Task Characteristics, Knowledge Sharing and Integration, and Emergency Management Performance: Research Agenda and Challenges

Irma Becerra-Fernandez
Florida International University
becferi@fiu.edu

Weidong Xia
Florida International University
xiaw@fiu.edu

Arvind Gudi
Florida International University
AGudi@aol.com

Jose Rocha
Florida International University
jose.rocha@business.fiu.edu

ABSTRACT

Emergency management tasks are inherently complex and dynamic, requiring quick knowledge sharing and decision coordination among multiple organizations across different levels and locations. However, there is a general lack of understanding about how to describe and assess the complex and dynamic nature of emergency management tasks and how knowledge integration help managers improve emergency management task performance. This paper describes a research project that aims at (1) developing the concepts of task complexity and uncertainty of emergency management tasks and (2) testing the mediating role of knowledge sharing and knowledge integration between emergency management task characteristics and performance. The overall research agenda, approaches, challenges and the advantages of utilizing a virtual Emergency Operations Center (vEOC) for this line of research are discussed.

Keywords

Emergency management task characteristics, emergency management task performance, knowledge sharing, knowledge integration, virtual emergency operations center.

INTRODUCTION

Disasters, both natural and man-made, if not dealt with appropriately, will cause significant human and economic consequences. While emergency management has gained the attention of policy-making at all levels, in particular following the 911 event and recent natural disasters such as Hurricane Katrina, there have been systematic and repeated failures in emergency response management at various levels. For example, analysis and investigation of the response activities and mechanisms following Hurricane Katrina indicate systemic flaws that existed even prior to the disaster (GAO, 2006) and that the lessons learned from Katrina were similar to those mentioned after Hurricane Andrew, which occurred ten years earlier (Becerra-Fernandez, Prietula, Madey and Rodriguez, Valerdi and Wright, 2008). As such, there is a critical need to understand and develop effective organizational and procedural mechanisms that can help systematically improve emergency management performance.

Emergency management tasks are inherently complex and dynamic (Becerra-Fernandez, Prietula, Madey and Rodriguez, 2007). Often the events themselves are rare and diverse due to the many characteristics that define them. Prior decisions may be thoroughly documented via after action reports, but these may not cover every issue. Frequently, unique and unanticipated events arise during each emergency. The nature of the decisions, where they are made, who makes them, the data and information resources required to make and monitor them, and the location of available knowledge to drive them may sometimes be unknown, unavailable, or both. In addition, emergency management tasks involve a large number of diverse organizations across different levels and locations. Although the difficulties of managing emergency tasks have been widely recognized, there is a general lack of frameworks that help describe and assess the complex, dynamic and inter-organizational nature of emergency management tasks. Appropriate conceptualization and measurement of key characteristics of emergency management tasks is a precondition for developing organizational and procedural mechanisms that aim improving particular aspects of the tasks.

Because of the complex, dynamic and inter-organizational nature of emergency management tasks, effectively managing knowledge sharing across organizations has become a critical emergency management success factor (Comfort, Dunn, Johnson, Skertich and Zagorecki, 2004). Surprisingly, very few studies have attempted to tap into the vast discipline of knowledge management to discover new and relevant theoretical basis that may lead to practical solutions. There is a lack of theory and tools that organizations can use to assess and improve emergency management success through effectively managing task complexity and knowledge integration.

The purpose of our research project is to take the initial steps to fill the above mentioned literature gaps by (1) conceptualizing and developing measures of emergency management task complexity and uncertainty, and (2) developing and testing a research model that focuses on the mediating role of knowledge integration between emergency management task complexity/uncertainty and task performance. In this paper, we discuss our key concepts, research model, overall research approaches, research challenges, and how this study could be advanced via the development of a virtual Emergency Operations Center (vEOC).

CONCEPTUALIZATION OF EMERGENCY MANAGEMENT TASK COMPLEXITY AND UNCERTAINTY

Based on the literature related to complex systems (Perrow, 1984), complex tasks (Campbell, 1988; Wood, 1986; and information processing (Galbraith, 1973; Daft and Lengel, 1986) and our field observations, we conceptualize two major characteristics of emergency management tasks: structural complexity and dynamic uncertainty. Structural complexity captures the snap shot of the configuration components and procedures of the tasks whereas dynamic uncertainty captures the ad hoc unpredictable nature of the tasks.

Task Structural Complexity is composed of three dimensions: *Component Complexity, Interactive Complexity, and Procedural Rigidity. Component Complexity* represents the multiplicity of the task components, e.g., number of people assigned, variety of organizations being represented, computer systems being accessed and used, machines required, and variety of resources required to complete the task. *Interactive Complexity* represents the degree of interactions and interdependencies among the components of the task, e.g., the inter-connectedness of the people and different organizations involved in a given task. *Procedural Rigidity* represents the lack of flexibility in terms of the sequencing and durations of the task components.

Task Dynamic Uncertainty is composed of three dimensions: *Task Novelty*, *Task Unanalyzability*, *and Task Significance*. *Task Novelty* captures the newness (unexpected and novel events that occur in performing the task) and nonroutineness (exceptional circumstances requiring flexibility) of the task (Daft and Macintosh, 1981). *Task Unanalyzability* represents the degree to which the task is unstructured and the information required to perform the task is equivocal thus leading to conflicting interpretations (Daft and Lengel, 1986; Daft and Macintosh, 1981). *Task Significance* captures the urgency and impact of the task. While task urgency focuses on the immediate priority and timeframe a task is needed to be done, task impact refers to the analysis and assessment of the extent of potential repercussions to prioritize when a task needs to be done.

CONCEPTUALIZATION OF KNOWLEDGE INTEGRATION AND SHARING

Because of the significant amount of information and knowledge that is needed for quick assessment and decision making, emergency management involves intense knowledge identification and sharing across the diverse organizations and locations. We define knowledge integration as the extent to which three specific types of knowledge involved in performing the task at hand is shared and applied across the organization (Sabherwal and Becerra-Fernandez, 2005). The three types of specific knowledge are: context-specific, technology-specific, and context-and-technology specific. *Context-specific knowledge* refers to the knowledge of the particular circumstances of time and place in which work is performed. *Technology-specific knowledge* is knowledge of the particular scientific or theoretical discipline, which comprises of rules of cause and effect and the tools and techniques used to address problems in that area. C*ontext-and technology-specific* knowledge refers to situation where the knowledge being shared is high in both context and technical specificity.
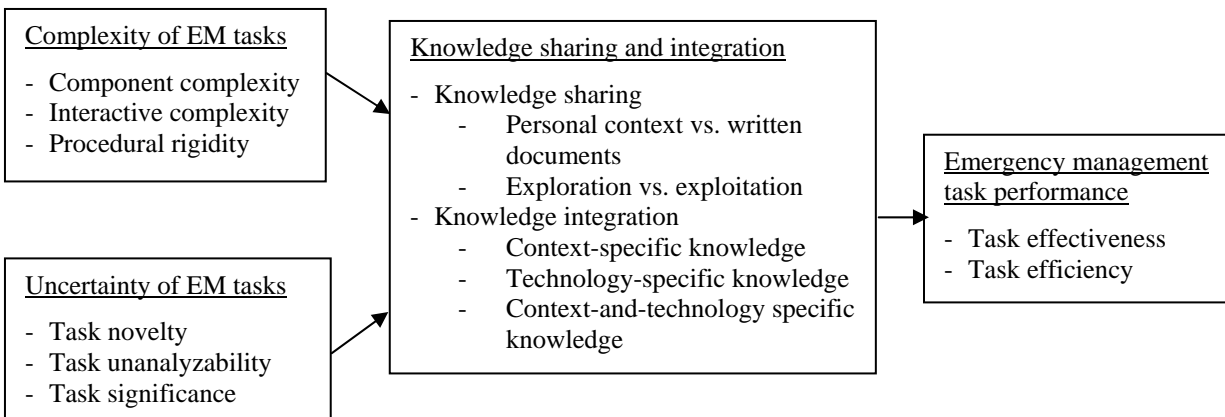
We define two purposes of knowledge sharing: *Exploration* and *Exploitation*. Knowledge exploration refers to situations where discovery of new knowledge is required because there is no existing knowledge for performing the tasks at hand (March, 1991). Exploration activities often involve search, variation, risk taking, experimentation, play, flexibility, discovery, or innovation. Knowledge exploitation refers to a directed search and utilization of

Proceedings of the 5ᵗʰ International ISCRAM Conference – Washington, DC, USA, May 2008
F. Fiedrich and B. Van de Walle, eds.

89

existing knowledge (McGrath, 2001). Exploitation activities often involve refinement, choice, production, efficiency, selection, implementation, and execution.

We define two mechanisms of knowledge sharing: through *Personal Interactions* versus through *Documentation*. Knowledge sharing through personal interactions is appropriate for knowledge that is difficult to codify and hard to formally articulate in writing, and as a result, such knowledge often resides in individuals based on their tacit experiences and social context. Knowledge sharing through written documents is appropriate for explicit knowledge that has been formally codified and written down, and as a result, is available for search and use in the forms of planning guidelines, standard operating procedures, best practices, lessons learned, and after action reports.

OVERALL RESEARCH FRAMEWORK

Figure 1 presents our overall research framework. Based on literature review and our field observations, we define two dimensions of task performance: *task effectiveness* and *task efficiency*. *Task effectiveness* refers to the extent to which the emergency incident requirements were met and the task outcome was satisfactory to the stakeholders. *Task efficiency* refers to the extent to which the task was completed in the required time frame and within the allocated budget and resources.

| Complexity of EM tasks
- Component complexity
- Interactive complexity
- Procedural rigidity | Knowledge sharing and integration
- Knowledge sharing
 - Personal context vs. written documents
 - Exploration vs. exploitation
- Knowledge integration
 - Context-specific knowledge
 - Technology-specific knowledge
 - Context-and-technology specific knowledge | Emergency management task performance
- Task effectiveness
- Task efficiency |
| Uncertainty of EM tasks
- Task novelty
- Task unanalyzability
- Task significance | | |

Figure 1. Overall Research Framework

As shown in Figure 1, our overall proposition is that appropriately defining and assessing key characteristics of emergency management, followed by effectively identifying and managing knowledge sharing and integration among the various participants of the task, would be an effective approach to manage the complex, dynamic and inter-organizational nature of emergency tasks to ultimately improve task performance. Phrased as an overall testable hypothesis, we propose that knowledge sharing and integration is an important mediating factor that helps reduce the complexity of tasks and improve emergency management performance. Practically, organizations can improve emergency management performance by establishing and sustaining knowledge sharing and integration as an important organizational and procedural mechanism for reducing the complexity and uncertainty of emergency tasks. A number of moderating and control variables that we also considered in the research model are not discussed in this paper, due to space constraint.

RESEARCH APPROACHES

The research is built on the foundational and field experience that the researchers have accumulated over the last few years, using a systematic five-stage approach. The research setting for this study is the Miami-Dade County Emergency Operations Center (EOC). The first stage, conceptual development, involves selecting and conceptualizing the key constructs to be included in the research model; specific activities include reviewing the relevant literature, interviewing emergency managers, and creating and refining the research model. In the second stage, instruments for measuring the research constructs are developed, and the specific activities include identifying existing measures from the literature, developing new measures, interviewing emergency managers, sorting

Proceedings of the 5th International ISCRAM Conference – Washington, DC, USA, May 2008
F. Fiedrich and B. Van de Walle, eds.

90

procedures to refine the initial pool of measures, pilot tests with emergency managers, and finalizing the instruments. In the third stage, survey data is collected from EOC participants, with the endorsement from EOC leaders. In the forth stage, measurement validation and model testing will be conducted using the survey data. In the final stage, dissertations and academic research papers will be produced, and executive summaries of research findings will be created and sent to study participants.

RESEARCH CHALLENGES AND FUTURE PLANS

There are a number of challenges that we face in conducting studies in the context of emergency management and knowledge management. First, the complex and dynamic nature of emergency management tasks make it difficult to compare the tasks involved in different emergency situations. Many factors associated with a particular task are difficult to capture and often cannot be effectively controlled by the researchers. Second, emergency management tasks involve many diverse organizations across different levels and locations. Participants from different organizations are often temporarily assigned to a particular emergency situation. Therefore, it is difficult to identify and access relevant participants on a regular basis. Third, many of the EOC participants for a particular incident may be "first time" entrants; so even if they possess extensive knowledge and expertise in the organizations they represent (such as water management, electric utility, phone services, etc.), they may not be familiar with the particular emergency response tasks at the EOC. Fourth, even when relevant participants can be identified, it is difficult to get a high response rate for survey data collection.

In order to overcome these challenges, an alternative infrastructure to support this research is needed, which will allow researchers to have some controls of the emergency tasks, can identify and access appropriate participants, can ensure that participants have relevant knowledge and experience, and can allow a more systematic and efficient collection of sufficient and quality data.

The Project Ensayo Virtual EOC (vEOC) (Becerra-Fernandez and Prietula, 2006; Becerra-Fernandez et al., 2007) provides an ideal opportunity and environment for developing a research agenda like the one described here. The Ensayo vEOC project is a large, multidisciplinary effort that is focused on building a virtual computational infrastructure that simulates the various functions and processes of an emergency management event. It provides an ideal environment where we can conduct experimental studies in which the vEOC test-bed will enable us to control and manipulate the independent (levels of task complexity and uncertainty) and mediating variables (knowledge sharing purposes, type of knowledge integration, mechanisms of knowledge sharing), and capture the outcome dependent variables (task effectiveness and task efficiency). The ability to control and manipulate the independent and mediating variables will enable us to increase the validity and reliability of the various measurements. In addition, the vEOC will enable us to overcome the challenges related to survey and disaster management studies as we discussed above. More specifically, the controlled experimental environments will enable us to (1) compare the tasks involved in different emergency situations; (2) control the types and backgrounds of participants involved in EOC tasks; (3) provide training mechanisms to those who are "first time" participants to a particular emergency situation; and (4) eliminate the difficulty of getting high response rate to surveys.

ACKNOWLEDGEMENT

REFERENCES

1. Becerra-Fernandez, I. Prietula, M., Madey, G., Rodriguez, D., Valerdi, R., Wright, T. Design and Development of a Virtual Emergency Operations Center for Disaster Management Research, Training, and Discovery. *Proceedings of the 41st HICSS*, January 2008, Hawaii.

2. Becerra-Fernandez, I. Prietula, M., Madey, G., Rodriguez, D. (2007), "Project Ensayo: a Virtual Emergency Operations Center for Disaster Management Research, Training, and Discovery." *Proceedings of the First International Conference on Global Defense and Business Continuity*, San Jose, CA.

Proceedings of the 5th International ISCRAM Conference – Washington, DC, USA, May 2008
F. Fiedrich and B. Van de Walle, eds.

91

3. Campbell, D. J. (1988). Task Complexity: A Review and Analysis. *Academy of Management. The Academy of Management Review,* 13, 1, 40.

4. Comfort, L. K., Dunn, M., Johnson, D., Skertich, R., and Zagorecki, A. (2004). Coordination in Complex Systems: Increasing Efficiency in Disaster Mitigation and Response. *International Journal of Emergency Management, 2,* 1-2, 62-80.

5. Daft, R.L. and Lengel, R.H. (1986). Organizational Information Requirements, Media Richness and Structural Design. Management Science 32, 5, 554-571.

6. Daft, R.L., and Macintosh, N.B. (1981). A Tentative Exploration into the Amount and Equivocality of Information Processing in Organizational Work Units, *Administrative Science Quarterly,* 26, 207-224.

7. Galbraith, J. (1973). *Designing Complex Organizations.* Reading, MA: Addison-Wesley Publishing Co.

8. GAO, (2006). Hurricane Katrina: GAO's Preliminary Observations Regarding Preparedness, Response, and Recovery.

9. McGrath, R.G. (2001). Exploratory Learning, Innovative Capacity, and Managerial Oversight. *Academy of Management Journal*, 44, 1, 118–131.

10. March, J.G. (1991). Exploration and exploitation in organizational learning. *Organization Science*. 2: 71-87.

11. Perrow, C. (1984). *Normal Accidents: Living with high-risk technologies.* Princeton, New Jersey: Princeton University Press.

12. Sabherwal, R., and Becerra-Fernandez, I. (2005). Integrating Specific Knowledge: Insights From the Kennedy Space Center. *IEEE Transactions on Engineering Management,* 52, 3, 301.

13. Wood, R.E. (1986). Task Complexity: Definition of the Construct. *Organizational Behavior and Human Decision Processes*, 37, 1, 60-82.

Proceedings of the 5th International ISCRAM Conference – Washington, DC, USA, May 2008
F. Fiedrich and B. Van de Walle, eds.

92