Web-based Community Disaster Management and Awareness System (CEMAS) in Malaysia

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ABSTRACT

Emergency situations are unavoidable. This paper presents the functions inherent in a prototype system that was developed in Malaysia for emergency management. The prototype is potentially useful in Selangor, a state in Malaysia that is prone to natural disasters such as flash floods and landslides. The paper is presented as a report of our on-going project in Malaysia and the intended future work regarding web-based emergency management systems in Malaysia. This prototype development is funded by the Ministry of Education in Malaysia and supported by the National Security Council of Malaysia (Majilis Keselamatan Negara, MKN).

Keywords

Emergency management, emergency awareness, Malaysia, prototype

INTRODUCTION

Disasters in Selangor such as floods and landslides have proven that loss of life and property is unavoidable despite past experience and good disaster management. Selangor is constantly subjected to monsoonal floods, landslides, and severe haze episodes (Raman, Ryan and Olfman, 2006). Nevertheless, the on-going efforts related to emergency management in Selangor suggest that residents are unprepared for disasters and do not have an emergency plan in place. At present, communities in Malaysia lack a robust solution to enhance disaster readiness. Every time a disaster strikes, the social situation of the community is severely affected. The landslide in Hulu Langat alone hit an orphanage and claimed the lives of 16 children (Star, 2011).

Unfortunately, tragedies brought about by landslides in Selangor continue to claim lives and damage property despite similar events in the past. This situation must change. Researchers have asserted that unpreparedness is mainly due to ignorance about the existence of problems (Dorasamy, Kaliannan and Raman, 2010) and hill-site safety factors (landslides in Ulu Klang), uncertainty about proper courses of action, and poor knowledge about geo-hazards.

The paper proceeds as follows. The next section examines the inherent issues in emergency management in Malaysia. It discusses three main aspects, namely, the nature of emergencies in Malaysia, the process and structure of emergency management in the nation, and the role of information systems in assisting emergency management efforts in Malaysia. Under the role of information system, a sub-section called Internet Penetration in Malaysia is discussed given that the prototype we have developed is based on a web-enabled system. The third section discusses the system feature and functionality of the prototype. The fourth section presents a summary of the status of the project. We end with a discussion on the areas for future research and the lessons learned from the project. In this paper, the term emergency management is used interchangeably with the terms disaster management and emergency preparedness.

DISASTERS IN MALAYSIA

Floods and landslides are a major concern for Malaysians (Dorasamy et al., 2011). Geographically, Malaysia is located near the equator, and its climate is influenced by the tropical rain belt. The movements of the tropical rain belt between the northern and southern tropics cause constant monsoonal floods and landslides in the country. The country's disaster profile indicates that the severity and unpredictability of such disasters is alarming and results in damage to property and the loss of lives (Dorasamy et al., 2011).

Literature on landslides and floods in Malaysia enlists the following factors as the root cause: inadequate safety precautions at hill-site developments, rapid development and environmental degradation resulting from massive deforestation, and uncontrolled hill-slope construction projects (Ngai, 1997). For example, the northeast monsoon brought heavy rain through a series of storms that caused extreme floods in the southern region of Peninsular Malaysia from December 2006 to January 2007. These storms are unusual (Ngai, 1997, 2006). A total of 22,091 families (in December 2006) and 28,747 families (in January 2007) were affected by the flood (Shafie, 2009). O'Arbayah et al. (2009) stated that the floods in Johor in 2006–2007, which displaced more than 312,386 residents, were extraordinary and tested the preparedness of everyone (O'Arbayah et al., 2009).

Based on the Asian Disaster Reduction Center Country Report (2006, 2008, 2009), landslides, floods, wind storms, epidemics, wave surges, droughts, and wild fires are among the natural disasters that are likely to affect Malaysia.

Table 1 presents the top 10 natural disasters in Malaysia between 1992 and 2011.

Disaster	Date Occurred	Numbers Killed
Storm	26 December 1996	270
Epidemic	September 1998	105
Earthquake (seismic activity)	26 December 2004	80
Mass movement, dry	11 December 1993	72
Epidemic	July 2007	56
Mass movement, wet	30 August 1996	50
Epidemic	January 1997	50
Flood	22 December 1993	30
Flood	7 December 2007	29
Epidemic	13 April 1997	28
Total		770

Table 1. Top 10 Natural Disasters in Malaysia

Source: Created on: 5 Feb 2011. Data version: v12.07, "EM-DAT: The OFDA/CRED International Disaster Database, www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium". Retrieved on 9 Feb 2011 from http://www.emdat.be/result-country-profile. (EM-DAT, 2010)

Disaster Management in Malaysia—Governance Structure

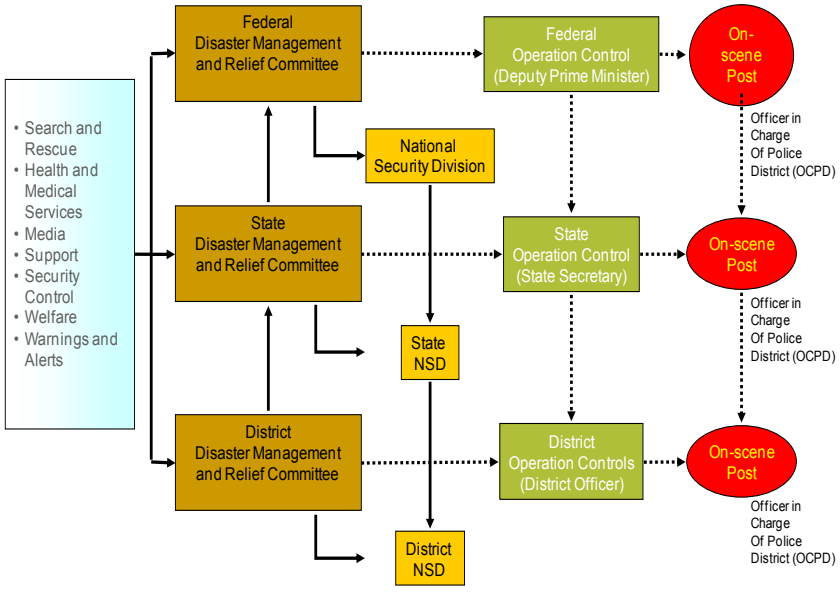

Figure 1. Structure of Disaster Management in Malaysia

Figure 1 illustrates the structure of disaster management in Malaysia. The disaster management committee operates with the bottom-up approach. All requests and information come from the district level to the state level and then to

the federal level. Every disaster warning is disseminated via several channels, including sirens, mass media, telephone, fax, website, Short Message System (SMS), and fixed line alert system. The National Disaster Management Strategy of Malaysia is the backbone strategy to achieve an effective coordination in and an integrated approach toward building a culture of prevention, protection, and public safety in the community (ADRC, 2009). Its vision is to create a safe environment for the community through disaster management and sustainable development in the 21st century. The above figure suggests that the structure of Malaysian disaster management operates with a three-tiered level. This structure suggests that the information flow and requirements in the event of a disaster in Malaysia are clear. However, in reality, our ongoing research suggests the following:

- The structure of disaster management is well established and governed. However, from a citizen-centric perspective, more can be done to enhance the awareness of citizens about the importance of disaster planning and response (DPR). In short, Malaysians, particularly those in Selangor, can be informed about the types of disasters, the disaster-prone areas, and the ways in which they can prepare for disasters in the future.
- The information flow, particularly in the event of a natural disaster, relies mainly on mass media, such as television news and printed media. In other words, a web-driven proactive discussion on and participation in issues regarding disasters is limited.
- The key entities and agencies that lead disaster management efforts can benefit from web-based systems that are designed to offer the following in relation to disaster management:
    - Timely flow of information about resources needed for disaster management at an intra-organizational level
    - Support from a web-based database that archives key statistics on disaster-related data, for example, material, equipment, expertise, and other assets needed to manage disasters
    - Facilitation of intra-organizational collaboration, communication, and coordination in planning for and responding to disaster situations

INFORMATION SYSTEMS AND DISASTER MANAGEMENT

The disaster management efforts of any organization can be enhanced through an extended use of information technology (IT) (Burnell et al., 2004). The authors of the current work propose a web-based information system that can enhance the aspects of disaster management for any organization through the following:

- Establishing a solid structure and a clear organization of emergency information as well as a common platform that is accessible to all relevant staff
- Creating of an organizational memory system that allows the staff to document and exchange emergency information, including the ways to deal with emergencies
- Providing an avenue through which the staff can retrieve emergency-related information from anywhere at anytime
- Enabling quick information retrieval
- Offering links to both external and internal information sources related to disaster management
- Improving the communication among various entities involved in disaster management through a common, accessible platform
- Providing a system that serves not only as a backup for the currently used paper-based documentation but also as a tool to aid training, simulations, meetings, tabletops, and other activities related to disaster management

Emergencies such as earthquakes, terror threats, and other natural or manmade disasters are examples of a complex and dynamic environment. The challenge for organizations is to develop a knowledge management system that can easily adapt to changes that occur in situations of great uncertainty. Previous studies (see for example Burnell et al., 2004) have suggested several attributes that information management systems should have in helping organizations

deal with a complex and dynamic environment. These systems include knowledge management systems that can perform the following:

- Provide a shared knowledge space with consistent and well-defined vocabulary
- Model and explicitly represent knowledge
- Permit collaborative efforts among employees
- Allow reuse of knowledge
- Empower employees based on a knowledge sharing culture

Disaster management involves various events and activities, for which IT plays a significant role (Davenport and Prusak, 1998). IT can support the creation, sharing, and dissemination of information as well as the creation of a useful organizational memory system to enhance emergency planning and response (Alavi and Liedner, 2001; Turoff et al., 2004). Knowledge management systems can assist organizations in dealing with dynamic and complex situations such as emergencies (Burnell et al., 2004). More recently, Turoff, Hiltz Bañuls and Eede (2013) suggest that despite improvements in terms of planning and infrastructure spending, on balance the process of planning and mitigating disasters is subject to improvement. In this regard to improve disaster management, the following issues warrant greater attention: (i) need for proper modeling specific disasters within a given local community (Turner, 2013); (ii) call for greater collaboration between public, private sector and citizens in creating disaster management systems are more robust (iii) designing systems that bring together both citizens and public sector agencies across the different phases of a disaster (Turoff et al., 2013). In addition Canós, Penadés, Gómez, and Llavador, (2013) further argue that there is clear role for the use of Information Technology to aid disaster management efforts. The authors present a comprehensive framework called SAGA which addresses how Information Technology can be mapped to the entire lifecycle of a disaster, based on their case studies across nine different countries. Our own review of literature pertaining to disaster management suggests that, New Zealand is the only country in the world that has defined the role of community involvement in its National Disaster Plan (see for example: Mitchelle et al., 2010).

Given the above backdrop, the project team secured government funding to develop a prototype of a web-based system that can support disaster management efforts in Malaysia. The next section discusses the key features and functions of the prototype.

INTERNET IN MALAYSIA

Based on the world Internet Statistics (2013) Malaysia has an Internet penetration rate of approximately 61%, from a population of close to 30 million people. The main provider of High Speed Broadband is by a government linked company (GLC) called Talikom Malaysia (TM) – which offers a products called Streamyx that enables users to download up to 5MBPS[i]. Almost 63% of Malaysians own a smart phone with the 3G penetration rate reported at close to 57%. The main providers of mobile Internet connection in Malaysia are Maxis, DiGi, and Celcom – these three private companies capture close to 85% of the mobile Internet market in Malaysia. In general, access to Internet is relatively affordable e.g. the 5Mbps Stremyx package can be obtained for approximately US$35 per-month[ii].

PROTOTYPE OFFERING

The role of information and communications technology in disaster situations has become clear through various disaster management systems, such as the Sahana Disaster Management Systems for tsunamis (2004), DERMIS by Turoff et al. (2004), Sarvodaya.org for tsunamis (2004), Information Management System for Hurricane Disasters (2001), Digital Typhoon, PeopleFinder and ShelterFinder, Strong Angel III (2006), Tsunami Resource and Result Tracking Systems of the UN, Case Management Systems in Singapore for SARS (2003), NIMS USA (2004); and DesInventar Systems, an integrated database in Latin America, Orissa, and South Africa.

Despite the existence of various information systems for disasters in various countries, a system that is suitable for all countries and all disasters has yet to be developed (Turoff et al., 2004). Raman et al. (2010) claimed that the lack of a universal information system for disasters is due to the uniqueness of every disaster. Hence, detailed system planning for developing such a prototype is needed to suit local requirements. Given the requirement for the system to become community centric, the prototype presented in the current work is called the Community Emergency Management and Awareness System (CEMAS). The subsections that follow illustrate the design principles and overall architecture of CEMAS.

Design Principles and System Architecture

The design principles for the prototype are wide and encompassing, as the prototype adopts the global standard of emergency management systems. Turoff et al. (2004) stated that systems designed to support disaster management, including DPR, should address four components, namely, design elements, system specification, design concept, and alternate design considerations. The authors go on to assert that when considering the design of any system to aid disaster management efforts, twelve fundamental roles (for users using a particular system) must be considered in the context of emergency management (Turoff et al. 2004 – pp. 15-17). These roles are, providing users with the ability to:

- Request for resource, people and things
- Allocate, delay, or deny resources
- Report and update a situation
- Analyze the situation
- Edit, organize and summarize information
- Maintain resource (logistics)
- Acquire more of new resources
- Oversight, review, consult, advice
- Alert all with a need to know
- Assign roles and responsibilities when needed
- Coordinate among different resource area
- Priority and strategy setting (e.g. command and control)

Based on these twelve underlying principles/guidelines, the CEMAS system architecture was conceptualized. As a result, CEMAS has three main modules namely the (i) iCEMAS (intelligent CEMAS) a knowledge-information base –which enables users to search for roles, allocate resources and logistics related elements), (ii) a Community Portal (to aid information sharing and alert issues and (iii) the Agency Portal (to aid coordinating/planning purposes for the local authority)

CEMAS System Architecture

Figure 2 illustrates the overarching system architecture.

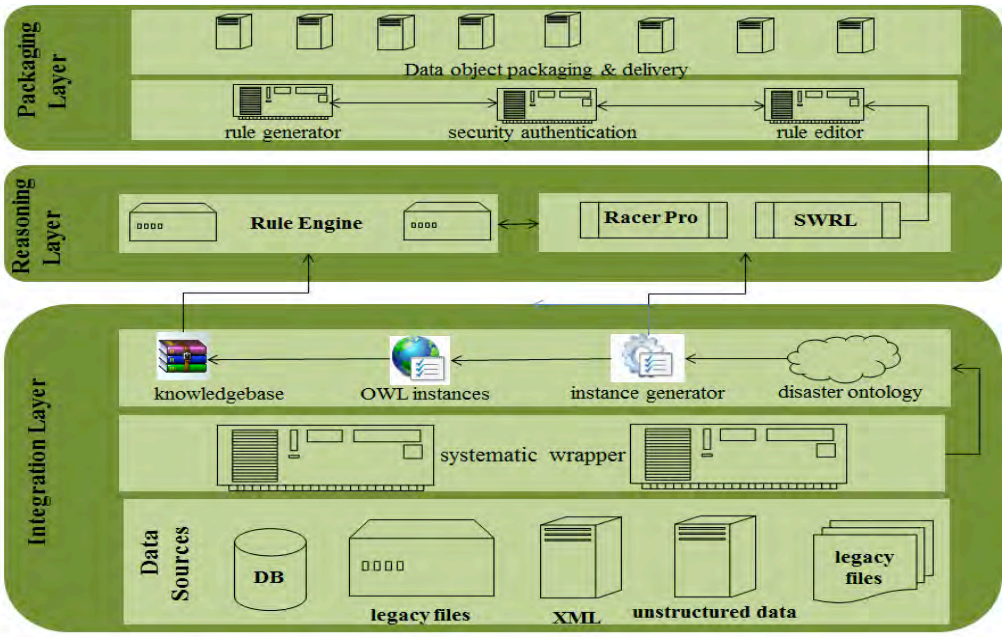

Figure 2. System Architecture of the Proposed System

In essence, the architecture is supported by three layers, namely, integration, reasoning, and packaging. All layers are disaster planning and response (DPR) specific. At the integration layer, an imminent outcome is a CEMAS for the DPR efforts of MKN Selangor with the related agency identified in this project. Figure 2 provides the logical view of our proposed prototype. CEMAS can be viewed as a three-tiered architecture. At the integration layer we have incorporated various data structures and formats (from existing legacy system) in a common database to aid faster information retrieval. At the reasoning layer – i.e. data interpretation for search purposes, rule based systems using software such as Semantic Web Rule Language (SWRL) and RacerPro were deployed. These systems essentially assist in providing more accuracy and precision when searching for information within a web-based system. The third and final layer is the packaging layer which essentially groups the citizen, agency and knowledge bases into three different modules which manifest themselves into different functions of the system, visible to the end user. The development of the system was based on open source protocols and sub-languages.

STAKEHOLDER REQUIREMENTS

To address the different requirements of the key stakeholders involved in emergency management in Malaysia, CEMAS offers the following features that address the needs of both the community and the National Security Agency.

Addressing Community Needs

For local communities within Selangor, CEMAS offers a dashboard containing the following features:

Information Base

- Knows their community and its strength to achieve satisfactory rescue/response
- Seeks professional advice from disaster-stricken communities via communication and collaboration platforms
- Provides alerts on disasters occurring in surrounding areas via registered SMS/emails
- Takes advantage of social networking platforms such as Twitter to improve disaster communication

Coordination-Related Features

- Accessible to available disaster programs and activities hosted by MKN Selangor, such as the frequent disaster awareness programs, drills, and simulations

Information or Knowledge-Related Features

- Assesses exposure to disaster risks and develops an emergency plan
- Periodically assesses the level of readiness and resiliency among residents
- Learns from past disasters for preparedness and improved resiliency
- Provides information about relief efforts, non-government organizations, shelters, disaster resources, trainings, vulnerable areas, and mitigation efforts of the government
- Provides real-time data about river levels, volume of rainfall, and climate

ADDRESSING THE NATIONAL SECURITY AGENCY (MAJILIS KESELAMATAN NEGARA-MKN)

CEMAS offers the following communication, coordination, and information-related features to aid the MKN in its disaster management efforts:

Communication-Related Features

- Makes current and future disaster-related programs known to the vulnerable community
- Communicates with first responders at ground level, including those closest to the victims
- Communicates with affiliates regarding the level of community readiness
- Reaches out to the members of communities to form a team of first responders at ground level

Coordination-Related Features

- Provides a platform for improved coordination among the first responders from the community, community heads and leaders, and the affiliates of MKN (e.g., district officers)

Information or Knowledge-Related Features

- Assesses and understands the level of community readiness
- Informs the community about relevant issues that are critical for community preparedness
- Educates the vulnerable community about emergency plans and supplies during disasters

PROJECT STATUS

As of this writing, the prototype has been developed, but its use and acceptance by the project's major stakeholders has yet to be tested by the project team. The project team plans to test the system in mid-February 2014. Specifically, the system will be tested at two levels. First, the system will be tested by selected residents of Selangor to ascertain the usefulness of the prototype in creating awareness on emergency management issues. We plan to use the System Usability Scale for this level. The prototype will also be administered at MKN Selangor, where key administrators will be interviewed to obtain their opinion after testing the prototype of CEMAS.

FUTURE WORK

The project team also recognizes that the following should be considered to ensure the successful deployment of CEMAS:

- Integration of CEMAS into the core activity at MKN
- Identification of key users (admin) and system ownership
- Provision of prototype training to key users and demonstration to citizens
- Development of a communication plan for all major stakeholders vis-à-vis the use of the system
- Integration of the database component of the system to the training and actual drills/simulation for emergency management and response

ACKNOWLEDGMENT

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[i] http://www.internetworldstats.com/asia.htm (downloaded February 3rd, 2014)

[ii] www.tm.com.my (downloaded February 5th 2014)