Knowledge management for rapid response

Aviv Segev
National Chengchi University, Taiwan
asegev@nccu.edu.tw

Abstract

In a crisis all rescue forces, government agencies, volunteers, and business sectors focus on obtaining the best response possible within sufficient time to be useful. The problem of the lack of a shared platform or similar communication methods among the collaborators usually arises within a few hours. The paper presents an outline of an ontology-based knowledge management system for the construction of a common platform for sharing different concepts in different languages and coordinating rescue forces. Motivation is supplied by the Boxing Day Tsunami crisis.

Keywords: *rapid response, knowledge management, ontology*

Knowledge Management for Rapid Response Situations

Applying rapid response in a situation, such as a crisis, usually entails bringing down physical as well as logical barriers to allow fast transfer of critical information. Knowledge Management comprises a range of practices used to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, either embodied in individuals or embedded in organizational processes or practice. However, during a crisis there exists a mass amount of information relating to new concepts which are not yet represented. The rapid response requires building a new knowledge management system sometimes in a matter of hours. Knowledge Management during rapid response situations will be influenced by mass production of information relating to multiple events. Communication will be limited in scope between the participants. Chaos and lack of official chain of control and decision making can be expected in this situation. Furthermore, the most critical aspect might be the time limitation.

Rapid response situations such as earthquakes, floods, fires, or war conflicts involve multiple civilians as possible casualties on one side. On the other side rescue forces are working and receiving support from volunteers, governments, and businesses. Meanwhile, the media is attempting to tap into all the players. Figure 1 outlines the players involved in a rapid response situation. Each player attempts to communicate its needs and make its offers through direct communication channels between the players. However, many times these channels are not unique and actually represent multiple communication channels. For example, a government could have multiple representatives from different agencies working to assist the rescue forces. Rescue forces would have to hold a direct communication line with each business or volunteer interested in providing help to the forces. Most important, the requirements of the civilians who are in need are not always known to the rescue forces. The Boxing Day Tsunami in 2004 hit Indonesia,

Sri Lanka, India, and Thailand the hardest, killing more than 225,000 people in eleven countries and inundating coastal communities. The immediate response of the global community was to send food aid and medical support. However, donated medicines in affected areas were stockpiled by the ton while they needed to be sorted and stored until they could be used appropriately or discarded [Mason, 2005]. The UK Foreign Office admitted that it had made several mistakes in responding to the tsunami crisis. The Foreign Office's rapid response team was sent to Sri Lanka believing that the worst affected area would be the Maldives but most British victims were in Thailand. Pressure on Bangkok British embassy staff meant that some e-mails went unopened on the first day, so a plea for help from Britons in Khao Lak was not seen [Telegraph, 2005].

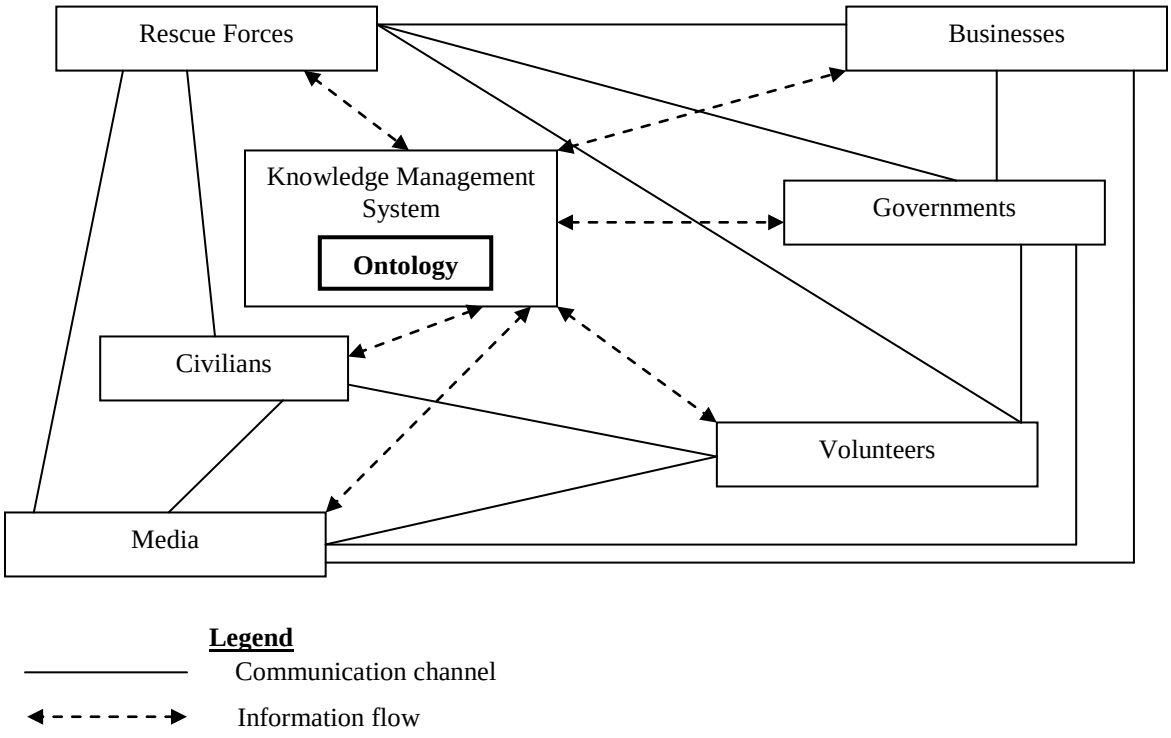

Figure 1. Rapid Response Knowledge Management System Environment

A Knowledge Management system can supplement all the communication channels by supplying a single point of information management flow. The system as depicted in Figure 1 can automatically be connected to process the information flow in each one of the players taking part in the rapid response situation. The system can collect information from civilians in the crisis, serving as a management system that directs information. Furthermore, the system can perform an initial processing of the information for making simple decisions, such as the number of requests from each location or the classification of request topics. A Knowledge Management system can be document based, i.e. any technology that permits management and sharing of formatted documents. Furthermore, Ontology/Taxonomy based technologies, such as OWL/RDF [Smith et. al., 2004] or Topic Maps [Gashol and Moore, 2006], can be used to summarize and utilize the documents and share the knowledge required by rescue forces and to supply relevant

information to different ground locations. A model for designing an ontology-based knowledge management system during a situation with time constraints is described next. The model describes the steps and the resources required to build a satisfactory solution which can serve as a basis for setting up the rescue and support systems under these time constraints.

Ontology Design for Rapid Response Situations

Ontologies are currently considered the *de-facto* standard for representing semantic information. Their design, however, is a difficult task, requiring the collaboration of ontology engineers and organization experts. Therefore, ontologies are manually crafted and tuned, which results in a static domain model, infrequently modified. Nevertheless, once ontologies are designed, their universal nature makes them an excellent mechanism for application interoperability.

A common definition of an ontology considers it to be "a specification of a conceptualization" (Gruber, 1993), where conceptualization is an abstract view of the world represented as a set of objects. The term has been used in different research areas, including philosophy (where it was coined), artificial intelligence, information sciences, knowledge representation, object modeling, and most recently, eCommerce applications. For our purposes, an ontology $O \equiv (V, E)$ is a directed graph, with nodes representing concepts (vocabulary or things (Bunge, 1977), (Bunge, 1979)) associated with certain semantics and relationships (Russell and Norving, 2003). For example, a crisis concept can be Supply Chain which will be associated with both the concept of Management and the concept of Food Aid, as displayed in Figure 2.

The static nature of ontologies conflicts with the dynamic nature of the world. Businesses often change and need to adapt the semantic representation of their occupations to the changing business environment. Governments, which change less often, still need to adapt their regulations to a global community, while maintaining some divergence from standard governance, reflecting local interpretations and lingual differences. An emergency incident requires collaboration among all these organizations with rescue and support forces within a limited timeframe. The research literature has proposed a hybrid approach, in which ontologies are recognized as static entities yet an organization can change its business semantic representation dynamically. To do so, an ontology is defined to have two parts: a static part (which is the global ontology) and a dynamic part, which evolves either by exporting ontologies or by discovery. With such a model, organizations can still interoperate using the universal part of the ontology and continuously change their business models using the local component of the ontology.

In the quest to identify frameworks, concepts, and models for crisis ontologies the term 'Open Ontology' was addressed in (Di Maio, 2007). 'Open Ontology' refers to a given set of agreed terms, in terms of conceptualization and semantic formalization, that has been developed based on public consultation. Previous efforts to utilize ontology for crisis response include the OpenKnowledge system, which supports and enhances the sharing and effective use of information and services among different actors (Vaccari et. al., 2006). Previous work also focused on blogs and the collaborative tagging approach (Ziesche, 2007). However, the present work takes ontology for crisis management further and enables real-time extension of the ontology.

An ontology-based model for multilingual knowledge management in information systems has been proposed in (Segev and Gal, 2008). The unique feature was a lightweight mechanism, dubbed context, which is associated with ontological concepts and specified in multiple languages. The contexts were used to assist in resolving cross-language and local variation ambiguities.

The technique presented here is different from the previous model since it requires the ability to create and modify the ontology in real-time as the crisis arises and continues to evolve. This requirement necessitates having a basic predefined multilingual ontology while allowing the expansion of the ontology according to the crisis circumstances and the addition of other languages within the crisis time limitations. The technique can be adopted to build an ontology where each concept can be represented in multiple languages and can be expanded for use in crises, such as the Boxing Day Tsunami.

The Sphere handbook (Sphere Project, 2004) is designed for use in disaster response and is applicable in situations where relief is required, including natural disasters and armed conflict. It is designed for use in slow- and rapid-onset situations, rural and urban environments, developing and developed countries, anywhere in the world. Analysis of the Sphere handbook index shows that it meets many requirements of an ontology and thus can be defined as an Index Ontology. The Sphere Handbook was translated into 37 languages and thus supplies a top level ontology that can be used concurrently in multiple languages. Since each high level Index Ontology concept is represented in multiple languages, there is faster ontology adaptation in crisis situations. A sample of a multilingual ontology in English, French (F), Tamil (T), and Sinhala (S) is presented in Figure 2. In addition, the top level ontology can be expanded according to the specific emergency using additional resources, for example, an index from a relevant book such as a medical manual, or Web sites, such as Wikipedia.

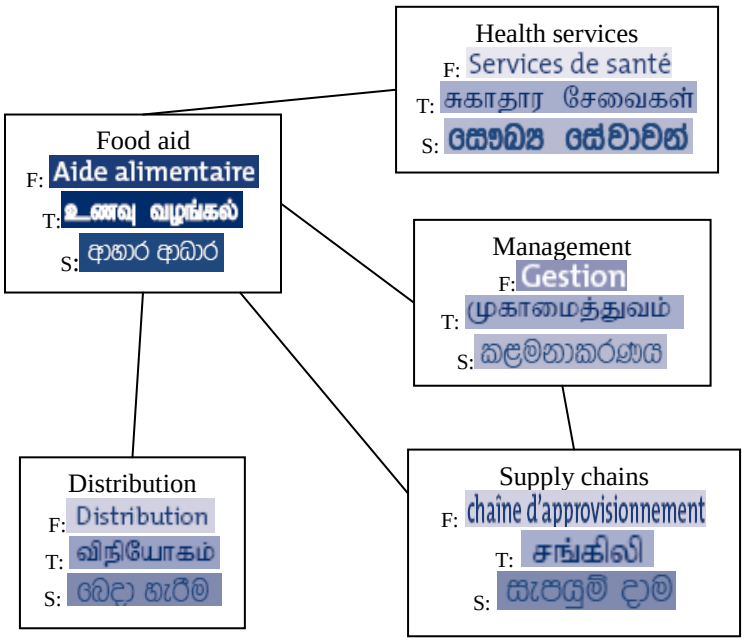

Figure 2. A Sample of the Extracted Ontology

Utilizing the Knowledge Ontology

The question arises of how the Index Ontology can support agencies and groups involved in a crisis. The answer can be divided into two separate tasks: to enable the information flow during the crisis to be matched with relevant ontology concepts and to direct the relevant information to the correct agency or individual. The ontology matching process directs the crisis information flow to the relevant ontological concepts. The crisis might include multiple types of information such as documents, emails, blogs, and update postings in message boards. The Index Ontology can serve as a knowledge base for directing crisis information flow. An information system deployed in a crisis can use the Index Ontology as an immediate knowledge representation that can be accessed by emergency forces. Civilians in a crisis can access such a system to link to relevant information or to provide real-time information that will be matched immediately with concepts predefined in the ontology. This ontology can be set up in the initial time frame of the crisis, allowing information to be sent in multiple languages using the same framework. The example of the Boxing Day Tsunami shows the relevance of such an ontology. For instance, an email or a blog web-site requesting food aid in the civilians' local language such as Tamil or Sinhala can be collected with all the incoming Food Aid requests from all the crisis locations to the relevant concept. Consequently, management teams can make decisions based on the information associated with the Management concept and its related concepts (Figure 2). An analysis of the number of documents relating to each ontology concept can be used to assist in the decision making process without requiring the initial manual processing of each document. For example, the emails can be classified according to topic concept, such as food or medicine, and further parsed according to locations, and the number of emails in each category can be analyzed to determine the criticality of certain issues – before the emails are even read. The knowledge management system can therefore support initial rapid response decision making to determine whether to put an emphasis on food or medicine and which locations need more support.

Conclusion

The paper presents an ontology-based knowledge management system for the construction of a common platform for coordinating rescue forces during a crisis. The knowledge management system can facilitate the sharing of different concepts in different languages to allow the coordination of rescue forces during disasters occurring in wide geographical regions, such as the Boxing Day Tsunami crisis.

A Knowledge Management system for rapid response situations is currently being developed based on the Index Ontology. Experiments of the Knowledge Management system based on blogs posted during the Katrina and South Asia earthquake crises are being used to analyze information flow based on the multilingual ontology. The research aims at implementing the Knowledge Management system in a real crisis scenario to enable assistance and real time analysis of the system.

References

Bunge M. (1977) Treatise on basic philosophy, The Furniture of the World, Ontology I, vol. 3, D. Reidel Publishing Co., Inc., New York, NY.

Bunge M. (1979) Treatise on basic philosophy, A World of Systems, Ontology II, vol. 4, D. Reidel Publishing Co., Inc., New York, NY.

Garshol L. M. & Moore G. (2006) ISO 13250-3: Information technology - Document Description and Processing Languages - Topic Maps - XML Syntax, ISO.

Gruber T. (1993) A translation approach to portable ontologies, Knowledge Acquisition, 5 (2).

Di Maio, P. (2007) An Open Ontology for Open Source Emergency Response System, Open Source Research Community.

Mason P. (2005) Tsunami relief: Same mistakes repeated, The Pharmaceutical Journal, 274, p. 178.

Russell S. & Norving P. (2003) Artificial Intelligence: A Modern Approach, 2nd edition, Prentice Hall, Upper Saddle River, New Jersey.

Segev A., and Gal A. (2008) Enhancing portability with multilingual ontology-based knowledge management, Decision Support Systems, 45, pp. 567–584.

Smith, M. K., Welty, C., and McGuiness, D. L. (2004), OWL Web Ontology Language Guide, http://www.w3.org/TR/owl-guide/, W3C Recommendation.

Sphere Project (2004) Humanitarian Charter and Minimum Standards in Disaster Response, The Sphere Project, Geneva.

Telegraph, FO report admits tsunami mistakes, http://www.telegraph.co.uk/news/uknews/1503920/FO-report-admits-tsunami-mistakes.html, 26 Nov 2005.

Vaccari L., Marchese M., Giunchiglia F., McNeill F., Potter S., and Tate A. (2006) OpenKnowledge Deliverable 6.5: Emergency response in an open information systems environment.

Ziesche S. (2007) Social-networking web systems: Opportunities for humanitarian information management, Journal of Humanitarian Assistance.