR). The principle of this method is to build a reasoning based on analogy, which consists in finding problems already solved which are similar to the new one, and to use these solutions to build the solution to the problem (DARPA, 1989; Slade, 1991). Two particular aspects of this method are the definition of similitude and evaluation criteria to assess that a case may be of some interest for the solution. As these criteria may vary, we propose to establish a "view point" approach of similitude and evaluation.
In this application to disaster management, the decision support consists in classifying, according to a similitude criteria and an evaluation criteria, a list of reference disasters that are pertinent to the decisions to be taken in a particular case. These disasters may serve as "positive" references, if they have a good evaluation, or as "negative" ones if they have a bad one.

This study will enable us to structure and formalize case studies by increasing the knowledge we have of problems and of information. It will help to find (according to particular points of view) what can be extracted from acquired experience.



Architecture of the Decision Support System

THE DEVELOPMENT STEPS

The design of such a Decision Support Tool is divided in three steps :
- Analyse the components of disasters and propose a common representation gathering all information which may be useful to assess similarity, to understand the decisions and the flow of events and finally to assess quality or efficiency of the management.
- Design methods and criteria to assess similarity and quality. We propose the concept of points of view, in order to allow any manager to specify what are, for him, similarity and quality. These points of view varying, from one kind of disaster to another, between countries or experts.
- Design a system which allows an efficient access to any data, creation and updating of points of view and easy use of decision support functions.

We have chosen an Artificial Intelligence approach because such a system cannot be definitly designed and propose only a constant behaviour. We think that the manager has to consider the system as his own to trust it: he must be able to decide its functioning and to understand its behaviour. A second reason to choose AI techniques is the constant evolution of techniques and disasters which creates the need for the system to memorize new disasters and to use new experiences as they come up.

The study consists in five integrated phases. The first phase consists in structuring relative information of different disasters by doing case studies. One case study consists of :
- the temporal aspect: a description of the disaster in a time frame (conditions, causes, events, etc.),
- the organizational aspect: a description of the decisions behind the actions done in a time frame (management of the relief effort, organizations implicated, experts, decisions, etc.),
- the causal aspect: a description of the consequences and an evaluation of the disaster and decisions, be they positive or negative (victims, pollution, cost, etc.).

The second phase consists of studying the notion of similitude (according to one or several viewpoints) between the temporal aspects, in order to select relevant cases in the database that are similar to the new disaster.

The third phase will study the notion of quality based on causal aspects of past disasters and criteria that the manager considers for the present one (representing also a view point).

The fourth phase consists in finding methods to help the user to adapt the different cases that are of interest to him (similar cases that managers find of good quality) in order to reuse some elements.

The final phase consists in defining how the user will be able to enter the temporal, organizational and causal aspects of new disasters in a well defined framework, so they can be used for decision support.

CONCLUSION

This research is a reflection on decision support systems in complement to functions of simulation and access to global information. It will bring structuration of relative information of disasters, and will facilitate the gathering and the treatment of this information. It will also permit to study the notion of similitude and the evaluation of disaster management. Finally, this study will validate the use of experience and case studies in decision support for emergency management. This information is often unusable in stress conditions, because of its location which can be far from where it is needed, because of its format or because of its size, which may be too large.
Our approach may constitute an efficient decision support by extracting from this information the only elements which are important for a fast and efficient decision making.

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- Design a system which allows an efficient access to any data, common and updating of points of view and easy use of decision support functions.

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The third phase will study the notion of quality based on some aspects of past disasters and criteria that the manager considers for the present one (depending on his point of view).

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