Knowledge-based Emergency Management Information Systems: Mapping DERMIS Principles

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ABSTRACT

Recent disasters which were composed of major floods and landslides events proved that despite past experiences and strong disaster management mechanism, life and property losses are still unavoidable. Emergency managers need a robust system that can ease the challenges faced. This paper proposes a functional system based on the working principle of The Dynamic Emergency Response Management Information Systems (DERMIS): Design Premise, Conceptual Design, System Specification and Supporting Design Considerations. These four principles are coupled with specific end-user requirements derived from our on-going work. The impact of this study on disaster management is significant to the scientific group within disaster management domain, the government agencies for policy and strategy formulations to preempt, deal with and, ultimately, improve survival rate in disaster.

Keywords:DERMIS, knowledge management system, emergency, disaster, ICT.

I INTRODUCTION

Information and communication technology (ICT) is regarded as key enabler of emergency management (Borkulo, Scholten, Zlatanova, & Brink, 2005; Dorasamy, Kaliannan, Raman, & Muthaiyah, 2011; Dorasamy & Raman, 2011; McEntire, 2007; Raman, Dorasamy, Maniam, & Muthuveloo, 2011; Murray Turoff, Chumer, Walle, & Yao, 2004; Wattegama, 2007). ICT can support all the disaster phases such as preparedness, mitigation, risk reduction, prevention, response and recovery. For instance, it can highlight risk areas, vulnerabilities and potentially affected population using ICT tools such as GIS (Geographical Information Systems), EWS (Early Warning Systems) and GPS (Global Positioning Systems).

Role of ICT in disaster can be seen by the emergent of various disaster management systems such as Sahana Disaster Management Systems for Tsunami (2004), DERMIS by Turoff et al. (2004), Sarvodaya.org for Tsunami (2004), IMASH, an Information Management System for Hurricane Disasters (2001), Digital Typhoon, PeopleFinder and ShelterFinder, Strong Angel III (2006), UN's Tsunami Resource and Result Tracking Systems, Case Management Systems in Singapore to handle SARS (2003), NIMS USA (2004) and DesInventar Systems, an integrated database in Latin America, Orissa, South Africa.

Despite the existence of various information systems for disaster in various countries, there hardly one system that is suitable for all countries and all disasters(Dorasamy & Raman, 2011). This is because each and every disaster event is unique (Murray Turoff, et al., 2004) and hence, requires detail system planning of such system development to suit local requirements.

In Malaysia, one of the challenges faced by state crisis management agencies is lack of tools for knowledge management(Dorasamy, et al., 2011). A preliminary interview with emergency managers revealed that the emergency managers require dynamic resource knowledge-bases. Absence of this results in time consuming activities during disaster responses. Consequently, emergency managers face difficulty in control and command with their novice emergency officers. Novice emergency officers hardly have platform to update or be informed about the current standard operating procedures and disaster imperatives. These challenges are further worsen by the fact that every disaster situations are unique and change is the only constant. This scenario cast a broad puzzle that a KMS can aptly solve. However, this proposition lacks empirical evidence, in Malaysian contexts. Therefore, researchers of this study aims to fill the knowledge gap by conducting the research as well as attempting to explore the KMS success factors in enhancing emergency support in Malaysia.

The result of this research will be constructive and beneficial to the Malaysian government especially MajlisKeselamatan Negara (National Crisis Committee, henceforth will be referred as MKN) to

plan for coherent knowledge platform to support better disaster planning and response (DPR). Hence, identifying success factors for using KMS in disaster planning is timely (Raman, et al., 2006).

Given the above research problem, the following research questions arise: To what extent can the KMS be implemented by emergency managers effectively to address the communication, coordination and information/knowledge management challenges that the organisation is currently facing in the context of DPR? Can an effectively designed KMS for DPR improve the emergency decision making?

The objectives of this paper are firstly to present a conceptual diagram of a KM system for DPR based on DERMIS and secondly to map DERMIS principles for a knowledge-based emergency management information systems. The paper is proceeds by describing current disaster scenario in Malaysia in section II, KM for disaster management in section III, DERMIS principles in section IV, the proposed conceptual system overview in section V, followed with discussion on how DERMIS can be mapped to design KMS for disaster.

II DISASTERS: THE MALAYSIAN CHAPTER

Floods and landslides are a major concern for Malaysians (Dorasamy, et al., 2011). Geographically, Malaysia is located near the equator and the climate is influenced by the tropical rain belt. The movements of the tropical rain belt between northern and southern tropics cause constant monsoonal floods and landslides in Malaysia. Recent disaster profile highlights that the severity and unpredictability of such disasters are alarming and increasingly damage property and cause loss of lives (ADRC, 2009; Dorasamy, Raman, Muthaiyah, & Kaliannan, 2010b). Based on ADRC country report (2009), landslides, floods, wind storm, epidemic, wave surge, drought and wild fires are among the natural disasters likely to affect Malaysia(ADRC, 2009). Prevention web quoted Malaysia's risk profile (probability of the disaster and its negative consequences) is high for flood, landslide, earthquake and tsunami with a total of 59,241 and GDP of US$0.95 billion exposed people to these disasters (PreventionWeb, 2011). Preventionweb.net illustrated that the vulnerability and risk level of disasters in Malaysia is high (ranked 7th for flood and 8th for landslide in the 1 (lowest) to 10 (highest) vulnerability scale).

KNOWLEDGE MANAGEMENT SYSTEMS FOR DISASTER

Disaster planning and response involves extensive coordination, communication, integration, dynamic and ad hoc environment (Murray Turoff, et al., 2004; Murray Turoff, White, & Plotnick, 2011)Burnell, Priest &Durrett, 2004). The nature of emergency/disaster warrants for a deployment of KMS to support communication, coordination and dissemination of valuable information and knowledge for emergency managers (Jennex & Olfman, 2005; Kostman, 2004; Van Kirk, 2004)Burnell, et al, 2004).

Integration of knowledge management systems (KMS) in emergency management is a recent development. Emergency managers need to access to life-saving information and knowledge in real-time. This requires coordination. KMS can play a pivotal role to enhance emergency managers' efforts that allow fast actions and response to problem at hand. Jennex (2008, pg. 4) conclude that we need KM to help organisation to make sense of what they know, to know what they know, and to effectively use what they know(Jennex, 2008).

Since KMS facilitates the process of KM, in the realm of disaster, KMS enable the collection, retrieval, dissemination and storing of the right knowledge. Especially in the context of disaster management, at a highly turbulent environment, the integrated knowledge solution will greatly improve the effort of disaster planning and response. In a broader context, information about disaster preparedness, lessons learned from past experiences, dos' and don'ts in emergency, disaster management plans, policies and guidelines must be made available. There must be an adequate coping mechanism to enable such knowledge to transform into life saving knowledge. This is evident in various KMS tools that were used for DPR during post 9/11 attacks in 2001, Hurricane Katrina in North America and during the Indian Ocean Tsunami in year 2004. Therefore, marrying both DPR and KMS can benefit community and emergency managers in the effort to relief its problems.Turoff et al., (2004) have aptly introduced DERMIS principles for designing suitable emergency knowledge-based systems.

III DERMIS PRINCIPLES

The working principle is The Dynamic Emergency Response Management Information Systems (DERMIS): Design Premise, Conceptual Design, System Specification and Supporting Design Considerations (Turoff, et al. 2004). Our prior research suggests that a comprehensive and robust

system that can improve disaster management in Malaysia does not exist. DERMIS is design principle introduced by Turoff et al. 2004 based on EMISARI (Emergency Management Information System and Reference Index) and as a result of in-depth literature review on information system for emergency management. EMISARI system is a communication system designed to support the operation of the integrating people and data into a single database during the Wage Price Freeze in 1971, in the US. EMISARI design and concept was later implemented by Internal Revenue Service (IRS) and General Service Department (GSD) for next 15 years (Turoff, et al, 2004). According to Turoff (2004). "EMISARI was the only system that could keep up with the evolution of the procedures and processes…As a result it was able to be used for any type of crisis." (Turoff, et al. 2004, p. 5).

DERMIS is particularly selected for this research as it presents the "need for a single integrated enterprise type system that spans all the functions of emergency response from planning, through execution and recovery, to training" (Turoff, et al. 2004, p.3). Underlying the Dermis principles, we propose that the resulting prototype can improve disaster planning and response efforts in Malaysia in particular, emergency managers.

These four principles are coupled with specific end-user requirements derived from our on-going work. The design principles for the intended system are wide and encompassing – as it adapts global standard of emergency management systems. Table 1 shows the DERMIS principles as described by Turoff et al. (2004):

Table 1: The DERMIS' Four Design Principles

A. Design Premises 1. System Training and Simulation 2. Information Focus 3. Crisis Memory 4. Exceptions as Norms. 5. Scope and Nature of Crisis 6. Role Transferability 7. Information Validity and Timeliness 8. Free Exchange of Information 9. Coordination	**B. Conceptual Design** 1. Metaphors 2. Human Roles 3. Notifications 4. Context Visibility 5. Hypertext
C. General Design Principles and Specifications 1. System Directory 2.Information Source and Timeliness 3. Open Multi - Directional Communication 4. Content as Address 5. Up-to-date Information and Data 6. Link Relevant Information and Data 7. Authority, Responsibility, and Accountability 8. Psychological and Social Needs	**D. Supporting Design Considerations and Specifications** 1. Resource Database and CommunityCollaboration 2. Collective Memory 3. Online Communities of Experts

SYSTEM OVERVIEW

System Features

The system will have a dashboard containing the following features:

i. Communication related Features:
   - Chat, forum and discussion tools to facilitate socialization to enable tacit knowledge sharing
   - To communicate life saving knowledge and past experience.
   - Announcement, notifications and bulletin boards to make current and future disaster related programmes known to the community of practice
   - Social media such as Twitters to be leveraged for improved DPR
   - To communicate with affiliates – federal, state and district officers

ii. Coordination related Features
   - To provide a platform for better coordination between first responders, community heads and leaders and with MKN's affiliates such as district officers
   - To assign responsibilities, roles and manage the changes

iii. Information / Knowledge related Features:
   - To provide access to relevant database on assets, people, drills and disasters
   - To inform the community on relevant issues that are critical for disaster planning and response
   - To provide learning materials on latest and current technology, research and development pertaining to DPR.

MAPPING TO DERMIS PRINCIPLES

Table 2: Mapping to DERMIS

DERMIS Principles	Mapping to the Proposed Systems
Design Elements	• Training and Simulation capability • DPR Information driven • DPR memory base • Knowledge Transfer capability • Information Validity and Timeliness • Free flow of knowledge sharing and exchange supported by system • Specification of roles and responsibility

Design Concept	• Metaphoric requirements • Human Role identification • Notification • Context and Content visibility • Transparency
Alternate Design Considerations	• Resources database • Extended to relevant MKN affiliates • Collective DPR knowledge memory • Online community of experts
System Specification	• Directory of DPR service • Sources of DPR information • Open – multi channel communication platform • Relevant DPR information • Social and psychological requirements

The Proposed System

The proposed diagram of KM system for disaster is composed of 3 layers: data source layer, integrated presentation layer and knowledge process layer. Data source layer provides all data and information for emergency managers to be able to view and take response therein via an integrated presentation layer. Knowledge process layer shows the process of knowledge being discovered/created acted upon and learned from,for every emergency incidents,. This is illustrated in figure 1.

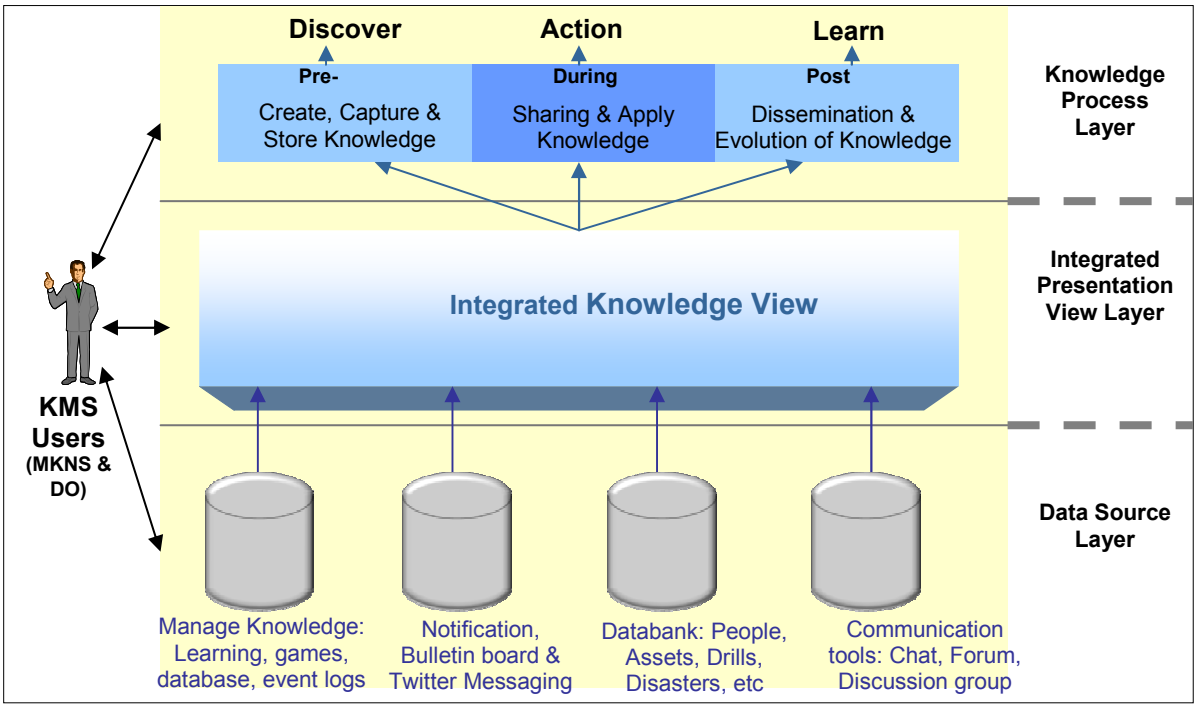

Figure 1: The Proposed Conceptual Diagram

An emergency management information system can be designed and developed effectively using DERMIS principles. The following paragraphs describe how each of DERMIS premises can integrate for the proposed system features as described in Table 2.

Design Elements: For a successful design, the system designers and developers should provide training and simulation capability. This can include learning materials and games. All information should be DPR driven from disaster memory. There must me features that enable free flow of information that is validated, timely and capable to transfer knowledge. Turoff, et al. 2004 assert that an emergency system must specify roles and responsibilities of emergency actors. They should be dynamic in nature. The system should have roles built-in within the knowledge-bases.

Design Concepts: Five concepts that are essential for an emergency system are metaphoric requirements, human role identification, notification, context and content visibility and transparency. Turoff et al. al (2004) referred metaphors as road map of event such as event log of what took place during the crisis. Human roles should be built in group's communication systems and supported by privileges and tools for carrying out those roles. Notifications are relevant alerts on changes in status and data/information that is related to roles, actions, responsibilities of the

members. Context visibility allows allow search for more item in the log. Transparency of information is extremely important to build trust among the users (Paton, et al., 2010; Murray Turoff, et al., 2004).

Alternate Design Considerations: Based on Turoff's recommendation, resource database such as database on assets, people, drills, notification are extremely important. These features can be extended to relevant affiliates or stakeholders to allow free flow of information. Other important features include collective disaster knowledge memory that contains disaster information such as disaster history, success/failure factors and lessons learned. Provision of online community of experts will enable life-saving knowledge transfer and sharing between practitioners/emergency managers and experts in the fields such as academics, researchers and scientists.

System Specification: Turoff et al, (2004) suggest that there should be a directory of emergency services available for emergency stakeholders and first responders. All sources of disaster information must be made available. However, it can be available based on different level of authority. Open – multi channel communication platform such as chat room, discussion group, and forum can be integrated. Social media such as twitter can be used for this purpose (Huang, Chan, & Hyder, 2010). All relevant information must be available. This includes the updated information on available resources in each district. Last but not least feature is social and psychological requirements. Emergency managers work in high pressured, time constrained and stressful situation. Hence, decision making are immensely influenced by social and psychological factors (French & Niculae, 2005; Paton, et al., 2010; Sattler, 2000). Any emergency system should take this factor into account.

IV CONCLUSION

This paper highlights to the KMS community that DERMIS principles as suggested by Turoff, et al. (2004) can be effectively used to design KM-based emergency management information systems. Hence, we conclude that KMS can be implemented successfullyfor DPR as it has the ability to support communication, coordination and information/knowledge challenges faced by the disaster management community. Designing a KMS for emergency managers will need a more sosio-technical approach as disaster management holds unique informational attributes unlike any other information systems. The proposed system is currently under development as part of a doctoral research and will be implemented to investigate the KMS success factors for disasters.

REFERENCES

ADRC. (2009).

Borkulo, E. V., Scholten, H. J., Zlatanova, S., & Brink, A. V. D. (2005). Decision making in response and relief phases. In PJM van Oosterom, S. Zlatanova & E. Fendel (Eds.), *Geo-information for emergency management - late papers* (pp. 47-54).

Dorasamy, M., Kaliannan, M., Raman, M., & Muthaiyah, S. (2011). *Knowledge Management Systems for Emergency Managers: Malaysian Perspective.* Paper presented at the International Conference on Semantic Technology and Information Retrieval, Putrajaya, Selangor, Malaysia.

Dorasamy, M., & Raman, M. (2011). *Information Systems to Support Disaster Planning and Response: Problem Diagnosis and Research Gap Analysis.* Paper presented at the The 8th International ISCRAM Conference Lisbon, Portugal

Dorasamy, M., Raman, M., Muthaiyah, S., & Kaliannan, M. (2010a). *Disaster Preparedness in Malaysia: An Exploratory Study.* Paper presented at the International Conference of WSEAS on Recent Advances in Management, Marketing and Finances, Penang, Malaysia.

Dorasamy, M., Raman, M., Muthaiyah, S., & Kaliannan, M. (2010b). ICT and disaster preparedness in Malaysia: an exploratory study. *WSEAS Transactions in Information Science and Application, 7*(5), 735-748.

French, S., & Niculae, C. (2005). *Believe in the model: Mishandle the emergency.* Paper presented at the International Conference on Information Systesm for Crisis Response and Management 2004, Brussels.

Huang, C.-M., Chan, E., & Hyder, A. (2010). Web 2.0 and Internet Social Networking: A New tool for Disaster Management? - Lessons from Taiwan. *BMC Medical Informatics and Decision Making, 10*(1), 57.

Jennex, M. (2008). A Model for Emergency Response System. In L. J. Janczewski & A. M. Colarik (Eds.), *Cyber warfare and cyber terrorism* (pp. 383-390). USA: IGI Global.

Jennex, M., & Olfman, L. (2005). Assessing Knowledge Management Success. *International Journal of Knowledge Management, 1*(2), 33-49.

Kostman, J. T. (2004). 20 Rules for effective communication in a crisis. *Disaster Recovery Journal, 17*(2), 20.

McEntire, D. A. (2007). *Disaster response and recovery*. NJ: John Wiley & Sons, Inc.

Murphy, T., & Jennex, M. (2006). Knowledge Management, Emergency Response, and Hurricane

Katrina. *INTERNATIONAL JOURNAL OF INTELLIGENT CONTROL AND SYSTEMS, 11*(4), 199-208.

Paton, D., Saut, S., Norio, O., Li-Ju, J., Petra, T. B., & Chris, E. G. (2010). Making sense of natural hazard mitigation: Personal, social and cultural influences. [doi:10.3763/ehaz.2010.0039]. *Environmental Hazards, 9*(2), 183-196.

PreventionWeb. (2011). Malaysia Risk Profile. Retrieved 28 January 2010, from www.preventionweb.net

Raman, M., Dorasamy, M., Maniam, K., & Muthuveloo, R. (2011). Knowledge Management for Social Workers Involved in Disaster Planning and Response in Malaysia: An Action Research Approach. *Systemic Practice and Action Research, 24*(3), 261-272.

Sattler, D. N. (2000). Disaster Preparedness: Relationships Among Prior Experience, Personal Characteristics, and Distress. *Journal of Applied Social Psychology, 30* (7), 1396-1420.

Turoff, M., Chumer, M., Walle, B. V. d., & Yao, X. (2004). The design of dynamic emergency response information systems (DERMIS). *Journal of Information Technology Theory & Application, 5*(4), 1-35.

Turoff, M., White, C., & Plotnick, L. (2011). Dynamic Emergency Response Management for Large Scale Decision Making in Extreme Hazardous Events. In F. Burstein, P. Brézillon & A. Zaslavsky (Eds.), *Supporting Real Time Decision-Making* (Vol. 13, pp. 181-202): Springer US.

Van Kirk, M. (2004). Collaboration in BCP skill development. *Disaster Recovery Journal, 17*(20), 40.

Wattegama, C. (2007). *ICT for Disaster Management*. Bangkok: United Nations Development Programme – Asia-Pacific Development Information Programme (UNDP-APDIP) and Asian and Pacific Training Centre for Information and Communication Technology for Development(APCICT).