Measuring Shared and Team Situation Awareness of Emergency Decision Makers

Yasir Javed, COMSATS Institute of Information Technology, Abbottabad, Pakistan
Tony Norris, Institute of Information & Mathematical Sciences, Massey University, Auckland, New Zealand

ABSTRACT
Large scale emergencies are usually responded to by a team of emergency managers or a number of sub teams. Team coordination has attracted considerable research interest, especially from the cognitive, human factors, and ergonomic aspects because the shared situation awareness (SSA) and team situation awareness (TSA) of team members is critical for optimal decision making. This paper describes the development of an information system (SAVER) based on SSA and TSA oriented systems design. Validation and evaluation of the implemented design shows that decision performance is improved by the SAVER system.

Keywords: Decision Making, Emergency, Shared Situation Awareness, Situation Awareness, Team Situation Awareness

INTRODUCTION
Large-scale urban emergencies such as tsunamis or volcanic eruptions are usually managed by several teams, e.g. police, healthcare, emergency managers, etc. The level of coordination within and between teams is so complex that if a single link fails it can risk the safety of the whole operation, for example, the mass evacuation of a city. Therefore, the coordination between teams is often supported by computer-based systems which can make available, process, and interpret huge amounts of information in a short space of time. A system design based on the shared situation awareness (SSA) of individuals and team situation awareness (TSA) can in principle improve the decision support performance of such systems.

In this paper we describe the design, development and evaluation of a system we have dubbed Situation Aware Vigilant Emergency Reasoner (SAVER) based on SSA and TSA design principles. The paper first discusses SSA and TSA and their various definitions before presenting the SAVER design and implementation. It then details the experiments devised to evaluate SAVER and explains the results prior to drawing conclusions and making suggestions for further work.

DOI: 10.4018/jiscrm.2012100101
SITUATION AWARENESS AND EMERGENCY DECISION MAKING

The first step in any type of decision making is understanding the situation so that its requirements can be fulfilled to achieve the decision maker’s goals. Situation assessment done by an individual decision maker for naturalistic decision making produces a product called situation awareness (SA) (Endsley, 1995).

Early work due to Adams et al (1995), Durso and Gronlund (1999), Smith and Hancock (1995) and Endsley (1995) has produced a range of definitions of SA and because there is no universally accepted meaning (Stanton et al., 2005) it is important to describe the way this particular study is using the concept. SA is often defined operationally in terms of the goals and decisions for a specific task (Endsley, 2000) so that a formal and broadly accepted definition of SA that has been found applicable across different domains describes SA as:

“The perception of the elements in the environment within a volume of time and space, the comprehension and the projection of their status in near future.” (Endsley, 1995)

This definition reveals three levels of SA (Endsley, 2000):

**Perception is level 1 of SA.** It means understanding the importance of information about any situation. For example in the context of a tsunami, the earthquake magnitude, source location, depth and direction near an earthquake epicentre are relevant attributes;

**Comprehension is level 2 of SA.** It indicates how people combine, interpret, store, and retrieve information. Comprehension also covers the integration of multiple pieces of information and determination of their relevance to a person’s goals. For example, combining the SA level 1 attributes described above will indicate if the event is under water or near a coastline and, if so, whether its intensity will trigger a tsunami and its likely impact;

**Projection is level 3 of SA.** It is the ability to forecast new situations from previous and existing ones. This ability allows for timely decision making that predicts future situations and counters risk. For example, wave height predictions and anticipated times of tsunami arrival on specified coast locations etc can help to initiate controlled evacuations.

SITUATION AWARENESS IN COLLABORATIVE SYSTEMS

In larger events, several organizations may be involved in emergency response and management and these may be co-located or spread over multiple locations. Additionally, managers may have different cultural backgrounds, environment and educational experience, and goals depending on their roles. Therefore, generating a common and accurate understanding of a situation that minimises error is a considerable challenge. Coordination is a key factor, especially as some participants may have expertise that needs to be accessed to handle various aspects of the emergency. In this regard, coordination has two aspects: coordination of people and organizations, and coordination of information and communications. The process of information coordination and decision support should ensure that managers have the information necessary for decision making bearing in mind that event data are evolving and often uncertain and incomplete. The support system should also present data and information in readily usable formats.

Moreover, in emergency situations most decision making and associated actions involve organised teams of individuals from the same or multiple organizations, depending on the type and scale of the emergency. A team is defined as “two or more people dealing with multiple information resources, who work to accomplish some shared goal” (Salas, 2005). Due to the
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