Information Technology in Disaster Risk Reduction

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1 Introduction: IT in Disaster Risk Reduction

It has been a decade since Japan had a catastrophe, the Great East Japan Earthquake and Tsunami on 11 March 2011. It caused severe damage to the northern coast of the main island of Japan and more than fifteen thousand eight hundred people died according to National Police Agency (2021). The disaster caused more global sustainable problems due to the nuclear power station incidents in Fukushima as in Kushida (2015).

Among the issues raised throughout the support for disaster response, there was no information system available in Japan at that time for immediate use in emergency response. For example, what was needed urgently a few weeks later than the catastrophe, was an information system for shelter management such that distribution of goods to shelters would be performed timely as reported in Murayama (2014). Eventually some industrial volunteers managed to implement such a system based on Sahana (Currión et al., 2007; Li et al., 2013), an information sharing system for humanitarian assistance at disaster developed originally by programmers in Sri Lanka as a free and open-source software just after the 2004 Indian Ocean earthquake and tsunami. However, a lot of customization was required and when the system was ready after one and a half months, it was too late

for practical use as victims were about to move to temporary housing from the shelters.

The research domain of information technology in disaster risk reduction is relatively new although disaster issues have been researched so long. Three prior special issues of Information Systems Frontiers have looked at this aspect. The pioneer issue edited by Janssen et al. (2010) looked into multi-agency disaster management and suggested a need to relate practice and theory by using human-centered approaches. Beydoun et al. (2018) followed this course with semantic technologies, and further analysis of related organizational theories, interoperability and IS readiness issues in disaster management. Ghosh et al. (2018) presented the use of social media content in disaster situations. Compared to those past special issues, this issue includes relatively more practical issues looking at human aspects as we introduce them in the next section.

Regarding information technology in disaster risk reduction for natural disasters, researchers in disaster science have looked into the environmental mechanisms and risks (e.g. Imamura et al., 2006; Bernard and Robinson, 2009). They have used information technologies available for their work. On the other hand, researchers from IT have been involved in disaster management since 1970s. Turoff (2002) and Van de Walle et al. (2009) presented the interdisciplinary nature of the research domain of information systems for emergency management. They set up a community, ISCRAM (Information System for Crisis Response and Management) for this area of research in 2004 and have held annual conferences including practitioners.

By taking similar perspectives, the International Federation for Information Processing (IFIP) has set up a domain committee and a working group on IT in Disaster Risk Reduction (ITDRR) to promote this exciting area of research and development. IFIP has held its annual workshop and conferences since 2016. In this special issue, several papers are from these conferences.

Due to the recent environmental changes, including global warming, we are facing an unexpected number of natural disasters and crises as well as their related consequences.

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Moreover, the recent global pandemic by COVID19 has brought us a great concern on how we communicate with each other in our societies. Remote meetings and events are more popular ever than before as the new normal, showing how information technologies could be of use at disaster.

We are also facing another era of Industrial Revolution: information technologies including artificial intelligence (AI) and social media are popular and used in daily life. Yet, they are not used fully in relief activities and in response to disasters. International differences in IT literacy as well as in IT equity might be among the reasons for this lack of use. In this special issue, these issues are explored as well from the viewpoint of the Sustainable Development Goals (SDGs) of the United Nations (UN). UN set up seventeen SDGs towards 2030 described in the 2030 Agenda for Sustainable Development according to United Nations (2015). Those goals include ending poverty with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection. Disaster risk reduction has been categorized in Goal 11, “Make cities inclusive, safe, resilient and sustainable,” on the other hand, disaster may effect all the SDGs, so that it should be looked at with wider viewpoints. Indeed, IT in disaster risk reduction cannot not be resolved only from the technological viewpoint. What we need presumably is to get together with researchers from diverse research domains such as social science. This is one of the conclusions from a workshop on IT in disaster risk reduction which was organized at the World Summit on the Information Society (WSIS) Forum 2021 as in ITU (2021).

The issues in IT in disaster risk reduction are of a multi-disciplinary nature and include various aspects of research areas such as information systems; IT; natural disaster sciences such as meteorology, social media, risk management, education, psychology and economics; and practical and strategic issues such as disaster management and policy making.

The aim of this special issue is to promote this multi-disciplinary area of research and development, and to encourage researchers and practitioners who work on information technologies to look into disaster issues including disaster management and disaster science as promising applications.

2 The Special Issue

We have selected nine papers for the present special issue and four more papers for the general issue after a thorough reviewing process from twenty submitted to the call and a multitude more that were submitted to the workshops. The special issue includes five papers whose earlier versions were presented at ITDRR conferences; these papers contain

significant extensions based on the feedback received at the conferences.

The accepted papers fall into five topics, viz. (1) human behavior at disaster, (2) use of social media for disaster management, (3) situation awareness at disaster, (4) inclusive support at disaster, and (5) 3C model. Situation awareness has been researched for long in ergonomics originally on aviation for aerial warfare, e.g. Endsley (1988). It has been applied to disaster management and became one of the major issues, e.g. Harrauld and Jefferson (2007) and many others such as Johnson et al (2011) and Sophronides et al (2017). The 3C model is from the groupware research domain, which looks at collaboration in terms of communication, coordination and cooperation, e.g. Fuks et al. (2008).

2.1 Human Behavior in Disasters

Two papers look into human behavior. The paper by Young and Aguirre (2021), entitled “PrioritEvac: An Agent-Based Model (ABM) For Examining Social Factors of Building Fire Evacuation,” describes an agent-based model with social dimensions of fire evacuation and responses to fire and smoke as well as simulation results for the station nightclub fire. It demonstrates that human behavior should be taken into consideration in such models.

The paper by Mirbabaie et al. (2021) entitled “Digital Nudging in Social Media Disaster Communication” investigates the possibility of the use of nudging, a form of behavior adjustment in social media so that emergency management agencies can make use of social media for information sharing with public. Literature survey and qualitative analysis with social media data were used. The paper could be categorized in the second group, the use of social media as well.

2.2 Use of Social Media for Disaster Management

Four papers presented the work using social media. The paper by Uchida et al. (2021), entitled “Development and Implementation of an ICT-based Disaster Prevention and Mitigation Education Program for the Young Generation” introduces an education program for young people to raise awareness of disaster prevention and mitigation making use of social media. The program consists of workshops for town watching and group discussion using DITS/DIMS (disaster information tweeting and mapping system).

The paper by Arapostathis (2021), entitled “A methodology for automatic acquisition of flood-event management information from social media: The flood in Messinia, South Greece, 2016” applies machine learning to classify Twitter content and glocalization methods to support decision making by professional responders. The research aims at providing real-time information from analyzed tweet and

the paper provides improvements to post-hoc analyses and after-action reports, which are used for the next round of emergency response planning and preparedness planning.

The paper by Mendon et al. (2021) entitled “A hybrid approach of machine learning and lexicons to sentiment analysis: Enhanced insights from Twitter data of natural disasters” utilizes machine learning algorithms revolve around unsupervised approach and lexicon-based approach to produce a framework for sentiment analysis on Twitter on natural disasters, Kerala floods in 2018.

The paper by Abouzeid et al. (2021) entitled “Learning Automata-based Misinformation Mitigation via Hawkes Processes” proposes a method to mitigate the effect of misinformation based on the learning of social media single user models, using decentralized Learning Automata (LA) to control Multivariate Hawkes Processes (MHP).

2.3 Situation Awareness at Disaster

Four papers examine situation awareness. The paper by Fromm et al. (2021), entitled “Social Media Data in an Augmented Reality System for Situation Awareness Support in Emergency Control Rooms” proposes how an Augmented Reality with the information from social media such as twitter could be of use for situation awareness in emergency control rooms.

The paper by Tanzi and Bertolino (2021) entitled “Autonomous Systems for Rescue Missions: design, architecture and configuration validation” reports on an autonomous system, ArcTurius, a rover whose primary objective is the precise location of survivors upon earthquakes. The system was validated in terms of design through simulation and formal verification. Although the authors does not mention situation awareness explicitly, the work presented is used to support for it.

The paper by Horita et al. (2021) entitled “Exploring the use of IoT data for heightened situational awareness in centralized monitoring control rooms” presents an qualitative case study within a centralized monitoring control room of a Brazilian early-warning centre with IoT sensor data from local places for situation awareness of local conditions by the qualified experts in the central control room operators.

The paper by Fujita and Hatayama (2021) entitled “Estimation Method for Roof-damaged Buildings from Aero-Photo Images during Earthquakes using Deep Learning” presents the development of a system for the estimation of damages in buildings after an earthquake, based on deep learning applied to aero photos with the location information by Geographic Information System (GIS) so that the Japanese government can issuing damage certificates more efficiently. Although the authors does not mention situation

awareness explicitly, the work presented is used to support for it.

2.4 Inclusive Support at Disaster

Two paper look into the inclusive aspects at disaster. The paper by Sasaki and Kitsuya (2021), entitled “Development and Evaluation of Regional Information Sharing System (RISS) for Disaster Risk Reduction” reports a use of Regional Information Sharing System (RISS) to provide the citizens with the information for daily life as well as the one for disaster risk reduction in case of emergency. The system was provided for inclusive support so that those such as the elderly without smartphone could make use of it as well. The paper presents the results from field tests.

The paper by Gjørøster et al. (2021) entitled “Universal Design of ICT for Emergency Management from Stakeholders’ Perspective -A Systematic Literature Review” reports the current state of inclusive aspects of ICT for emergency management based on a systematic literature survey on universal design, ICT and emergency management between 2008 to 2020 using predefined frameworks.

2.5 3C Model

One paper is related to the 3C model in this special issue. The model could be looked at more for disaster management since collaboration is an important aspect for disaster response and management.

The paper by Simona et al. (2021), entitled “A Scoping Review on Agency Collaboration in Emergency Management Based on the 3C Model” analyses the technological support to collaboration services in emergency management by literature review based on the 3C Model.

The paper on situation awareness by Horita et al. (2021) investigated collaboration in the control room operators.

3 Future Research

Disaster risk reduction is a promising research and practical domain for information technologies. We have introduced a small number of the examples in this special issue. What is exciting about this research domain is that the research results may well be connected to humanitarian aid. We hope that many of the readers would start thinking what contributions they could make.

There are many open issues that are yet to be tackled. We highlight a few of them.

For situation awareness (SA), team SA is suggested by Endsley (1995), which would be more applicable to emergency response and management compared to individual SA. Endsley and Jones (2001) suggest inter-team SA which

would be required in disaster response with stakeholders with different perspectives and cultures. Kanno et al. (2013) try and incorporate mutual belief to team SA.

Trust issues are another aspect to be researched in disaster management. Murayama et al. (2013) present the needs of trust for disaster response from their experience of IT support for disaster response at the Great East Japan Earthquake and Tsunami.

Social science approaches are applied in Disaster Risk Reduction, such as the use of qualitative research. White et al. (2009) suggested the use of social media for emergency management and Hiltz et al (2014) conducted interview with emergency managers on the use of social media.

There are many more issues we can expect in this research domain such as the use of 3C model for collaboration in disaster response and management, as well as inclusive issues such as usability and situational disability. For instance, inclusive issues (Malteser International, 2015) and cyber security issues are equally important for disaster response and resilience. We expect more papers may well be coming from the security and privacy domain in future. Security incidents are disasters, indeed and there would be more opportunity to apply disaster response and management to security as well as to look into the security and privacy aspects in disaster management.

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