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Building an Ontological model in Decision Support of Crisis Response

Chia-Hwa Liu,
Institute of Applied Information Technology, Hsing Wu University

***Abstract*—The decision making in crisis response is a very difficult and complex problem in human and society environment. It requires rigorous information and communication-intensive effects, tactful utilized for reducing uncertainty, accurate calculating and comparing costs and benefits, and managing resource in a fashion beyond those regularly available to handle routine problem. However, recently, the new developing theory of information technology provides the possibilities for tackling the complexity of domain. Namely, ontological approach, which can be used to share knowledge with incident parameters, and thus effectively increase the communication and countermeasures. Since the model can be used as a comprehensive knowledge model to simulate the level of reusable knowledge, and the form of a taxonomy or classification schema can be used to reflect requirements, it is believable to justify an efficient tool for decision support. In this paper, therefore, we explore an ontological model to help companies understand, communicate, share, change, measure and simulate all the aspects of cases with crisis response in decision making. Some practical cases and slots related with real properties will be analyzed in the simulation.**

***Keywords*: decision making, crisis response, ontological model**

I. INTRODUCTION

In recent years, with the frequent occurrence of crisis incidents and threaten events around the individual, business and government, the consequence cause a lot of damage and regrets, it triggers to develop intelligent and effective decision support systems for critical response and management. The general public commonly recognizes events such as building collapses, train and bus collisions, earthquakes, tsunami and other large-scale crisis as risk incidents. Events such as the food contamination or city bombing and even the September 11 attacks in 2001 of US are well publicized examples of crisis incidents. According the survey of events, timely response to crisis incidents is crucial to prevent current situations getting worse; it is helpful to settle crisis as soon as possible and thus could reduce the number of casualties and other potential damages. Figure1 explain the trend of cost in settlement. However, the decision making in crisis response is a very difficult and complex problem in real environment. It requires rigorous information and communication-intensive effects, tactful utilized for reducing uncertainty, accurate calculating and comparing costs and benefits,

and managing resource in a fashion beyond those regularly available to handle routine problem.

Figure1: The cost of settlement will depend on the time and correspondent crisis response actions

However, recently, the new developing theory of information technology provides the possibilities for tackling the complex factors in specific application domain. Namely, the conceptual modeling focused on ontological approach, which can be used to share knowledge with incident parameters, and thus effectively increasing communication and countermeasures. Since ontological model can be used as a comprehensive knowledge model which enables the developer to simulate the level of reusable knowledge, and the form of a taxonomy or classification schema can be used to reflect requirements, [2],[11] it is believable to justify an efficient tool for decision support. In this paper, therefore, we explore an ontological model to help companies understand, communicate, share, change, measure and simulate all the aspects of cases with crisis response in decision making. Some practical cases and slots related with real properties are presented and analyzed in the simulation. Since the research is attempting to analyze and develop a ontological model with protégé package, the related content of event will be stored into the database for simulation.

The organization of the paper will divide into five sections. While in section one, the basic research background is introduced. In section 2, we survey and explain the related researches. Section 3 describe the proposed frame-based ontological system and explain the needed details of element, and section 4 will describe current practices of simulation results. Finally, in the section 5, the overall conclusion and future perspectives are given.

II. PREVIOUS STUDY

A. Literatures review

Prior research has made many efforts in constructing crisis databases over the decades. [1], [3]-[5] The content describe in [7] classify the issues of crisis event, which may be solved by some artificial intelligent technologies. The system presented in [10] is based on a technique of case-based reasoning, which is a very prominent research method for crisis response problem. Some concepts refer from [8] and [9] are good original system design. The entire system structure in [11],[12] are very fancy and practical for system development, which utilize the ontological model to simulate knowledge refinement and elicitation. [19] presents a natural disaster data and information management system, which is based on reducing the cost and time for contingency and decision-making cases.

B. Crisis management

Today, crises strike corporations, political and government institutions and a plethora of organizations, as well as individuals. In this paper we first analyze the types and the causes of crises, and strategies as crisis response. Some crises trigger off major and irreparable damage, and some can result in improved credibility (crisis as opportunity).[1][6] Due to the

significance of crises, today's management pays a lot of attention to crisis communication. Crises have, or at least ought to have, a strategic position in the life of organizations crisis and crisis communication can be understood by means of using strategies as a crisis response. [7],[9]

During the crisis response process, it is important to identify types of crisis first, since in that different crisis necessitate the use of different crisis management strategies. Though the potential crises are enormous, but generally hereafter crisis can be clustered and categorized into eight types.[6],[18],[19], this is the basic property we will classify in crisis event for reasoning.

1. Natural disaster
2. Technological crises
3. Confrontation
4. Malevolence
5. Organizational Misdeeds
6. Workplace Violence
7. Rumors
8. man-made disasters (Terrorist attacks)

Three elements are common to a crisis: (a) a threat to the organization, (b) the element of surprise, and (c) a short decision time, that is the impact and influence range could be further classify with related degree, it depends key indexes of circumstance of event, we will indicate in range field.

Early response activities give to the decision-makers the information needed to set the objectives and policies for crisis assistance, to take into account the priorities of the affected people themselves and to decide how to make best use of the existing resources for necessary assistance. Each resource element (human, vehicles, other hardware, etc...) describes each individual resource which will be involved in the crisis response. It will be listed in reaction output of ours system. It could be one of these attribute contain in communication module for different users sharing.

C. Ontology and Decision support system

Ontology is a model of real domain in the world, which connects together with a set of individual instances of classes constituted a knowledge base. [2] Which use ontological language for making ontological statements, developed as a follow from resource description framework (RDF) is intended to be used over the web, and all its elements are defined as RDF resource. A decision support system (DSS) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily.[14],[15] Recently, a properly designed DSS in an interactive software-based with heuristic intelligence has intended to help decision makers more efficiently, which compiles useful information from a combination of raw data, documents, and personal knowledge, or business models to identify and solve problems and make decisions.[4],[11].

In our system we will build an ontological modeling knowledge base, the knowledge representation will use Protégé classes for manipulation, [13],[16],[17] which is defaulting for supporting each phases of crisis management shown as Figure 2, however, here we only support in response phase first.

Figure2 : Phrases of crisis management all may be supported by the knowledge base of ontological modeling

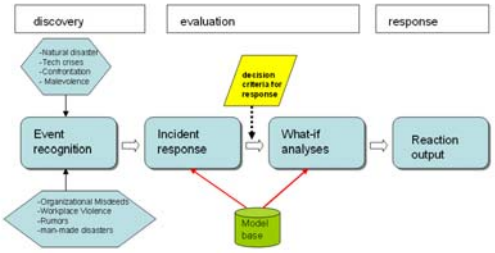

Figure4 :Basic system schema design for crisis response

The proposed simulation system use an frame based ontological knowledge base to support the operation of expert system. The entire system is triggered by a rule-based inference module, and uses an communication interface to share result with users. All the consecutive steps are provided as in Figure 3.

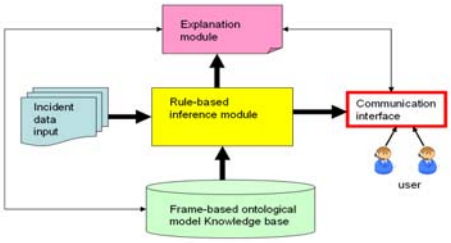

Figure 3:The system use expert system schema to support decision

III. RESEARCH MODEL DEVELOPMENT

The proposed schema of our system is based on the characteristics of DSS, but it is design for supporting decision makers in crisis situation instead of the role to replace them. The schema is built on the 4 basic procedures mentioned as Figure 4. Which consists three phases to analyze the correspondent event, and supported by an ontological model knowledge base. The related knowledge frames of each crisis event are further classified via the class defined module of Protégé, The detail slots are shown as in Table 1.

Table1 :The crisis event frame: A successful crisis activity evaluation content may be divided into different classes, which are organized into the slot of frame with related properties

property	domain	range
Crisis extent	3	12-1
Key assets	2	12-5
Affected population	41	7-3
Applied resources	1	11-6
Monitoring note	0	9-6
Damage assessment	3	5-3
Evacuation plan	1	12-3

IV. SIMULATION AND ANALYSIS

The ontology describes important concepts and relations within the chosen problem area. The construction prototype system includes the following components: (1) Obtain the relational database schema and data records; (2) Analyze the relation schema of the database and identify tables, fields, and constraint information; (3) Transform the relation scheme into the ontology elements with the rules engine; (4) Transform the database records into ontology instance using mapping rules; (5) Verify and store the generated OWL ontology document. In this section we use an open source platform tool for simulation. Namely Protégé, which provides frame for knowledge classes building, and use OWL to arrange the formal semantic rules for inference. The Protégé's core includes a wide range of constructs and techniques for support of activities such as: ontology creation, visualization and manipulation in different forms of representation.[13] Figure 5 has shown the interface of simulation crisis case. In Figure 6,

the event output of RDF content and related crisis schema is presented.

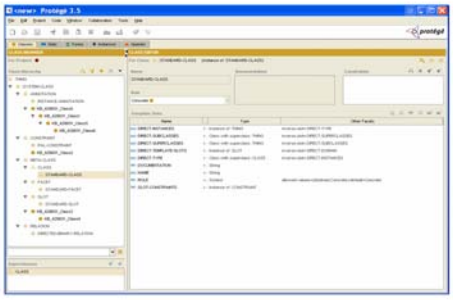

Figure 5:Generic user interface of Protege, showing the Crisis class classification view

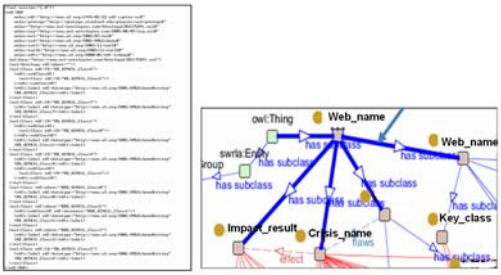

Figure 6: The event output RDF content and related crisis class relationships

V. CONCLUSION

The decision making in crisis response is a very difficult and complex problem in human and society environment. In this paper, we present an ontological modeling approach to process the problem. Which focused on attributes of crisis event, based on the database and reasoning engine, it can be used to share knowledge with incident parameters, and thus effectively increasing communication and countermeasures. Since ontological model can be used as a comprehensive knowledge model for the developer to simulate the level of reusable knowledge, and the form of a taxonomy or classification schema can be used to reflect requirements, it is believable to justify an efficient tool for decision support. In this paper, therefore, we explore an ontological model to help companies understand, communicate, share, change, measure and simulate all the aspects of cases with crisis response in decision making. Some practical cases and slots related with real properties are analyzed in the simulation.

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