1. INTRODUCTION

In recent years, emergencies have been posing severe threats to environment, economy development and personal life. It is reported that the figure of death is about 200,000 and the economic loss is over 100 billion dollars each year in the first decade of the 21st century (Shan, 2006). Consequently, emergency response systems (ERS) have been established all around the world (Meng, 2006). In ERS, resource matchmaking schema (RMS) comprised of Domain Ontology Design and Reasoning for Resource Matchmaking in Emergency Response Systems

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ABSTRACT

In an emergency response system (ERS), resource matchmaking schema (RMS) consists of emergency impact assessment, resource utility classification and mapping between impact and utility. These tasks serve the resource allocation and must be done before launching rescue activities. However, related concepts and relations have little explication. Consequently, an adequate knowledge structure is necessary. In this paper, a domain ontology for RMS (RMS_Ontology) is formally defined, on which impact-utility mapping and rule-based reasoning process are implemented. Based on the ontology defined, the authors illustrate how RMS is realized and the way reasoning process works in the ERS application of highway network under severe weather conditions. Finally, a prototype system has been developed to facilitate knowledge management and to improve the performance of emergency disposal procedures.

Keywords: Emergency Response System, Ontology, OWL, Reasoning, SWRL
emergency assessment and resource management, determines the performance of the subsequent processes including emergency supervision and resource allocation. Since the overall process involves different departments, there is a great need of unified language to describe concepts and their relations explicitly such that cross-departments could share knowledge and communication. From that aspect, Ontology has been proved as a successful technology to meet those requirements. One of the famous ontology definitions reads, “An ontology is an formal, explicit specification of a shared conceptualization” (Gruber, 1993). And formal semantic representation would be understood by machines, which further support knowledge share and interoperation among different departments. Furthermore, due to the complexity and uncertainty situation in emergency, Humans have often used heuristic arguments to arrive at conclusions (Kendal & Creen, 2007). A rule-based representation technique is a knowledge representation technique and a structure that relates on one or more premises (conditions or antecedents) or a situation to one or more conclusions (consequents) or actions (Antonio & van Harmelen, 2004).

In fact, many researchers have made progress in the domain of ERS, knowledge representation and decision support. Wang created a domain ontology to model emergency cases reported on Web pages by extending the ABC ontology (Wang, 2009). Garrido proposed an ontology for Environment Impact Assessment (EIA), which analyses the effects to environment resulting from human activity, ecosystem integrity and the quality of the environmental services (Garrido & Requena, 2011). Dengel implemented a desktop application and figured out how semantic services could help in collaborative processes (Dengel, 2007). Zeng used the ontology to acquire user’s behaviors within E-learning systems and proved its accuracy (Zeng, 2009). Zeng developed the application of NKIMathE which facilitates the mathematical knowledge management and serves for QA platforms (Zeng, 2006). Abanda, Ng’ombe, Tah, and Keivani (2011) investigated how of Semantic Web technology can be deployed in the decision support system for land delivery in Zambia.

However, little attention has been paid on the RMS involving emergency impact assessment, resource utility classification and impact-utility mapping. Few researches have deployed a rule-based reasoning process in ERS combining with the domain ontology knowledge. In this paper, RMS_Ontology is proposed to establish a conceptual framework for RMS after term collection and relation construction. And the rule-based reasoning process is demonstrated in 5 steps. Then the knowledge and rules are employed in an ERS application. Finally, the architecture of the application is described and the ontology management module serves ontology evaluation and maintenance for domain experts.

The paper is organized as follows: in Section 2, the definition of RMS_Ontology is formally expressed where most important concepts, relations and axioms are interpreted. Section 3 describes the rule-based reasoning procedure. Section 4 explains the deployment of RMS and reasoning procedure in the ERS of highway network under server weather conditions. Section 5 shows the architecture and Web interface of the prototype system. Section 6 concludes the whole paper.

2. DOMAIN ONTOLOGY DESIGN

2.1. Methodology

The aim and scope of establishing such a domain ontology for RMS is to identify the characteristic and impact of emergency, classification and utility of resources, mapping between impact and utility. After an in-depth study, we find that those concepts differ in nature. More specifically, resource utility is ‘static’, which means the property of utility is stable, depending on the type of resource. So resource utilities would better be formalized as individual instances. Emergency impact, on the contrary, is ‘dynamic’, binding with specific emergency context, such as the location and
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