Chapter 12

Visualizing Composite Knowledge in Emergency Responses Using Spatial Hypertext

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ABSTRACT

Having the right information at the right time is crucial to make decisions during emergency response. To fulfill this requirement, emergency management systems must provide emergency managers with knowledge management and visualization tools. The goal is twofold: on one hand, to organize knowledge coming from different sources, mainly the emergency response plans (the formal knowledge) and the information extracted from the emergency development (the contextual knowledge), and on the other hand, to enable effective access to information. Formal and contextual knowledge sets are mostly disjoint; however, there are cases in which a formal knowledge piece may be updated with some contextual information, constituting composite knowledge. In this paper, the authors extend a knowledge framework with the notion of composite knowledge, and use spatial hypertext to visualize this type of knowledge. The authors illustrate the proposal with a case study on accessing to information during an emergency response in an underground transportation system.

DOI: 10.4018/978-1-4666-2788-8.ch012
INTRODUCTION

Emergency response is among the most critical activities performed by humans: a process where decisions affecting lives and properties must be made in short time. These decisions must be made from information coming from different sources, which must be accessed and combined adequately to avoid both information lacks and overloads. Moreover, different actors may require different information elements or, at least, different views of them. For instance, decision makers at a control room may have more sophisticated means to access to the information than the responders working at the emergency location, carrying mobile devices with reduced graphical capacity. Thus, information management is becoming a key aspect of modern emergency management systems, as illustrated by recent cases described in Jennex and Raman (2009) and Murphy and Jennex (2006).

The emergency response plan is a document that includes the procedures to be activated in response to any type of incident, plus all the information required to make decisions (such as maps, pictures, videos, etc.). The advance of information technologies has enabled the development of rich-content emergency response plans, going beyond the classical printed documents to become sophisticated hypermedia structures integrating text and multimedia content to provide decision makers and responders with the most accurate information. Typical cases of rich information are the use of Geographical Information Systems to calculate the optimal road to an emergency location, or video recordings of the different sections of a subway tunnel. Nevertheless, a valuable part of the information required to solve emergencies cannot be available in advance, as it must be gathered from the emergency location; this information is known as the context of the emergency, and may be very relevant for decision making. For instance, routes calculated by route planners may be unusable in case of avalanches or earthquakes or even traffic jams, so they should not be used by response teams.

In general, contextual information is complementary to the context-independent one; that is, there are parts of emergency response plans considered contextual, and the plans include the necessary actions to gather such information and make it available to decision makers. In some cases, context overrides non-contextual information previously available. For instance, if a road is closed, some request should be sent to the route planner to recalculate and find a clear way to the place. In other cases, overriding is not recommendable, as previously recorded information can still be valuable. If a tunnel has collapsed, the video of the tunnel should not be shown as an optional escape way, but could be still available to look for valuable information such as possible obstacles, or just to analyze properties of tunnels similar to the damaged one for which there is no video recording available.

Managing contextual information poses several challenges, from its capture to its visualization. Specially challenging is how to have access to both contextual and non-contextual information related to the same object (e.g., the road and the tunnel in the aforementioned cases). Having the appropriate mechanisms is important, as wrong information can lead to wrong decisions. In this paper, we tackle the problem of combining contextual and non-contextual information to make it available to decision makers in emergency responses.

The main contribution of the paper is the definition of a framework for knowledge representation and visualization. The framework builds on previous work on knowledge management and hypermedia engineering to provide a full-lifecycle solution for knowledge organization and visualization. Starting from a context-enabled knowledge model, that includes the so-called composite knowledge, we create emergency re-
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