Knowledge Management for Disaster Response: A Proposed Framework

Magiswary Dorasamy[a], Murray E. Jennex[b], Murali Raman[c], Maniam Kaliannan[d]

[a]Universiti Tunku Abdul Rahman (UTAR)
magiswary@mail.utar.edu.my

[b] San Diego State University
mjennex@mail.sdsu.edu

[c] Multimedia University, Cyberjaya
Murali.raman@mmu.edu.my

[d] Universiti Teknologi MARA, Malaysia,
maniam123@salam.uitm.edu.my

ABSTRACT

Knowledge management encompasses a wide range of disciplines. Most organizations face difficult challenges in managing knowledge for emergency response, but it is crucial for response effectiveness that such challenges be overcome. Organizational members must share the knowledge needed to plan for emergencies. They also must be able during an emergency to access relevant plans and communicate about their responses to it. In this paper we purport the idea that knowledge management systems allow more effective and timely disaster management efforts. We present our idea based on our experience in working with knowledge management systems to support emergency preparedness initiatives in North America. We propose a framework that can be used by local researchers and practitioners to better understand the influence of knowledge management on disaster management.

Keywords
Disaster Management, Knowledge Management Systems, Wiki Technology

1.0 INTRODUCTION

This paper discusses the relationship between information and communication technology (ICT and its impact on disaster management efforts. The academic nature of this paper stresses on how (ICT), manifesting itself in the form of a knowledge management (KM henceforth) system, can enhance disaster management efforts within organizations. The paper is written based on our involvement with prior and on-going work (in Malaysia) that pertains to the use of km system in aid of disaster management.

2.0 KNOWLEDGE MANAGEMENT DEFINED

Knowledge management encompasses a wide range of disciplines. Groupware, decision support systems, expert systems and other forms of collaborative systems are examples of technology related to knowledge management (Gupta and Sharma, 2004). A single definition of knowledge management does not exist (Alavi and Leidner, 2001). Knowledge can be viewed from several perspectives for example "as a state of the mind, as an object, as a process, a situation of having access to information or even as a capability" (p.109). Knowledge can be tacit or explicit (Nonaka 1994; Nonaka and Takeuchi, 1995).

Jennex (2005) utilized an expert panel, the editorial review board of the International Journal of Knowledge Management, IJKM, to generate a definition of KM as the practice of selectively applying knowledge from previous experiences of decision making to current and future decision making activities with the express purpose of improving the organization's effectiveness. Another key definition of KM includes Holsapple and Joshi (2004) who consider KM as an entity's systematic and deliberate efforts to expand, cultivate, and apply available knowledge in ways that add value to the entity, in the sense of positive results in accomplishing its objectives or fulfilling its purpose. Finally, Alavi and Leidner (2001) concluded that KM involves distinct but interdependent processes of knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application. Taken in context, these definitions of KM focus on the key elements of KM: a focus on using knowledge for decision making and selective knowledge capture. This is important as the selective focus on knowledge capture separates KM from library science which attempts to organize all knowledge

and information and the decision making focus emphasizes that KM is an action discipline focused on moving knowledge to where it can be applied. Ultimately, KM may best be described by the phrase "getting the right knowledge to the right people at the right time" and can be viewed as a knowledge cycle of acquisition, storing, evaluating, dissemination, and application.

An organization's ability to survive given dynamic changes within its environment, is contingent upon its ability to quickly respond to change (Burnell et.al., 2004). This includes among others the ability to effectively manage its knowledge resources (Burnell et al., 2004). Burnell et al. assert that "an effective knowledge-based organization is one that correctly captures, shares, applies and maintains it knowledge resources to achieve its goals" (p.203). This echoes the view of March and Simon (1958) who state that successful organizations are able to adapt to any dynamic environment. The information processing theory states that the role of having accurate and up to date information is vital particularly when organizations deal with a turbulent environment (Burnell et al., 2004). Implementation of a knowledge management system that can support managers to proactively respond to a highly turbulent environment will benefit an organization (Burnell et al., 2004). This would include organizations that plan and prepare for an emergency situation, either man-made or due to the forces of nature (Kostman, 2004).

KM is better understood when the concepts of Organizational Memory, OM, and Organizational Learning, OL are incorporated. Jennex and Olfman (2002) found that the three areas are related and have an impact on organizational effectiveness. Organizational effectiveness is how well the organization does those activities critical to making the organization competitive. OL is the process the organization uses to learn how to do these activities better. OL results when users utilize knowledge. That OL may not always have a positive effect is examined by the monitoring of organizational effectiveness. Effectiveness can improve, get worse, or remain the same. How effectiveness changes influences the feedback provided to the organization using the knowledge. KM and OM are the processes used to identify and capture critical knowledge. Knowledge workers and their organizations 'do' KM; they identify key knowledge artifacts for retention and establish processes for capturing it. OM is what IT support organizations 'do'; they provide the infrastructure and support for storing, searching, and retrieving knowledge artifacts.

The purpose of implementing knowledge management systems in organizations varies. Von Krogh (1998) takes a business perspective stating that knowledge management systems help increase competitiveness. Hackbarth (1998) suggests that knowledge management systems lead to greater innovation and responsiveness.

Davenport and Prusak (1998) provide three reasons why knowledge management systems are implemented in organizations: (i) to enhance visibility of knowledge in organizations through the use of maps, hypertexts, yellow pages; directories etc. (ii) to build a knowledge sharing culture i.e. create avenues for employees to share knowledge and (iii) to develop a knowledge infrastructure, not confined to technology solely, rather create an environment that permits collaborative work. Work by Hackbarth (1998) and Davenport and Prusak (1998) imply that knowledge management systems can support an organization in planning for and dealing with emergencies. Therefore, a logical next step is to examine what constitutes a knowledge management system.

3.0 KNOWLEDGE MANAGEMENT SYSTEMS (KMS)

A knowledge management system in paper study refers to any IT based system that is "developed to support and enhance the organizational knowledge processes of knowledge creation, storage, retrieval, transfer and application" (Alavi and Leidner, 2001- p.114). This definition includes expert systems, Web based group support systems, online directories etc. Gupta and Sharma (2004) divide KMS into seven major categories as follows:

- Expert Systems, artificial intelligence and knowledge based management system (KBMS) - Main purpose of these systems is to capture knowledge and perform analysis on existing knowledge base to assist in decision-making. Often associated to rule based and pattern recognition systems.
- Groupware (Computer Supported Collaborative Work) - Systems that permit sharing and collaborative work. Often described synonymously to Lotus Notes. However, one could suggest that asynchronous (e-mail, wikis, electronic-logs) and synchronous systems (videoconference, chat) are newer applications that can fall into this category (Bates and Poole, 2003).
- Document management systems - Systems that support the need for managing text and images to make information much more accessible. This is similar to the idea of office management systems i.e. use of various word documentation and spreadsheet software.
- Decision support systems (DSS) - Business applications that usually contain summaries of large amounts of data, filtered and synthesized particularly to support strategic decision-making. The focus of DSS is on analysis of quantitative data and presentation tools for managers.

- Semantic networks - The focus is on systems that explain not just relationships between entities but the meaning based on how the entities are structured. Semantic networks can be used to "represent domain knowledge explicitly and shared" (Gupta and Sharma, 2004).
- Relational and Object oriented databases - Systems that permit management of both structured (relational) and much more complex data sets (OODBMS).
- Simulation tools - Systems that run computer based simulations for a variety of purposes.

4.0 EMERGENCIES, DISASTERS AND CRISIS MANAGEMENT

Princeton University defines an emergency as "a sudden unforeseen crisis (usually involving danger) that requires immediate action. Another Web resource defines an emergency as "any abnormal system condition, which requires immediate manual or automatic action to prevent loss of load, equipment damage, or tripping of system elements which might result in cascading and to restore system operation to meet the minimum operating reliability criteria." The notion of disaster management can be viewed in the broader lens of crisis management. This paper uses the term 'emergency' synonymous to the term 'crisis'. Majority of literature on crisis management use the term crisis to describe both emergency and disaster situations, which includes but not confined to man-made and natural disasters (Fink, 1986; Booth, 1993; Myers, 1999; Seeger et al. 2003; Herman, 1965; Miller, 2004).

Charles Herman is one of the pioneers in developing crisis management models. Herman (1965) states that any crisis situation consists of three key elements:
- "It threatens high priority values of the organization goals
- It presents a restricted amount of time in which decisions can be made and
- Is unexpected or unanticipated by the organization" (p. 64).

Herman's definition implies that crisis management is unstructured and complex in nature. This view of crisis is similar to that of Miller (2004) who defines a crisis based on nine attributes. Miller states that a crisis:
- "Suddenly occurs
- Demands quick reaction
- Interferes with organizational performance
- Creates uncertainty and stress
- Threatens the reputation, assets of the organization
- Escalates in intensity
- Cases outsiders to scrutinize the organization
- Permanently alters the organization" (p. 19).

The Institute for Crisis Management (ICM) classifies crisis situations into sixteen categories (Miller, 2004-p.21): business catastrophe, class action suits, defects/recalls, environmental damage, financial damage, labor disputes, sexual harassment, white-collar crime, casualty accident, consumer action, discrimination, executive dismissal, hostile takeover, mismanagement, whistle blowing and workplace violence.

Fink (1986) defines a crisis as an "unstable time or state of affairs in which a decisive change is impending - either one with the distinct possibility of a highly undesirable outcome or one with a distinct possibility of a highly desirable and extremely positive outcome" (p.15). This definition is somewhat different compared to standard definitions of emergency/crisis situations (for example Chandler and Wallace, 2004; Claremont Colleges Disaster management Plan 2004), where the notion of an emergency is often associated to a negative outcome. Fink goes on to suggest that the purpose of managing crisis is to eliminate any potential risk to the organization.

Seeger et al. (2003) offer a broader definition of organizational crisis management relative to Fink's (1986) definition. They define organizational crisis as an "unusual event of overwhelmingly negative significance that carries a high level of risk, harm and opportunity for further loss" (p.4). The authors cite spills, floods, and explosions as examples of crisis situation that can impact individual careers, health, and well being in addition to preventing organizations from resuming regular operations.

Booth (1993) suggests that every crisis is unique and cannot be accurately planned for. Fink (1986) suggests that emergency management teams in organizations ask themselves the following questions when developing a crisis management plan: "Who is responsible for notifying employees? Who is the backup? Who is responsible for notifying the media? Which local, state, or federal government agencies may need to be notified, and who will do so? Your switchboard operators are your first line of defense (or offense). What will they tell reporters or the public at large when they call? Who is responsible for briefing them? And do they need to be bilingual?" (p.60).

Chandler and Wallace (2004) studied emergency response in organizations throughout the United States. Their study compares the emergency response efforts between 2001 and 2004, with a specific focus on organizational resources devoted to disaster planning. The survey was administered at the Disaster Recovery Journal (Spring 2004) world conference. The highpoints of their study are summarized as follows. On September 11, 2001, close to 20% of companies represented in the study did not have any formally documented crisis management plan. By mid-September 2002, 66% of companies studied increased overall organizational commitment and efforts in planning for emergencies. Post 9/11, 36% of companies increased resources devoted to emergency response; 53% reported a modest

increase. Only 9% said that there was no change in the organization's view of emergency response after the incident. Terror threats, bomb threats, biological hazards, and dealing with explosive materials are ranked higher in terms of risks, after 9/11. In terms of written policies, the survey respondents said that following 9/11, the emergency response/disaster recovery plans for their respective organizations now include procedures to handle "bomb threats (70%), computer crime (49%), terrorism attacks (47%), mail threats (47%), chemical release (43%) and hazardous material release (43%).

Chandler and Wallace (2004) describe four areas that should be incorporated by crisis planners in their respective policies: (i) determining guidelines and standard policies for resuming business as usual after a crisis situation, (ii) real-time tracking of implementation plans, (iii) use of simulation in training staff involved in crisis response, and (iv) prioritizing what needs to be in the organization's crisis planning process.

Myers (1999) uses the term disasters to describe a crisis. He suggests that organizations should develop a four-stage disaster response plan: (i) prevention, which includes preparedness training, (ii) development of an organized response with a focus on damage containment, (iii) protection of cash flow by using alternate procedures, and (iv) restoration of facilities by resuming normal operations. Myers identifies the essential issues, which should be part of a crisis response plan: "Notification to employees and customers; damage assessment; rerouting incoming phone calls and/or messaging; initiating restoring computer processing capability; physical security; and relocating personnel" (p.9).

5.0 ICT AND DISASTER MANAGEMENT

Prior to the establishment of the Homeland Security Department, the task of managing information pertaining to crisis situations and crisis management in the United States was under the jurisdiction of the Office of Emergency response (OEP) (Turoff, 1972). The information requirements for the OEP were largely handled by a group of consultants from both business and academia. Over time, the OEP recognized that a system that could provide timely and relevant information to crisis responders was needed (Turoff, 1972). In 1970, twenty-five people working on crisis response were able to collaborate via a computerized Delphi system (Turoff, 1972). Computerized Delphi techniques can be administered via the web today (see for example Cho and Turoff, 2003 and Turoff and Hiltz, 1995).

In 1971, the OEP was assigned the task of monitoring a new form of crisis called the "Wage Price Freeze" (Turoff et al., 2004). This new role for the OEP included among others, to "monitor nationwide compliance, examine and determine requests for exemptions and prosecute violations" (p. 5) in relation to wage and price changes in the economy. This led to the advent of a flexible system called the Emergency Management Information System and Reference Index (EMISARI). EMISARI was a system designed to facilitate effective communication between people involved in monitoring the Wage Price Freeze situation. The system was designed to integrate people and data into a common platform that could be updated regularly by people who were non-technical administrators (Turoff et al., 2004). The EMISARI system was flexible and enabled several hundreds of people to collaborate in responding to a crisis (see for example Rice 1987, 1990 and Turoff, 2002).

Lee and Bui (2000) documented vital observation with the use of a crisis response system during the massive earthquake that hit Kobe, Japan in 1995. Several key lessons for crisis management system designers based on Lee and Bui's work were identified. Relevant information should be included in the crisis response system prior to the actual crisis situation. This is to ensure that crisis responders have sufficient information to guide the decision-making processes in responding to a crisis. Lee and Bui (2000) imply that the task of gathering relevant information to support crisis response should be incorporated into part of the crisis response strategic initiative. Information from prior experiences should become part of the crisis management system. The system should somehow be able to capture both tacit and explicit knowledge about how prior crisis situations were dealt with. Lessons, which are learned, can be used to guide future action. Lee and Bui (2000) in this regard imply that the design of any crisis response system should support some form of organizational memory component.

In addition to designing relevant systems features to support crisis planning and response, researchers suggest that successful implementation of any crisis management system is contingent on how well people are trained to use such systems (Patton and Flin, 1999; Turoff, 1972; Lee and Bui, 2000). Patton and Flin, for instance, suggest that crisis management systems be incorporated into crisis response related activities such as training, simulations, drills, and evacuation exercises. Turoff (1972) states that crisis management systems that are not normally used will not be used when an actual crisis situation occurs.

The majority of post 9/11 literature on crisis management is confined within the realm of commercial entities (Braverman, 2003). Developments within the domain of crisis management information systems have accelerated over the past few years, particularly after the 9/11 events (Campbell et al., 2004). The authors accurately mention that issues such as resources, expertise, and personnel should be addressed at the onset, prior to designing crisis management systems within the context of local and state level communities.

They call for development of "a generic set of requirements" (p.2) that can be used by both the state and local authorities to support crisis planning and response. The researchers however do not base their study on any particular theoretical foundations. Campbell and associates (2004) examine the effect of asynchronous negotiation given "a structured task and a specified negotiation sequence" (p. 3), in the context of crisis responders.

6.0 WHY CRISIS RESPONSE NEEDS KM?

Murphy and Jennex (2006) in their study of the use of KM in Hurricane Katrina response concluded that KM should be included in all crisis response, the rest of this section summarizes their findings.

Crises can happen at any time making it difficult for organizations to have the right resources where and when they are needed. Most organizations don't have experience with real emergencies so they need to take advantage of all available experience as decisions need to be made fast and under stress and high tension circumstances. The complexity of communicating, collaborating, and decision making processes in the context of crisis response efforts cannot be undermined.

The above paragraph implies that an organization's ability to survive given dynamic changes within its environment is contingent upon its ability to quickly respond to change, in a crisis mode. This includes the ability to effectively manage its knowledge resources. Burnell et al. (2004) assert that "an effective knowledge-based organization is one that correctly captures, shares, applies and maintains its knowledge resources to achieve its goals" (p.203). This echoes the view of March and Simon (1958) who state that successful organizations are able to adapt to any dynamic environment. The information processing theory states that the role of having accurate and up to date information is vital particularly when organizations deal with a turbulent environment (Burnell et al., 2004). Integrating KM processes can support managers to proactively respond to a highly turbulent environment and will benefit an organization (Burnell et al., 2004). This would include organizations that plan and prepare for emergencies and crisis response situations (Kostman, 2004).

Figure 1 can be used to further discuss why KM can support crisis response efforts. A crisis response center (often led by a crisis response manager) deals with various stakeholders during a crisis situation. Different stakeholder groups often have different skills, resources, technical expertise, and more importantly experience in responding to a particular crisis. For any crisis response center, issues such as managing different stakeholder expectations, priorities, and the various resource and skill sets they bring into an actual crisis response mode, is complex and dynamic. This could lead to difficulties in making accurate decisions, under time-pressured and intense situations, while responding to a particular crisis. In this context, we suggest that a KMS can be used to capture and then re-use of specific crisis response knowledge which can be used to support decision making when a crisis actually occurs. The Practice of selectively applying knowledge from previous experiences during turbulent moments of decision making, to current and future decision making activities with the express purpose of improving the organization's effectiveness, would be possible via a KMS. In addition, we further add that given the dynamic nature of crisis situations, coupled with different inputs and requirements from various stakeholder groups, a crisis response manager and centre therein, is subject to information overload, which can prevent timely and accurate decision making. A well tested and implemented KMS in this context can helps to decide what to look at, what decisions to focus on, and what decisions can be made automatically and/or in advance.

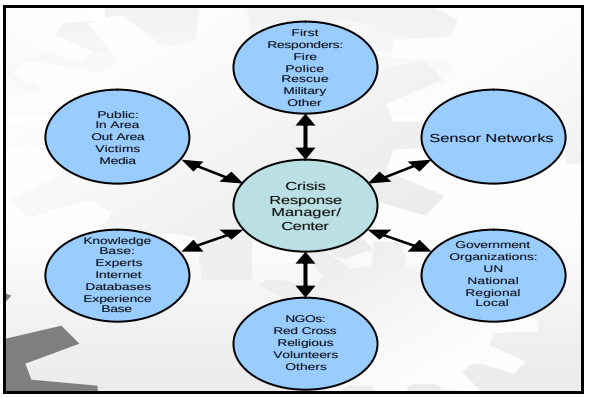

Figure 1: Complexity of emergency response
Source: Foundation of Knowledge Management

KM is an action discipline; knowledge needs to be used and applied for KM to have an impact. Crisis response relies on the use of knowledge from past situations to generate current and future response procedures. Lessons learned and the understanding of what works best in given situations (both examples of knowledge) enables emergency managers to prepare planned responses as a counter to the stress of the emergency and to ensure all relevant issues are considered during emergency response decision making.

KM SYSTEM AND DISASTER MANAGEMENT MODEL

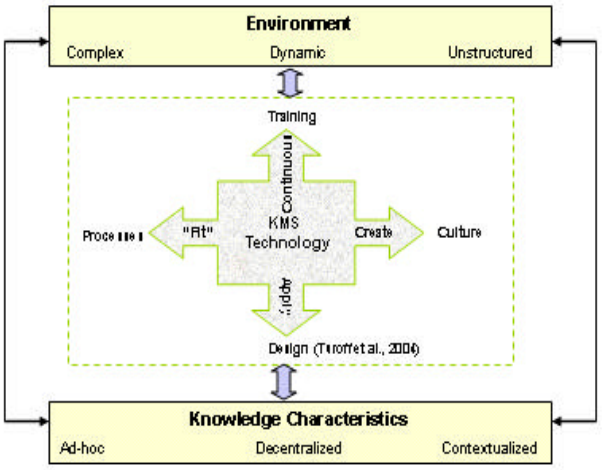

Figure 2- KM and Disaster Management

Figure 2 illustrates the nature of the relationship between KM systems in support of disaster management efforts. The environment faced by emergency responders is complex, dynamic, and unstructured. This assertion echoes the work of Burnell et al. (2004). The majority of literature about emergency management information systems do not clearly state that systems designed to support emergency response, are associated to knowledge management. We argue that, based on our prior experiences, the environment faced by emergency responders forces them to deal with the following characteristics of knowledge:

- Ad hoc — knowledge within emergency responders is largely tacit and utilized as and when an emergency occurs. Individuals and groups involved in emergency response may not necessarily think about responding to a particular situation beforehand. This implies that the knowledge that they need to respond to an emergency is ad hoc in that it is required as and when a crisis occurs.
- Decentralized — the knowledge repository to respond to a particular crisis in a consortia environment is predominantly decentralized, in a given environment.
- Contextualized — Emergency response requires responders to deal with knowledge that is highly contextualized. Every crisis is unique and requires a different set of ideas and response initiatives (Burnell et al., 2004).

Given the above, we suggest that any system designed to support emergency response, should be closely linked to ideas inherent within the domain of knowledge management. A particular technology selected to support emergency response should cater for knowledge that might be decentralized, ad hoc, and highly contextualized.

Open source systems e.g. Wiki technology might be an option for organizations that intend to use/design any information system to manage information/knowledge related to emergency response. Wiki technology is appropriate for knowledge that is dynamic and decentralized (Wagner 2004). Nevertheless, technology alone is not sufficient to foster effective emergency response initiatives. The system should be designed to cater for the requirements of emergency responders and must be used in every drill and emergency training activities (Turoff et al., 2004). We add that in addition to effective design and training considerations, two additional factors are required when thinking about disaster management systems:

- A "fit" between the knowledge management system and the existing emergency response policies must be sought after. Stated differently, the technology should support and not hinder emergency response initiatives.
- There is a need to foster a knowledge sharing culture between various entities involved in a given emergency response organization structure. In the case of CUC, this refers to the willingness of different emergency operation centers to share information/knowledge with one another.

7.0 CONCLUSION

The paper in its present form is written in a theoretical manner. The model that we are proposing in Figure 1 was derived from the second author's prior work in North America in the context of disaster management and use of KM systems. The model is currently being tested in the local context though our work with the Malaysian Association of Social Workers (MASW).

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