Risk Reduction in Natural Disaster Management Through Information Systems:
A Literature Review and an IS Design Science Research Agenda

Guido Schryen, Information Systems Research, University of Regensburg, Regensburg, Germany

Felix Wex, Information Systems Research, University of Freiburg, Freiburg, Germany

ABSTRACT

Natural disasters, including earthquakes, Tsunamis, floods, hurricanes, and volcanic eruptions, have caused tremendous harm and continue to threaten millions of humans and various infrastructure capabilities each year. In their efforts to take countermeasures against the threats posed by future natural disasters, the United Nations formulated the "Hyogo Framework for Action", which aims at assessing and reducing risk. This framework and a global review of disaster reduction initiatives of the United Nations acknowledge the need for information systems research contributions in addressing major challenges of natural disaster management. In this paper, the authors provide a review of the literature with regard to how information systems research has addressed risk assessment and reduction in natural disaster management. Based on the review the authors identify research gaps that are centered around the need for acquiring general knowledge on how to design IS artifacts for risk assessment and reduction. In order to close these gaps in further research, the authors develop a research agenda that follows the IS design science paradigm.

Keywords: Hyogo Framework, IS Design Science, Literature Review, Natural Disaster Management, Risk Reduction

INTRODUCTION

Natural disasters, including earthquakes, Tsunamis, floods, hurricanes, and volcanic eruptions, have caused tremendous harm and continue to threaten millions of humans and various infrastructure capabilities each year. For example, according to the World Disaster Report of the International Federation of Red Cross and Red Crescent Societies (IFRC, 2010), the megathrust earthquake centered near Sumatra on December 26, 2004, generated a tsunami that resulted in more than 220,000 deaths and caused total damages amounting to 9.2 billion US$, the tropical cyclone Nargis on May 2, 2008, lead to almost 140,000 deaths and 4 billion damages,

and the Haiti earthquake on January 12, 2010 caused more than 220,000 deaths. Overall, the estimated number of people killed and the estimated damage caused by natural disasters amounted to almost 1 million and 1,000 billion $US, respectively, over the period 2000-2009. These statistics do not appropriately reflect the millions of people whose lives were indirectly disrupted by the economic impact of natural disasters. Their ability to raise a modest income is reduced and the prospect of escaping poverty is postponed (UN/ISDR, 2004a). Unfortunately, the trend during the last three decades shows an increase in the number of both natural disasters and affected populations (UN/ISDR, 2004a; p. 3).

In their efforts to take countermeasures against the threats posed by future natural disasters, the United Nations adopted "Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action" (UN/ISDR, 1994) by providing guidance on reducing disaster risk and the impacts of disasters. The review of progress made in implementing the Yokohama Strategy (UN/ISDR, 2004b) led to the formulation of the "Hyogo Framework for Action" (HFA) for the decade 2005-2015 (UN/ISDR, 2005), which identifies three strategic goals for the coming years in ensuring more systematic action to address disaster risks in the context of sustainable development and in building resilience: (a) The integration of disaster risk reduction into sustainable development policies and planning. (b) The development and strengthening of institutions, mechanisms and capacities to build resilience to hazards. (c) The systematic incorporation of risk reduction approaches into the implementation of emergency preparedness, response and recovery programmes.

In order to operationalize the strategic goals of the HFA and to strive for "risk reduction", the HFA also contains key activities required, which indicate the multidisciplinary nature of future challenges in NDM. For example, the creation and deployment of national institutional and legislative frameworks requires research activities in the political science, legal studies, cultural studies and sociology; the assessment of existing human resource capacities for disaster risk reduction and the allocation of resources for the development and the implementation of disaster risk management policies calls for research activities in the organization and management sciences; also the need for facilities to record, analyze, summarize and disseminate statistical information on disaster occurrence, impacts and losses, the maintenance of information systems as part of early warning systems, and the promotion of the use of information and communication technologies and related services to support the dissemination of information to citizens clearly reveals that information systems research (ISR) is among the scientific disciplines that can substantially contribute to reducing risk.

The need for ISR contributions in addressing major challenges of NDM is also acknowledged in a global review of disaster reduction initiatives of the UN (UN/ISDR, 2004a). The report concludes that the innovative use of information, technology and applied research in support of comprehensive disaster risk management is central to strategic areas and that greater public use of information systems can lead to more access to risk management information tailored to the needs of specific users.

While the relevance of information systems (research) for NDM has been acknowledged and we identified more than 70 academic publications in the NDM field, we are not aware of any survey that reviews the literature with regard to how ISR has addressed risk reduction in NDM. We argue that such a review is particularly useful in two regards: First, it shows how well the strategic goals as formulated in the HFA by the UN/ISDR have been supported. The results provide guidance for post HFA activities as already being planned in the "Post-2015 Framework for Disaster Risk Reduction" (UN/ISDR, 2013). Second, the review allows for identifying research gaps and suggesting future research paths where both the disaster management and the IS communities can jointly help close the gaps. We provide such a joint research agenda that might help bridge the gap between the IS

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