ABSTRACT

Oh, Eun Ho. Ph.D. Student, Purdue University, May 2010. Impact Analysis of Natural Disasters on Critical Infrastructure, Associated Industries, and Communities. Major Professor: Makarand Hastak.

Critical infrastructure play an important role in supporting industries and communities and also responding against natural disasters to reduce their impacts (i.e., routes and bridges for evacuation and public buildings for sheltering). Due to global warming, there is an increase in the frequency of extreme weather events, which pose a high risk of functional and structural failure of critical infrastructure. Recent natural disasters, such as the 2008 Midwest floods and Hurricane Ike in the United States and the earthquake in Sichuan, China caused severe damage to the infrastructure as well as the associated industries and communities that were relying on the infrastructure. The estimated damages due to Hurricane Ike were a staggering $27 billion, the third worst in U.S. history. A common observation in the analyses of these natural disaster events is the inadequacy of critical infrastructure to withstand the forces of natural calamities and the lack of mitigation strategies when they occur on the part of emergency-related organizations, industries, and communities. If the emergency-related agencies thus could identify and fortify the vulnerable critical infrastructure ahead of time, the damage and impacts can be significantly reduced.

Therefore, the general objective of this research is to develop a decision support system (DSS) for identifying region-specific mitigation strategies based on the inter-relationships between the infrastructure and associated industries in the affected region. The inter-relationships are defined in terms of the dependency of activities of local industries and communities on associated critical infrastructure.

Data for disaster impact analysis in terms of the social, economic, and technical aspects were collected for facilitating and improving preparedness for the impact of natural disasters. This research derived that criticality, vulnerability, and severity can be key metrics for the framework of the DSS to understand how critical infrastructure, industries, and communities are inter-related in terms of the impacts of natural disasters and how the natural impact can be measured. Measurement factors, such as the potential damage or failure of the critical infrastructure and its probability of occurrence were identified in order to establish the network system of the DSS, which uses Bayesian Network theory and the System Dynamics Simulation method. The DSS will allow development of customized strategies and plans for preparedness, response, and recovery using the criticality and vulnerability analyses for each affected area. Eventually, a better understanding of the impact of disasters on infrastructure and associated industries and communities would assist emergency-related agencies in identifying appropriate disaster mitigation strategies.