# Decision Making Support in Emergency Response

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## INTRODUCTION

An emergency event can be chronologically divided into three phases: prevention, response, and investigation. Preventive actions attempt to anticipate all emergency situations and describe procedures intended to avoid undesirable outcomes. Unfortunately, not all circumstances can be predicted and some cannot be avoided. When undesirable situations occur, an emergency response action has to be set off. The response phase is very complex because decisions have to be made in a very short time and sometimes without the desirable information. An investigation usually follows any incident in order to find out the causes of the emergency, assess the effectiveness of the response, and generate recommendations for future preventive and response actions (Ochoa, Neyem, Pino, & Borges, 2006).

Concerning the emergency response phase, actions are usually carried out by several teams which should work in a manner as cooperative and articulated as possible to eliminate or reduce the impact of the disaster. These teams usually follow established procedures to deal with emergencies contained in emergency plans. In most events, actions are coordinated centrally but decisions are made at both central and local levels. Information plays an important role in these decisions. According to Dykstra (2003), when things go wrong in emergency management, the reasons are generally related to breakdowns in information, communication, and/or coordination.

During an emergency response, most decisions require knowledge from procedures, described in emergency plans, and from the previous experience of decision makers. A huge amount of contextual information has to be processed. This information comes from several sources, including the emergency field. The prompt capture and distribution of this information can play an important role in the decisions made by emergency teams. Most emergency response plans, however, are not designed to deal with this type of contextual information.

In some cases, contextual information is not available; in others the information exists but has not been disseminated. Conversely, team members have fresh information that could be useful to other teams, but they do not have the means to pass it on. A system processing information coming from the field and helping to propagate it to the right people at the right time would enable control rooms to better deal with emergencies (Brezillon & Naveiro, 2003).

The goal of this article is to describe a framework for understanding the interrelationship between the different types of knowledge. This framework should guide the design of systems able to store the captured contextual information and selectively disseminate it to decision makers and to emergency response teams. The system based on this framework should focus on the contextual information captured in the course of incident resolution, either by control room demand or incidentally by team members dealing with the emergency.

With such a system, people in control rooms should be able to make decisions assessing information derived from the event, in addition to, of course, from

the procedures established by emergency plans. One of the main requirements of such a system is to provide decision makers with the right amount of information, avoiding both overloading and starvation. The system should help control personnel and manage the acquisition and dissemination of relevant contextual information among operation teams.

This article is divided as follows. We provide some background on the use of different types of knowledge during emergency response work, use the framework to review the information systems technology used to support decisions in emergency handling, and then conclude the article.

## BACKGROUND

Emergencies are the concern of several organizations and researchers worldwide (Woods & Cook, 2002). Although the focus of each group is different, the groups usually recognize the need for better tools to promote interoperability among institutions that need to make decisions to resolve the emergency. An example of this shared thinking is the Seminar on Crisis Management and Information Technology (Seminar Report, 2002), which is a seminar aimed at finding better solutions for global crisis management, mainly peace support operations. In this seminar, it was stated that integrated Information and Communication Technology (ICT) systems, designed to support decision-making and communication in multilateral peace support operations, are an important tool.

Similarly, Smith (2003) argues that information sharing and interagency coordination are clearly needed to facilitate a successful emergency incident response. In that paper, a set of requirements is proposed for a consequence management solution, based on the principles of the Incident Command System (ICS), an all-hazard approach, established by the Federal Emergency Management Agency (FEMA) in the USA. Some examples of these requirements include: monitoring of multiple information sources for possible alerts to response participants and rapid risk communication/ alert dissemination.

The examples above illustrated how researchers and practitioners are concerned with the cooperation aspects of emergency management. However, the issues are not only on helping the information reach people, but also on the quality of this information. Currion (2003) highlights a problem faced by humanitarian assistance teams: the growing gap between the supply of, and demand for, high quality information. There is a lack of information management, which makes people suffer either from data starvation or from information overload. They made several recommendations, such as investment in a framework for training and incentives for the staff to be more rigorous in collecting and using data, applying filter mechanisms (policy and structural).

Other works emphasize the need for decision support systems in emergency management. Gadomski, Balducelli, Bologna, and Costanzo (1998) propose an environment based on intelligent agents to guide decisions. An emergency response plan of an underground transportation company was turned into a multimedia system integrating text, audio, video, 3D models, and animations (Canós, Alonso, & Jaén, 2004). This solution has improved the usability of the emergency plan, though its lack of current contextual information was considered a serious limitation.

The emergency response phase starts when a dangerous situation needing immediate action occurs, and ends when such situation has been resolved. During this period, well-trained teams execute a set of actions under time pressure, aiming at saving lives or property. These teams usually belong to more than one organization; for instance, firefighters and policemen. Frequently, each organization has its own training and its own resources to coordinate its actions and to support communication among their team members. At the same time, these organizations must communicate with each other so that a large body of shared knowledge is built and used to make most decisions during the emergency response process.

The knowledge can be available in different forms, and be of different nature, as illustrated in Figure 1. First, the previous personal knowledge (PPK) is embedded in each emergency responder's mind. It has been acquired during past experiences, training, and simulations of real-life settings. This type of knowledge is fundamental in this domain because it reduces the time needed to make decisions. It is tacit, highly personal, and hard to formalize, as already pointed out by Nonaka and Takeuchi (1995).

Second, the previous formal knowledge (PFK) is usually explicit and does not change during the course of the emergency. One of its main sources is the emergency response plan, which describes the