Towards Central Repository Design for Domain of Interlocking Institutional Worlds: Successful Collaboration Starts with a Sharing Platform

Mohd Ismawira Mohd Ismail[1], Nor Hidayati Zakaria[1], Mohammad Nazir Ahmad[2] and Kamarul Faizal Hashim[3]

[1]*Universiti Teknologi Malaysia, {wira@i-erat.com, hidayati@utm.my}*
[2]*Institute of IR4.0,Universiti Kebangsaan Malaysia, {mnazir@ukm.edu.my}*
[3]*University of Dubai, {kbinhashim@ud.ac.ae}*

ABSTRACT

Creating and organizing disaster knowledge into a common platform from various agencies and sources is vital to the enhancement of disaster management efforts. Prominent leading disaster relief organizations including the European Union, Federal Emergency Management Agency, United Nation, World Health Organization (WHO), National Disaster Management Agency, and National Disaster Management Agency (NADMA) have acknowledged integrated effort as a fundamental element to address disaster. However, despite the increasing data availability, challenges in terms of data interoperability and incompatible data still persist. This paper highlights the importance of a Central Repository (CR) design that supports knowledge and best practices in sharing in disaster management strategies, and discusses key lessons learned from 22 countries in their effort to improve data collection, interoperability, and sharing capabilities. Therefore, through this paper, we hope to fill the gap by aiming at increasing the effectiveness of interlocking inter-agency's institutional worlds which lead to information and knowledge sharing.

Keywords: Central repository design, Interlocking Institutional Worlds, Knowledge sharing, Flood management.

I   INTRODUCTION

Interlocking Institutional Worlds (IWs) are collections of interlocked organizations interacting together in a domain. These organizations interact and exchange information to achieve a common objective. Often these organizations are made up of many players from different backgrounds. Hence the need of standard and common terminology must be established to avoid misunderstanding. Some of the IWs domains include the Olympics, the semantic web, Postal codes (Colomb R. M., 2013; Colomb & Ahmad, 2007) and flood management (Khantong, 2018; Khantong & Ahmad, 2020). Disaster management falls into IWs domain (Khantong & Ahmad, 2020). The importance of an integrated knowledge sharing effort in the disaster management domain is vital, and is addressed by prominent leading disaster relief organizations including the European Union (EU), Federal Emergency Management Agency (FEMA), United Nation (UN) and National Disaster Management Agency (NADMA), who have acknowledged integrated effort as one of the fundamental elements to address disaster.

Studies in disaster management have emphasized the need for an efficient knowledge sharing platform, as brought up in the Tsunami event. World Health Organization (WHO) has determined the need for new strategies and approaches to leverage on the magnitude of data resources available, which have the potential to improve disaster management. But it also has complexities and challenges. Data interoperability is a big challenge that arises from incompatible data standards and nomenclatures used in different disciplines. The European Union reported that various methodologies exist for disaster loss data collection in Europe. The available loss databases vary between states in their level of completeness and detail. Systems created vary in their purpose. This introduce heterogeneities leading to another main challenge to ensure the availability and accessibility of accurate and reliable disaster risk information when required.

To date, there are no proper standards or guidelines on how this shared knowledge should be captured, organized and shared. In Malaysia, the country has NADMA to lead the new disaster management structure. NADMA has identified overcoming information challenges as an important joint task force mission, and carries the belief that sharing of information is critical in disaster management as no single entity (Government agencies, NGO, international organization) can be the source of all required information.

This paper highlights that, despite increasing data availability from a wide range of sources that unlocks unprecedented potentials for disaster risk reduction,

data sharing remains a challenge. Although the problem has been addressed by several initiatives, the following challenge still remains: to make online data integration a routine and making data sharing a practice. This has moot for the idea for an alternative central repository (CR) design to address IWs domain knowledge sharing requirements.

II CR FOR ENABLING KNOWLEDGE SHARING IN THE DOMAIN OF IWS

Knowledge sharing is crucial in disaster management efforts. The disaster domain is made up of many players from different backgrounds. IT has been relied upon by these players in modern society as a digital technology to capture, create, organize and distribute knowledge. The systems belonging to the players combined, allow for new discovery of unsuspected patterns and hidden relations allowing holistic understanding through interdisciplinary integration from data across relevant disciplines. But, data interoperability is a big challenge that arises from incompatible data standards and nomenclatures used in different disciplines. There are no proper standards on how this knowledge sharing should be captured, organized and shared in which a new design for CR to support IWs domain can fill the gap.

III CONFRONTING THE CHALLENGES OF DISASTER MANAGEMENT

Natural disasters are a worldwide issue. They cause catastrophic losses. Many countries produce their disaster management programs to reduce disaster impact with the objective to potentially manage disaster throughout the disaster lifecycle phase of mitigation, preparedness, response and recovery. Managing risk is often referred to the reducing of impact, such as reducing loss of life, loss of assets and property damage. Managing vulnerability involves various social and economic issues regarding the capability of a human community to cope with the disaster event. Many countries have relied upon technologies including informatics to manage disasters. Learning from previous events and having a common platform for knowledge sharing is considered crucial for the domain to capture, organize and share knowledge as part of disaster management efforts.

A. Availability of Reliable data

The availability of reliable data has been a major constraint in the disaster domain. Not that data is unavailable, but the nature of the domain requires inter agency collaboration. Where each agency holds their own data, data scarcity happens. A systematic storage of data associated to disaster events has been a sketchy effort at best in developed countries, and at infant stages in developing countries. Data

management has the potential to contribute towards the betterment of the disaster domain. It eliminates confusion and unfamiliarity during disasters. For instance, technology such as big data analytics allows for early prediction, while geospatial technology allows for better understanding at site. One can imagine the chaos if the front lines were entirely unfamiliar with the disaster site. However, no amount of technology sophistication can be optimized effectively without human intervention. It involves issues of training, coordination and understanding between players, willingness to share data, resource sharing and support from the top. These can be agreed as critical factors that need to be embedded for technologies to be effective to support the disaster domain (National Research Council, 2007; Berg & Phillips, 2017). Hence it is important to understand the requirements in data sharing for this kind of domain.

B. The Information Sharing Concept and Interoperability

Disasters vary widely from small to catastrophic. Understanding this fact allows us to accept that, while experts can identify roles of first responders, these roles are not always fulfilled on each incident that occurs. Solving the interoperability problem is not just a technical issue. In many cases, spending on technical solutions fails to meet the needs of end users. It needs understanding of the domain, navigating human relationships and trust, as it is made of people from different jurisdictions, agencies and disciplines (Contestabile, 2011). There is also a general consensus that the impact of disasters is also determined by the victims' unequal exposure to risks reported by United Nations Office for Disaster Risk Reduction (UNISDR). To address complex interactions between natural hazards and human vulnerabilities, requires adaptive strategy (Mizutori & Guha-Sapir, 2018). The UNISDR also reported gaps in economic data losses, where only 37% data was captured throughout the 1998-2017 period. Moreover, 63% of the direct costs of majority of the disasters were unknown or not well captured. Overcoming information challenges is vital, as sharing of information is critical in disaster management, as no single entity (Government agencies, NGO, international organization) can be the source of all required information. As mentioned above, solving the interoperability problem is not just a technical issue. Too often organizations come to realize that the solution invested on does not meet the needs of end users. Solving the interoperability challenge involves navigating human relationships and issues of trust, and this is something that must be approached at first, especially in a domain like IWS,

as the lack of this will impede information sharing. Recognizing these challenges, a new central repository design must be approached sequentially from a people, process and technology standpoint and work through a process whereby they can understand each other's need for information, and trust can be developed between the parties.

C. Country Efforts to Improve Data Collection and Sharing Capabilities

Disaster risk is increasing in line with population growth in exposed areas. This has also contributed towards the increased value of losses. Yet many countries have difficulties in managing disasters and estimating future losses, as the domain is not well understood, and is hampered by low quality of historical data. Here, we have conducted a study on the efforts taken by 22 countries to improve data quality and encourage sharing capabilities. We limit the study based on the country loss database (DB), repository and integrated risk management platform, as it is related to our study of designing a CR for interlocking domain related to disasters.

Table 1. Country Efforts to Improve Data Collection, Interoperability and Sharing Capabilities

Country	DB/CR for Integrated Risk Manage-ment Platform	Information	Source
Austria	Yes	Maintained and kept updating its disaster CR. Collaboration between Federal agency for torrent and avalanches control.	European Commission Joint Research Centre (ECJRC)
Belgium	Yes	Has databases with partial loss recordings	ECJRC
Bulgaria	Establishing	In the process of establishing its loss database.	ECJRC
Croatia	No	Regularly updates its disaster databases	ECJRC
France	Yes	Public has partial access.	ECJRC
Germany	Yes	Public has partial access.	ECJRC
Greece	Yes	Publicly accessible national disaster databases.	ECJRC
Italy	Yes	Publicly accessible national disaster databases.	ECJRC
Netherland	No	Nil	ECJRC
Portugal	Yes	Regularly updates its disaster databases.	ECJRC
Romania	Yes	Regularly updates its disaster databases.	ECJRC
Slovenia	Yes	Regularly updates its disaster databases	ECJRC
Spain	Yes	Regularly updates its disaster databases.	ECJRC
Sweden	Yes	Publicly accessible national disaster databases.	ECJRC
United Kingdom	No	Nil	ECJRC
Bahamas	Yes	Only on GIS based data	United Nation Economic Commission for Latin America and the Caribbean (ECLAC)
Belize	No	Develop a Disaster Preparedness and Response Act.	ECLAC
Dominican Republic	No	Established National System for Prevention, Mitigation and Disasters Response	ECLAC
Haiti	No	No institutions that promote a strategy for science and technology	ECLAC
Jamaica	No	No mandate explicitly requiring disaster risk analysis.	ECLAC
Sri Lanka	Yes	Established the Inspiring Sri Lankan Renewal and Development (ISLAND) portal for disaster knowledge sharing and response.	University of Hudders-field Repository
Malaysia	No	Established Directive No 20.	Centre for Excellence in Disaster Manage-ment and Humani-tarian Assistance

Table 1 above presents and analyses how countries cope with the demand and challenges of inter-organizational collaboration, information integration and sharing needs in the disaster domain. We realize that the methods and their execution varies between countries, even though the objective may be similar in terms of their level of completeness and detail. The IT systems used to support the activities also vary in purpose and complexity. Even though recording disaster events is important, there is still no internationally agreed method derived. Most countries may refer to the framework by United Nations but will alter it to their flavor. This is the reason some countries may reflect not having a central platform for loss database. For instance, the European Commission Joint Research Centre (Ríos Díaz & Marín Ferrer, 2018) reported that 3 of 15 participating member states do not have a loss database. We can also learn; disaster is an event involving many agencies needing to collaborate and share data. However, it is a complex domain. Most countries may opt to begin the initiatives for data sharing between a few groups or selected agencies with common relations and interest. Austria for example started its central collaboration and data sharing between Federal agency for torrent and avalanches control; Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. In Belgium, Germany, Italy and Spain, they started with partial loss recordings based on specific disasters limited to floods. Italy started rolling out with only two regions, Sicily and Umbria. While in Bahamas, only GIS related data was captured as a start.

IV DISCUSSION

The purpose of this paper is to discuss the fact that, despite increasing data availability from a wide range of sources, promising to unlock unprecedented opportunities for disaster risk reduction, data interoperability and a central platform for knowledge sharing remains a challenge due to a number of barriers. For one, interdisciplinary integration is obtained with the integration of data across relevant disciplines. This introduces incompatibility in data standards and nomenclatures used in different disciplines. Although the problem has been addressed by several initiatives, the following challenge still remains: to make online data integration a routine. This paper presents the need to look at an alternative approach towards a central repository design, to support domain needs where many players are expected to interoperate by sharing information. We bring the discussions as below:

A. Lack of guidelines and standards for inter-agency coordination

The disaster domain demands for interagency coordination. Coordination is difficult but vital in disasters. Based on Table 1, it can be seen that establishing a disaster repository has been a priority in many countries. However, the process of data collection, data storage and sharing data has no standards, and it lacks guidelines. IT systems supporting disaster data vary significantly not only between countries, but also among government agencies. Some use simple tables, federated databases and integrated systems linked to other databases such as cadastre or hazard database. This has prevented data from being shared and being aggregated for collaborative decision and action (Mozersky, et al., 2020). A good CR design supporting many players should consider standards. Below are some initiatives addressing this: (a) In US, the Federal Emergency Management Agency (FEMA) developed a data loss collection toolkit at the community level including detailed terminologies and uniform disaster situation reports (Manafi, Saraei, & Mostofi, 2018). (b) In Slovenia, the country established a methodology to assess and document data collection to ensure high quality data that is verified at local, regional and state levels. (c) Italy has developed standard forms for collecting flood loss data, which is done at the regional level, such as in Umbria.

B. The call for new strategies and new approaches by World Health Organization (WHO) and the US Department of Homeland Security (DHS)

There is a growing consensus on turning on information for wider view on disaster situations. "Getting better at responding" means getting prepared. One way to be prepared is to have information on disaster events and its determinants. WHO suggested that a preparedness system must ensure inputs such as data in relation to disasters including technical data and resource data, can be transformed into outputs to be used to improve effectiveness and capabilities. DHS recognizes that new efforts should be established to develop policies and guidelines that address sharing in all emergency phases, including defining the type of data that should be shared, roles and responsibilities of participating organizations, data quality requirements and interoperability requirements. For one, a CR design should be modelled to focus on domain requirements and business needs so as to be more adaptive to support coordination efforts.

C. Agreed Terminologies

Incompatibilities happen from many sources, and the lack of precise and agreed definitions is one of the main factors. A consensus must be reached between players involved. Engaging diverse stakeholders in a collaborative process is important but challenging (Sitas, et al., 2016). In the disaster domain, not having mutually agreed terminologies reflects towards poor communication, leading to delayed decisions or even unavailable services (Abbas, Norris, & Parry, 2018). Standard terminologies promote consistent data for strategic decision making and allow rapid retrieval of information. This leads to meaningful and actionable data, resulting in improved outcomes (Pandit, Debryune, O'Sullivan, & Lewis, 2020).

D. Information Sharing

Inter-organizational information sharing, and interoperability is an increasing area of interest in the disaster domain in particular. Studies have proposed the importance of information sharing in disasters, especially in large scale events, and how a lack of interoperability is a major impediment (Contestabile, 2011).

Based on Figure 1, the concept of inter-agency collaboration in disaster management has been toyed with in the 1970s. But, only in 1994 the United Nations declared the Yokohama Strategy focusing on collaboration. Since then, its successors, the Hyogo and the Sendai frameworks, continue improving the initiatives promoting cooperation, communication and effective decision making enabled by technologies. The current Sendai Framework promotes sharing and use of non-sensitive data and information to address common disaster risks. Information sharing is important in the disaster domain in order to improve information

delay, which has been said to have a direct impact on slow response, poor prioritization and uncertainties (Waring, Alison, Shortland, & Humann, 2020).
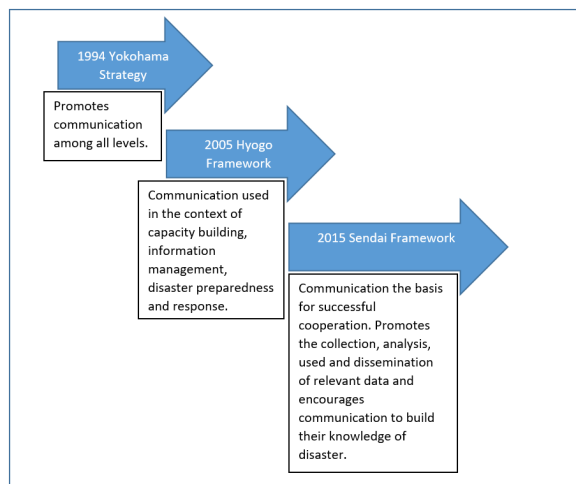

Figure 1: United Nation collaboration guideline

E. Sustainable Knowledge Platform

The need for a sustainable sharing platform is becoming more important as humans gain more understanding and find ways to manage disasters. The end goal is to create more disaster resilient societies and communities (Rehman, Sohaib, Asif, & Pradhanab, 2019). The National Research Council (NRC) reports that this can be achieved through a significant advancement in basic knowledge, and on deploying technology capabilities to utilize it. The knowledge from that can be turned into know-how actions (National Research Council, 1999; Kates, et al., 2001). Furthermore, with a sustainable platform it could contribute towards: ● Understanding of disaster trends through historical events ● Planning and formulating better disaster strategies ● Providing of standards and semantics for meaningful interoperability and unification ● Adaptive business changes ● Building and expansion of networks of experts

F. Low Visibility of Disaster Issues

The Centre for Research on the Epidemiology of Disasters (CRED) maintains the Emergency Events Database (EM-DAT). A low visibility of disaster issues can be overcome with a central inter-operation sharing platform. Despite all efforts, disaster knowledge appears fragmented. There is a gap that needs to be patched to improve collective decision making (Strzelecki, 2019). CRED highlighted that central platforms can improve rational decision making and assist in policy-maker priorities (CRED, 2019). In a report by WHO, it was found that several efforts leading to a central repository were made since 2006 (WHO, 2009). Information on disasters,

particularly related to health issues, was available and collected. However, the following observations were recorded: ● Fleeting and perishable – There was no single repository or category in the libraries (health libraries in particular) for this discipline. ● Different types of materials – There were several types and formats such as published and unpublished materials, photos, audio/video resources, maps and presentations. ● Information scarcity spread out in several places – No agency/institution seemed responsible for collecting and archiving disaster information. No method for collection was applied, and therefore it was not accessible to the domain (locally, regionally or nationally) ● Not always published – "Grey literature", including media reports provided a wealth of information on disasters and all their phases ● Data available only from those involved in operations of a particular emergency – It was thus personalized/institutionalized in different and varying styles and formats, and with tremendous turnover rates of staff, this added another factor for the fleeting of information.

V CONCLUSION

Until a standard guideline for inter-agency data sharing for disaster management is relatively accomplished and produced, it will most likely result in a poor understanding of the domain. The recording of disaster events is largely accepted and important, but no standards or agreed definitions exists, making national and global statistics incomparable and unreliable. Many countries face data scarcity, and to integrate them is difficult, as heterogeneities in terms of technology, people and processes exists. The ability and the speed at which data can be shared will determine how well an incident will be managed. Therefore, this paper offers an alternative view towards a CR design for inter-agency collaboration.

REFERENCES

Abbas, R., Norris, T., & Parry, D. (2018). Pinpointing What is Wrong With Cross-Agency Collaboration in Disaster Healthcare. Journal of the International Society for Telemedicine and EHealth, 1-10.

Azeroual, O., & Schöpfel, d. (2019). Quality Issues of CRIS Data: An Exploratory Investigation with Universities from Twelve Countries. MDPI, 1-18.

Bello, O. D., Khamis , M., Osorio, C., & Peralta , L. (2017). Mainstreaming disaster risk management strategies in development instruments . Santiago: United Nations publication .

Berg, S. V., & Phillips, M. (2017). Data Availability as a Key Tool for Regulating GovernmentOwned Water Utilities. Utilities Policy , 30-37.

Colomb, R. M. (2013). Representation of Action is a Primary Requirement in Ontologies for Interoperating Information Systems. IGI Global, 68-76.

Colomb, R. M., & Ahmad, M. (2007). Merging Ontologies Requires Interlocking Institutional Worlds. Applied Ontology, 1-12.

Contestabile, J. M. (2011). Concepts on Information Sharing and Interoperability. Johns Hopkins Applied Physics Lab, 1-16.

CRED. (2019). Natural Disasters 2019. Brussels: Centre for Research on the Epidemiology.

Groeve, T. D., Poljansek, K., Ehrlich, D., & Corbane, C. (2014). Disaster Loss Data Recording in EU Member States. Luxembourg: European Commission .

Kates, R. W., William C. , C., Corell, R., Hall, M., Jaeger, C., & James , I. (2001). Sustainability science. Science, 641-642.

Khantong, S. (2018). A Design of Domain Ontology to Support Flood Response Management and Sharing. Johor Bahru: Faculty of Computing, Universiti Teknologi Malaysia.

Khantong, S., & Ahmad, M. (2020). An Ontology for Sharing and Managing Information in Disaster Response: In Flood Response Usage Scenarios. Journal on Data Semantics, 39-52.

Majlis Keselamatan Negara. (2020). Retrieved from http://www.ump.edu.my/doc/arahan-mkn-no.20-semakan-semula-09_02_2013.pdf

Manafi, S., Saraei, M., & Mostofi, R. (2018). Evaluation of integrated management to reduce the crisis with approach to spatial data infrastructure. Journal of Fundamental and Applied Sciences, 554-570.

Mizutori, M., & Guha-Sapir, D. (2018). Economic losses, poverty and disasters 1998–2017. Geneva, Switzerland: UNISDR.

Mozersky, J., Walsh, H., Parsons, M., McIntosh, T., Baldwin, K., & DuBois, J. (2020). Are we ready to share qualitative research data? Knowledge and preparedness among qualitative researchers, IRB Members, and data repository curators. IASSIST quarterly.

National Research Council. (1999). Our Common Journey: A Transition Toward Sustainability. Washington DC: The National Academies Press.

National Research Council. (2007). Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management. Washington DC: The National Academies Press.

Pandit, H. J., Debryune, C., O'Sullivan, D., & Lewis, D. (2020). Standardisation, Data Interoperability, and GDPR. IGI Global, 119-225.

Pathirage, C., Amaratunga, D., Haigh, R., & Baldry, D. (2008). Lessons learned from Asian tsunami disaster: sharing knowledge. International Conference on Building Education and research (BEAR), (pp. 1051-1066). Sri Lanka.

Rehman, J., Sohaib, O., Asif, M., & Pradhanab, B. (2019). Applying systems thinking to flood disaster management for a sustainable development. International Journal of Disaster Risk Reduction, 101101.

Ríos Díaz, F., & Marín Ferrer, M. (2018). Loss Database Architecture for Disaster Risk Management. Luxembourg: Publication Office of the European Union. doi::10.2760/647488

Sitas, N., Belinda, R., Cundill, G., Prozesk, H., Nel, J., & Esler, K. (2016). Fostering collaboration for knowledge and action in disaster management in South Africa. Current Opinion in Environmental Sustainability, 94-102.

Strzelecki, A. (2019). Google Medical Update: Why Is the Search Engine Decreasing Visibility of Health and Medical Information Websites? International Journal of Environmental Research and Public Health, 1-13.

Waring, S., Alison, L., Shortland, N., & Humann , M. (2020). The role of information sharing on decision delay during multiteam disaster response. Cognition, Technology & Work, 263-279.

WHO. (2009). Workshop on Managing Disaster Health Information. Jakarta Indonesia: World Health Organization.