

**Exploring the Issues of Information and Communication Technology (ICT) Application in
Disaster Risk Management:
A Case Study of 2014 Major Flood Event in Kelantan**

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Abstract

Recent study has estimated that 60% of the Malaysian population reside near or along the coastline for their socio-economic. As the threats of natural disaster have grown in terms of intensity and frequency over the years due to climate change, the coastal population of Malaysia are at a higher risk of being affected in so many ways. To successfully mitigate inevitable disaster risks, information and communication systems play significant roles in increasing community preparedness, assisting response and recovery processes and building up capacity for prevention efforts. Although there has been an established information and communication system designed before to tackle the issues along with standard operating procedures, unfortunately the issues still persist. This paper aims to explore the underlying issues of information and communication technology (ICT) application in disaster risk management based on a real life scenario from the major flood event which hit Kelantan, Malaysia in 2014. Specifically, this study presents evidences using a qualitative analysis for indentifying and classifying ICT application issues related to disaster risk management, prior, during and post disaster-hit via a focus group discussion consisting of key stakeholders from the construction industry. The findings show that communication system failure, loss of data and weak coordination inter- and intra-agencies are amongst the dominant issues identified by the focus group. It is expected that the insights from this study would constitute formation of a more holistic and effective policies and guidelines to foster ICT applications in disaster risk reduction.

Keywords: Disaster Risk Management, ICT Application, Case Study, Focus Group Discussion

1. Introduction

Strategically located, Malaysia is blessed with 4,675 kilometers of coastline surrounding the country in which recent study has estimated as much as 60% of the Malaysian population reside near or along the coastline due to their socio-economic activities (WHO, 2007; NIDM, 2014). As the threats of natural disaster especially flood have grown in terms of intensity and frequency over the years due to climate change, the coastal population of Malaysia such as in the East Coast region are at a higher risk of being affected in so many ways. The 2014/2015 major flood event for example were considered as one of the worst hydrological disaster to ever hit Malaysia as economic losses suffered by the East Coast community was close to RM 2.9 billion, whereas RM 800 million had to be spent by the government for repairs and reconstruction of critical infrastructure such as schools, hospitals, roads and bridges (CIDB, 2016). Approximately 250,000 people were affected in Kelantan with as many as 2,374 permanent houses were completely destroyed and in need of total reconstruction (Md. Taha, 2015; Wan Yussof, 2015). Considering the significant economic losses suffered due to increasing frequency and intensity of major disaster events, it is fundamental to manage the disaster risks in such a way that negative impacts towards economic, social, environmental and infrastructure facets can be successfully reduced. Disaster risk management (DRM) has received much attention in recent years due to paradigm shift, from managing the disaster itself to managing the disaster risk instead (Yodmani, 2001) following strong advocacy from the notable institutions such as United Nations and various academic scholars.

One of the effective ways to successfully mitigate inevitable disaster risks is to utilize the potential of information and communication technology (ICT). Advancement of ICT over the years has opened up possibility of information management to become a change agent in disaster risk reduction which can have direct impact to community resilience (Subedi, 2010). ICT can play vital roles in increasing community preparedness, assisting response and recovery processes and building up capacity for prevention efforts. For example, remote sensing and geographic information system (GIS) are widely used all over the world for monitoring to provide early warnings (Wattegama, 2007) while telecommunication technologies such as mobile and wireless technologies are critical for rescue and response purposes during and post-disaster (Fajardo and Oppus, 2010; Rahman *et al.*, 2012). However, although the high potential of ICT application in reducing disaster risk were highlighted by various scholars for the past decade, employment of such system in Malaysia are believed to be moderate at best with only little success. For example, established ICT systems such as early warning systems, emergency alert to local community and standard operating procedures (SOP) such as Directive 20 designed to reduce disaster risks in Malaysia are found to be ineffective which has led to low level of stakeholder's preparedness and poor coordination of response and rescue efforts in the event of disaster. Inability of the current system to collect, disseminate and retain critical data and information has also led to ill-defined prevention measures.

Therefore, this study aims to answer the following research question: what are the underlying issues of ICT application in DRM among key stakeholder within construction industry in Kelantan? In specific, this study has two (2) main objectives which are: 1) to explore, synthesis and classify the major issues in ICT application in DRM based on a real-life scenario from the major flood event which hit Kelantan, Malaysia in 2014 from the perspective of key stakeholders within the construction industry; and 2) to develop and propose a three-dimensional (3D) conceptual model of ICT application in DRM in Malaysia with incorporation of sustainability elements. To achieve these objectives, focus group discussion (FGD) was conducted to identify the ICT application issues pertaining to DRM. Data synthesis and in-depth analysis reveal that (1) stakeholders' knowledge, awareness & preparedness; (2) accessibility & quality of information; and (3) data, database & server management are amongst the three most dominant issues identified by the focus group.

2. Literature Review

Disaster risk is defined as the potential of lives, livelihoods, health status, assets and services losses which transpire communities or societies in a future period of time (UNISDR, 2009). Three main components of disaster risks are vulnerability, exposure and weather & climate events (IPCC, 2012). Dynamic interaction between these three components forms risk factors which posed threats towards the economic, social, environmental, governance and structural (i.e. critical infrastructure) wellbeing of the communities, especially marginalized and vulnerable groups. In Malaysia, flood is by far the leading type of disaster exposure where annual average losses amounted for USD 1.49 billion with average number of affected population is approximately 20,000 persons per year (CRED, 2017). Although formation of hazard-specific legislation, policy and guidelines now incorporates DRM and land-use planning to minimize flood risk exposure, development occurring in floodplains for example continues to occur as a result of contemporary land-use planning and risk management processes (Smith and Petley, 2008; Wheater and Evans, 2009). Therefore, as disaster threats are certain, key stakeholders should direct their attention and efforts to reduce the flood risks via the implementation of risks mitigation measures to lessen the impacts.

Disaster management in Malaysia under jurisdiction of National Security Council (NSC) and parallel coordination between National Disaster Management Agency (NADMA), state and other federal government agencies generally adopt the four main phases of disaster management cycle (DMC) by FEMA (2010) as per **Figure 1**. Arrays of ICT applications in disaster risk reduction can be affiliated into the four phases of DMC (ESCAP, 2016). This cycle is universally adopted and practiced across the world population according to Altay and Green (2006) in the field of disaster management. Disaster management is a rigorous information and communication-based processes (Sagun, 2010) in which ICT plays a leading role as the key enablers for achieving effective disaster risk reduction (Wattegama, 2007). Advancement of ICTs over the years



Figure 1: Disaster Management Cycle in Malaysia, Adapted from FEMA (2010).

has promoted effective and efficient information management in disaster management (Subedi, 2010) especially in providing solutions in the four phases of the DMC (ESCAP, 2016). The application of ICT into DRM in Malaysia can be deemed as moderate with various systems being used throughout the nation, albeit with different level of success. For example, post-tsunami disaster in 2004, a National Tsunami Early Warning System was introduced, while communication technologies such as Fixed-Line Disaster Alert System, Government Integrated Radio Network and social media such as Facebook and Twitter are used to promote awareness and disseminate early warnings are being utilized (NIDM, 2014; CFE-DM, 2016). In addition, Flood Forecasting and Warning System are also used to send alerts via short messaging system (SMS) to government officers in-charge as well as real-time information of rainfall and river water which is published online via 'infobanjir' webpage (Khalid and Shafiai, 2015; Shah, Mustaffa and Yusof, 2017). However, ICT applications are subject to limited usage in managing emergency situations only, while performance of communication system and capability of information system to disseminate quality information have been unreliable (Meissner *et al.*, 2002; Subedi, 2010).

3. Methodology

The study was conducted in Kota Bharu, Kelantan for strategical reasons and access to high level of stakeholders' participation. Kelantan has 15,105km² of land coverage and as of 2014, the population estimate for Kelantan was 1.72 million (Department of Statistics Malaysia, 2017). Due to the severity of losses and damages that the state had to endure in 2014/2015 major flood, Kelantan was chosen as the location of this study. To gauge the perception of stakeholders on the ICT application issues, focus group discussion (FGD) method was chosen for this study. FGD is favored as opposed to individual interview or questionnaire survey as it permits in-depth investigation of the research topic with active communication and participation from research participants in order to generate data (Peek and Fothergill, 2010). A total number of 300 key stakeholders from construction industry varying from local authorities, government officials, engineers, developers, local businessmen, suppliers, contractors, manufacturers, academicians, health officials as well as local community representatives were invited to join and participate in the focus group discussion held in February 2015. The stakeholders were divided into five (5) main groups in accordance to five sustainability elements which are social, infrastructure, economic, environment and governance; identified relevant for this research focus. In each of the groups, a forum discussing issues related to flood management from the sustainability perspective consisting of social, infrastructure, economic, environment and governance themes were conducted. Details of sub-themes pertaining to each main theme can be observed in **Table 1** below.

Table 1: Categorization of Theme and Sub-Themes of ICT Application Issues According to Sustainability Elements.

Disaster Management Cycle (DMC)	Sustainability Elements				
	<i>Social</i>	<i>Infrastructure</i>	<i>Economic</i>	<i>Environment</i>	<i>Governance</i>
Prevention Preparedness Response Recovery	Health; Housing; Education; and Marginalized Community.	Roads/ Accessibility; Potable Water; Electricity/ Energy; and Waste Management.	Industry; Local Business; Agriculture, Livestock & Fisheries; and Volunteerism.	Biodiversity; Drainage; Land Use; and Delivery of Amenities & Data.	Disaster Risk Policy; New Development; Climate Change; and Finance.

The forum for each group lasted around one to two hours. Focus group interviews were transcribed, and points were noted down by a total number of forty (40) repertoires assigned for the whole project. Transcript contents were keyed-in into Microsoft Excel, analyzed, synthesized and classified via content analysis technique with specific focus on ICT application issues. Simple statistics is then applied to represent the re-occurrences distribution of individual concept and then relative theme; the results are visually presented using graphs and charts.

4. Findings

Discussion amongst the stakeholders revealed six major ICT application issues which then classified into five (5) sustainability elements: social, infrastructure, economic, environmental and governance. Findings are then presented in accordance to the four (4) phases of DMC. The six major issues in all those cycle phases are as per the following, keywords denoted in bracket () are used to visually represent the major issues in the radar graphs in the following section:

- i. Low level of knowledge, awareness and preparedness (Awareness/Preparedness);
- ii. Low accessibility and poor quality of information (Information);
- iii. Poor data, database and server management (Data/Database);
- iv. Low availability and effectiveness of early warning systems (Early Warning Systems);
- v. Communication System Failure (Communication); and
- vi. Poor Inter- and Intra-Agencies Coordination (Coordination).

4.1 Prevention

Across the FGD population, in respect to Prevention phase in the disaster management cycle, awareness/preparedness-based issues were indicated as the most dominant major issue, with 30 re-occurrences quoted by the participants. This was distantly followed by issues in data/database with 15 re-occurrences. Interestingly, communication-based issues only recorded 2 re-occurrences while coordination issues were deemed as irrelevant by the participants. The rest of the distribution can be seen in **Figure 2**. In addition, as shown in **Figure 3**, from thematic based standpoint, social theme is the most dominant theme as compared to other themes with 32% re-occurrences; followed by environment (28%) and governance (20%).

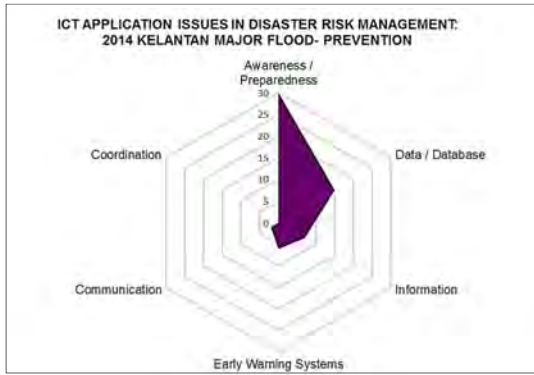


Figure 2: ICT Application Issues in Disaster Risk Management: Prevention.

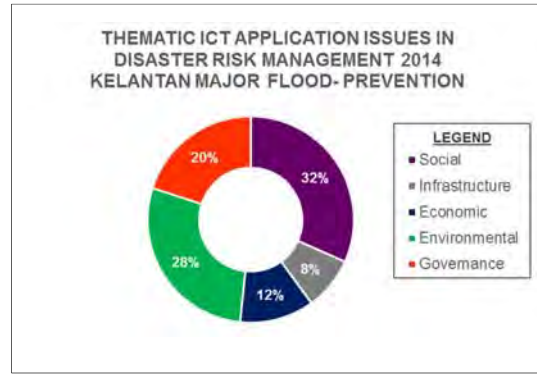


Figure 3: Thematic ICT Application Issues in Disaster Risk Management: Prevention.

4.2 Preparedness

In relation to preparedness phase in the disaster management cycle, the distribution of the re-occurrences throughout the population was fairly skewed as compared to the previous cycle phase. There are three major issues reported by the participants as significant which are information-based issues with 16 re-occurrences, awareness/preparedness-based issues with 14 re-occurrences and data/database related issues were third highest with 9 re-occurrences. The rest of the distribution can be observed in **Figure 4**. Additionally, thematic analysis and grouping of the major issues from the perspective of sustainability elements can also be seen in **Figure 5** where three stand-out themes were identified with environmental and social themes shared the same amount of re-occurrences distribution with 29%, followed by economic theme with 21% re-occurrences.

4.3 Response



Figure 4: ICT Application Issues in Disaster Risk Management: Preparedness.

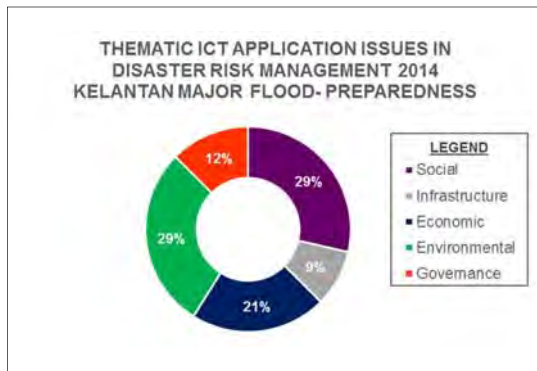


Figure 5: Thematic ICT Application Issues in Disaster Risk Management: Preparedness.

Moving on to the third phase of the disaster management cycle which is response, the distribution of the re-occurrences across the FGD population was more or less evenly distributed. Information related issues are ranked highest with 13 re-occurrences, while awareness/preparedness-based issues with 10 re-occurrences, closely followed by the rest of the major issues as shown in **Figure 6**. Furthermore, thematic based analysis conducted based on sustainability perspective revealed that environmental theme emerged as the highest ranked theme with 31% re-occurrences, followed by governance (22%) and social (21%) themes. This scenario is represented by **Figure 7**.



Figure 6: ICT Application Issues in Disaster Risk Management: Response.

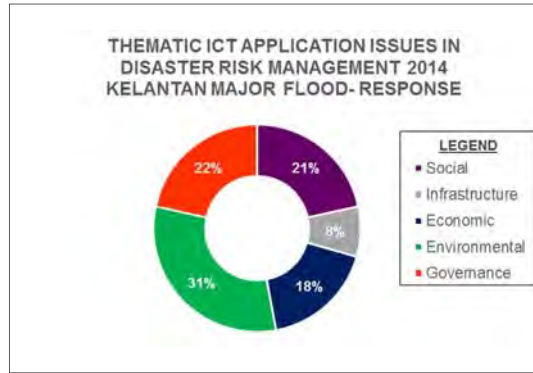


Figure 7: Thematic ICT Application Issues in Disaster Risk Management: Response.

4.4 Recovery

Lastly, in relation to the fourth phase of the disaster management cycle which is recovery, the distribution of re-occurrences were found to skew towards data/database related issues with 8 re-occurrences and awareness/preparedness-based issues with 7 re-occurrences throughout the population. The rest of the major issues distribution can be observed in **Figure 8** below. Also, it is interesting to note that total number of re-occurrences for this cycle phase are much less when compared to the previous cycle phases with only 26 counts while prevention phase had 60 counts and preparedness and prevention phases both had 56 and 51 counts. Similarly, thematic analysis and classification of major issues in accordance to sustainability phases were carried out and environmental theme emerged as the most dominant theme with 46% of the re-occurrences quoted by the participants; followed by governance theme with 31%. The rest of the distribution is shown in **Figure 9**.

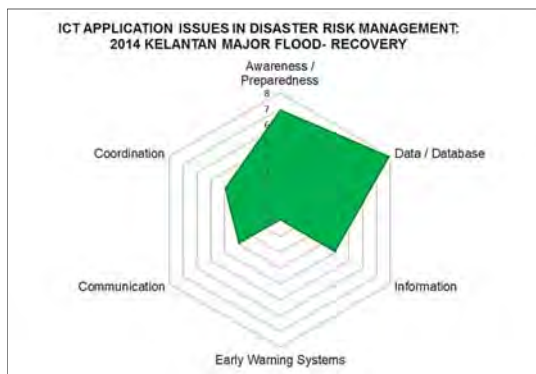


Figure 8: ICT Application Issues in Disaster Risk Management: Recovery

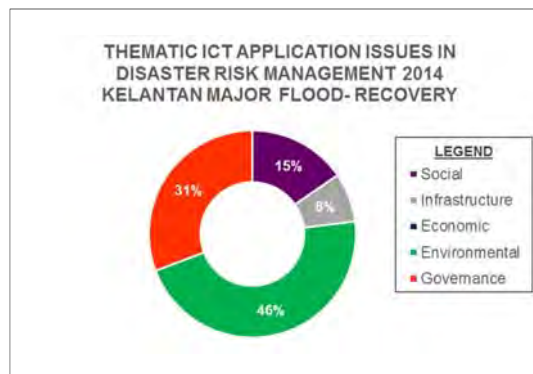


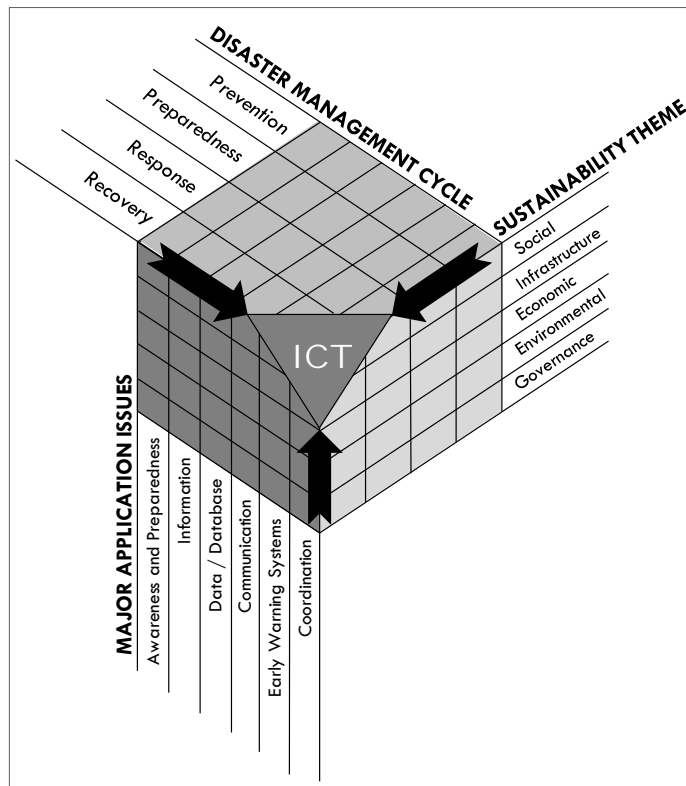
Figure 9: Thematic ICT Application Issues in Disaster Risk Management: Recovery.

5. Discussion

This research paper was established to explore, synthesis and classify the major issues of ICT application in DRM based on a real-life scenario from the perspective of key stakeholders within the construction industry. Based on the FGD findings, the application of ICT in DRM in the case of Kelantan flood can be concluded as limited and ineffective which has led to low level of preparedness amongst the stakeholders while response and recovery efforts were also poorly coordinated. Hence, the severity of impacts in terms of physical damages to buildings and profitable assets, displacement of local communities along with mortality losses were undesirably high. Multiple application issues were reported but the most interesting finding was that communication related issues were not considered as significant as initially presumed.

Similarly, the importance of early warning systems was not highlighted as highly as initially thought. Even though the participants acknowledged the low availability and effectiveness of current early warning systems in place, re-occurrences distribution of this type of issue across the entire FGD population was considered as insignificant with only a total number of 19 re-occurrences reported; the second lowest number after coordination related issues. However, the participants did recognize the importance of information and awareness/preparedness related issues in which both are closely-linked to each other. Both issues had a combined re-occurrences distribution of 101 counts, approximately 52.33% throughout the entire FGD population. Implementation of effective and high-quality information systems will be a great help to facilitate improvement on local community's knowledge, awareness and preparedness on related disaster risk in general.

Based on the above findings, a three-dimensional (3D) conceptual model of ICT application in DRM in Malaysia with incorporation of sustainability elements was herein developed. This model can be observed in **Figure 10**. The 3D model was developed by incorporating three components which are disaster management cycle (DMC), sustainability theme and major application issues. DMC phases were represented according to the cycle itself while sustainability theme (elements) were organized to reflect the domination of each theme in respect to ICT application, in which social theme is the most dominant theme. Major ICT application issues were also organized in accordance to their relative rankings, in which awareness/preparedness related issues is the most dominant item.



6. Conclusion

ICT have enormous untapped potential in assisting and protecting human population and living organisms in the event of natural or man-made disasters. Unfortunately, implementation of ICT application in the field of DRM especially in Malaysia has been rather largely ineffective. Understanding of ICT application issues are highly beneficial to formulate proactive policies, strategies and measures to improve the implementation ICT in the field of DRM. Building on the research findings and existing literatures on ICT application pertaining to DRM research field, this research paper has provided the platform for identification and classification of major application issues that impeded successful implementation of ICT in reducing disaster risks. Consideration of sustainability elements has provided an added-value to the research outcome where major issues associated with the relative sustainability themes can be dealt with exclusively in accordance to theme by the decision-makers or inclusively from the sustainability standpoint to further improve the implementation processes.

The approach used in this study was designed to engage key stakeholders from the Kelantan's construction industry and promote active participation to gauge their opinions, perceptions and

suggestions from real-live experiences which was vital to the project outcomes. Findings indicated that low level of knowledge, awareness and preparedness within the local community along with low accessibility and quality of information are the two most dominant major issues when discussing ICT application in DRM research field. Subsequently, thematic analysis from the perspective of sustainability elements revealed that social theme and infrastructure are the most dominant themes. Overall, the study has developed a 3D conceptual model of ICT application issues in DRM with incorporation of sustainability elements. Further research is needed to investigate the irregularities pointed out in the discussion section. Testing and validation of the proposed 3D conceptual model can also provide a platform for future work.

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