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Identification of Indicators for Infostructure Capability Measurement in Disaster Management

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Abstract
Purpose: The aim of this paper was the identification of indicators of infostructure used in dealing with disaster activities, specifically in the electricity companies.
Design/methodology/approach: A literature review was conducted in finding suitable indicators from a selection of references.
Findings: The discussion highlights the final phase undertaken in classifying the indicators for the three processes in disaster, namely coordination, communication and control. The main contribution of this paper was the identification of the indicators of infostructure for disaster management and their classification according to the three processes of disaster management.
Research limitations/implications: The research focus in identifying the indicators to be used in measuring infostructure capability in managing disaster in electricity supply industry.
Practical implications: The findings in this paper may serve as a guidance in developing a measurement tool that may help electricity companies or related stakeholders in measuring their disaster activities in reducing the impact of disaster.
Originality/value: This research may yield some light on the measurement of infostructure usage during a disaster faced by electricity company, as well as venturing of the development of suitable tool for the assessment in future research.
Paper type: Research paper

Keywords: Evaluation, Efficient disaster management, Capabilities

Introduction

Disaster management typically consists of several important processes, as suggested by Nojavan et al. (Nojavan, Salehi, & Omidvar, 2018) that feedback process in disaster management can be measured using consultation, coordination and communication. Magiswary (Dorasamy, Raman, Muthaiyah, & Kaliannan, 2011) in his research stated that for knowledge management system to be adopted in disaster, the system must have the ability to support communication, coordination and information challenges faced by the responders in managing disaster. These studies have shown that the processes involved in disaster evolved around the process of communication and coordination. Earlier researches supported the focus

of this research which relied on the 3Cs, namely identified as coordination, control and communication.

The first C, coordination, was based on the content from the paper of Seppanen et al. (2013) that explain the importance of having a timely and accurate information for all the relevant agencies in responding to a disaster. As in any event of disaster, multiple agencies will be involved that has an effect on the utilisation of response systems and the knowledge needed to coordinate all agencies' efforts.

All this information will then be disseminated to the participating disaster agencies, as defined in infostructure which stated that information need to be passed to the next hierarchical level in the disaster management activities. This component also was supported by the work of Raju (2013) that stated that coordination is important in any disaster efforts, along with the use of effective policy and practices in ensuring information and resources that can be distributed to the victims.

The second C, communication, can be seen focused more on the usage of social media as stated by Alexander (2014) that explains on the potential of using social media in disaster situation. As in an event of disaster, typically information could not be shared, the lack of communication causes the agencies involved to not knowing where to provide help and to be updated of the status of the place being affected by the disaster.

The third C, control was needed in any disaster efforts as there is a need for an authority to govern all the activities in a typical disaster management activity. Suitable roles and responsibilities need to be identified in ensuring that information can be passed to the right agencies at the right time.

In understanding the relationship between infostructure and the three processes, the 3Cs, any implementation of disaster management requires information that promotes better coordination and communication. Lack of coordination in disaster operations can be the result of delay in taking control of the situation or lack of shared information for the agencies to make decisions and collaborating with other relevant agencies.

Infostructure that has been defined specifically in the context of disaster management for this research is information that exists in disaster that is utilised for coordination among participating disaster agencies. Infostructure promotes information sharing among agencies which roles and responsibilities has been determined by authorities. The control element is vital in ensuring the information is received by the right agency at the right time. The information is passed using certain technology that ensure fast communication to enable timely and reliable information to stakeholders. Infostructure serves as the important foundation in aiming for a better disaster management implementation as it relates to information utilisation including the role of information, processes involved, how agencies should use it and how to control the usage of it.

In order to theoretically ground the conceptual domain of infostructure, the research aims to explore the issues surrounding infostructure and the 3Cs. It is crucial to understand the nature of these processes and its relationship with infostructure, and how it can be measured using maturity model. The 3Cs are major processes in disaster management and there is a need to break it down to specific indicators that may be included in the assessment of the disaster using a maturity model.

Therefore, this article is devoted to the identification of indicators decomposed for the three selected processes, applied to infostructure in disaster management. The processes and indicators will be used in building a suitable assessment tool for infostructure usage in disaster management domain.

This paper is organised as follows: in the second section, methodology used will be explained. The third section will discuss on the indicators identified for the infostructure. Concluding, we discuss the future research on how the indicators will be applied in creating a tool.

Methods

A full literature review and search for existing tool was conducted to assess capabilities of processes. Literature review helps to understand the concept and overview of tool in the form of maturity model and the relationship with the process of disaster management. In addition, past research helps to understand the functions of maturity models as assessment tool in other areas and how it can be beneficial in the area of disaster management.

The infostructure maturity model indicators are identified through extensive literature review analysis on disaster management area and its relationship to infostructure. The term infostructure was defined by our earlier study as promoting the sharing of information of all agencies by passing resources through a coordinated method by utilising ICT (information and communication technologies) infrastructure that linked to disaster affecting electricity companies (Latif, Arshad, & Janom, 2015).

Earlier literature review search for information as the key term as there is limited article containing infostructure that belong in the disaster management area. Articles used in this research were searched from online database in the domain of disaster management. The searching method was introduced by Nah & Lau (2001), which the title of the articles must contains either the keyword 'infostructure' and it must contain the term 'disaster management'. However, since disaster management can belong to different area of research, the selection of research article was not only limited to the keyword of disaster management, but also other equivalent words. These words range from crisis management, emergency management or disaster response. From the review, analysis and classification of related factors, three processes identified earlier emerged as critical to infostructure in disaster management, which are coordination, communication and control. These three key dimensions for the maturity model are decomposed to establish key process areas or established as indicators in this research for each maturity level that will be identified. The seven indicators are initially identified and operationally defined in the next section.

Findings

The research objective is to measure a disaster agency's competency and capabilities, where the outcome of the measurement can be used to improve the existing processes in disaster management specifically the 3Cs. The measurement of the three processes need to be directed to more detailed areas under each process to ensure an accurate representation of the process can be generated.

On the basis of existing literature on dimensions of infostructure and issues of disaster management, an assessment tool for infostructure using maturity model is proposed. The three processes used in building the maturity model are decomposed into indicators that fulfilled the conceptual definition and quantity measured. Extensive reviews and analysis of various journal and articles from proceedings was carried out that meet the two criteria set for all three processes. Table 1 provides the details of the three processes with the seven indicators identified.

Table 1: Definition, Quantities Assessed and Its Literature Sources

Indicators	Conceptual Definition	Quantity Measured	Literature Sources
Coordination dimension			
Responders	The agencies personnel that has been given authority in managing disaster	Does the disaster agency have authority and knowledge in managing disaster?	Sharing of information and resources (Bharosa, Lee, & Janssen, 2009; Chen, Sharman, Rao, & Upadhyaya, 2008; L. K. Comfort, 2007; L. K. Comfort & Haase, 2006; L. K. Comfort & Kapucu, 2006; L. Comfort, Ko, & Zagorecki, 2004; Gao, Wang, Barbier, & Liu, 2011; Janssen, Lee, Bharosa, & Cresswell, 2010; Kapucu, 2006, Kapucu & Garayev, 2011; Mcmaster & Baber, 2012; Seppänen & Virrantaus, 2015; Waring, Alison, Shortland, & Humann, 2019) Communication (L. K. Comfort, 2007; Kapucu, 2006; Reynolds & Seeger, 2005; Shittu, Parker, & Mock, 2018; T. A. Steelman & McCaffrey, 2013; T. a. Steelman, Nowell, Bayoumi, & McCaffrey, 2014) Reynolds & Seeger 2005; Kapucu 2005; Comfort 2007; Steelman, Nowell, Bayoumi, & McCaffrey, 2012; Steelman & McCaffrey, 2013; Shittu, Parker, & Mock, 2018) Responding in organised and collaborative manner(Alexander, 2014; L. K. Comfort, 2007; Gao et al., 2011; Kapucu, 2006; Mcmaster & Baber, 2012; Refsgaard & Baker, 2007; Waring et al., 2019) Roles and responsibilities (Boin & Bynander, 2015; L. K. Comfort, 2007; L. K. Comfort, Dunn, Johnson, Skertich, & Zagorecki, 2004; Mcmaster & Baber, 2012; Raju & Becker, 2013; Refsgaard & Baker, 2007) Ability to lead and influence people (Chu, Chen, Liu, & Zao, n.d.; Cohen, Goldberg, Lahad, & Aharonson-Daniel, 2017; L. K. Comfort, 2007; L. K. Comfort & Haase, 2006; Curnin, Owen, Paton, & Brooks, 2015; Kapucu & Garayev, 2011; Pan, Leidner, & Pan, 2009) Limited capacity and resources (Bharosa et al., 2009; Coles, Zhuang, & Yates, 2012; Kapucu, 2006; Maldonado, Maitland, & Tapia, 2009)

Task-flow	The process involved when the responders perform decision making, steps involved in distributing information and coordinating the processes involved	Does the disaster agency have set up a suitable goals and processes on disaster management? Does infostructure usage in disaster processes emphasises on effective management of disaster?	Performing disaster tasks (Boin & Bynander, 2015; Mcmaster & Baber, 2012) Coordinated response (McMaster & Baber 2012; Boin & Bynander 2014; Berariu, Fikar, Gronalt, & Hirsch, 2016; Waring et al., 2019) Information exchange (Muhren & Walle, 2010; Seppänen & Virrantaus, 2015; T. a. Steelman et al., 2014; Yeo & K. Comfort, 2017; Shittu, Parker, & Mock, 2018; Waring et al., 2019) Inflexible administration approach in urgent, dynamic conditions (Bharosa et al., 2009; L. K. Comfort, 2007; Kapucu, 2006; Mcmaster & Baber, 2012)
Communication dimension			
Technology	The tasks involved in ensuring the Internet and chosen communication tool is available	Does the available technology able to support infostructure usage across agencies? Does the issues related to technology retard the communication among agencies?	Use of IT for Interactive communication (L. K. Comfort et al., 2004; Iannella & Henricksen, 2007; Kapucu, 2006; Palen, Hiltz, & Liu, 2007; Pan et al., 2009; Paquette, 2016; Quarantelli, 2006; Simon, Goldberg, & Adini, 2015) Ability to communicate (Bharosa & Janssen, 2009; Kapucu, 2006; Rahman, 2014; Refsgaard & Baker, 2007; Seppänen & Virrantaus, 2015) Inflexible information systems (Bharosa & Janssen, 2009; Goto, Sato, Hashimoto, & Shibata, 2017; Usuda, Hanashima, Sato, & Sano, 2017) Types of communication component (Azmani, Juliana, Idrose, Amin, & Saudi, 2018; L. K. Comfort & Haase, 2006; Refsgaard & Baker, 2007; Reynolds & Seeger, 2005; Simon et al., 2015)
Competency	The process of identifying the capability of people inside the agencies and terms used in communication across agencies	Do the responders capable in understanding and implementing infostructure during disaster? Does the agency provide education or training related to use of infostructure?	Lack of shared common language (Giuliani, Revez, Sparf, Jayasena, & Havbro Faber, 2016; Kapucu & Garayev, 2011) Lack of trust among organisations (L. K. Comfort, 2007; Kapucu, 2006; Kapucu & Garayev, 2011; Mcmaster & Baber, 2012) Skilled communicators (L. K. Comfort & Haase, 2006; Kapucu, 2006; Reynolds & Seeger, 2005, Shittu et al., 2018) Authority of communication (Comfort 2007; Madianou, Ong, Longboan, & Cornelio, 2016)

Social Media	Objectives in using social media to disseminate information and identifying the ownership of used social media platform	Does the usage of social media can support infostructure in communicating during disaster? Does the disaster agency understand and capable in using social media to support infostructure usage?	Lack of trust (Boin & Bynander 2015; Simon, Goldberg, & Adini, 2015) Modern communication tool helps (Palen et al. 2007; Palen & Liu 2007; Gao et al. 2010; Chu et al. 2011; McMaster & Baber 2012; Boin & Bynander 2015; Starbird, 2016; Kaewkitipong, Chen, & Ractham, 2016; Azmani et al., 2018) Use of Social Media in Disasters (Palen & Liu 2007; Yates & Paquette 2010, Starbird & Starbird, 2016; Alexander, 2014; Simon et al. 2015; Houston et al., 2015; Kaewkitipong, Chen, & Ractham, 2016; Azmani et al., 2018)
Control dimension			
Government	Program or initiatives implemented by the government, and establishing legal framework for disaster	Does the government provide sufficient support for infostructure usage in disaster management?	Incentives and recognition (Boin & Bynander, 2015) Collaboration among stakeholders (Ha, 2015; Kapucu & Garayev, 2011; Lin Moe & Pathranarakul, 2006; Maldonado et al., 2009; Raju & Becker, 2013; Waring et al., 2019)
Policy	Governing the processes of disaster management by establishing proper policies	Do the policies and procedures are sufficient to support infostructure usage in disaster management?	Need for evaluation metrics (L. K. Comfort & Lin, 2008; Janssen et al. 2009) Absence of policy (Comfort et al. 2004; Comfort 2007; Ha 2015; Islam & Walkerden, 2017) Strategic, objectives & effective planning Comfort 2007; Baker & Refsgaard 2007; Ha 2015; Koyama et al., 2019)

Discussion

This section will discuss on the selected literature reviews that were utilised in identifying the seven indicators used in developing the infostructure measurement tool for disaster management.

Responders

Many researches have proved the importance of sharing important and quality information during a disaster which believed to among the necessary condition for the success of managing a disaster. Typically, activities involved during a disaster will be coordinated among public agencies (i.e. police, fire department and medical services) which has their tasks outlined during the crisis preparation and response planning. Timely and accurate data obtained enables the agencies involved to respond appropriately to the disaster. According to Comfort and Haase (2006), the practicing managers and responders involved in the aftermath of a disaster must be able to perform collectively in building a communications infrastructure. This will assist personnel from the different agencies with various background, responsibility and authority to adapt to the rapidly changing conditions of a disaster. In the event of a disaster, emergency managers are expected to act and respond with their existing knowledge and experience. However, past researches (L. K. Comfort & Haase, 2006; Gao et al., 2011) have

showed that performance of a response can be improved by increasing range, frequency and access to information sources, including real-time feedback collected from the responders and victims of the disaster. The aspects of the leadership are also considered as a significant factor in promoting better disaster management. From management perspective, decision making in disaster has been widely addressed by scholars of the field, from individual, group and the organisational level (Hardy & Comfort, 2015; Kapucu & Garayev, 2011; Leskens, Brugnach, Hoekstra, & Schuurmans, 2014). Agencies that worked independently outside of disaster must to be able to transition and arranged into temporary supra-organisations that requires them to combine their "routine" expertise and applied appropriately to respond to the disaster agile conditions into a multi-agency management capability agency members of the supra-organisations. These organisations may include any agencies that are directly or indirectly involved with the occurrence of disaster such as utility, water and communications (Janssen et al., 2010). Considering the importance of both emergency services and non-emergency services like energy to be able to collaborate during disaster, this research will look into how the responders' ability and experience from various background is able to facilitate effective and expedient disaster recovery. Considering the significance of having capable leadership and responders in developing an effective multi-agency actions, Cumin et al. (2015) have recognised the unique characteristics of agencies responders with differing work routines, organisational cultures, operating practices, disaster management experience and area of expertise in playing a crucial role in ensuring a fast and efficient disaster management. Collaboration from multiple agencies require an established communication among the agencies in receiving accurate and timely information requirements during a disaster relief. Agencies that involved will require information in assessing the situation based on their interpretation of information coming from multiple sources. Having a large numbers of responding agencies, which may have combined with communications problems and authoritative decision makers, will sometimes overwhelm the 'control' aspect of the disaster relief operations (Mcmaster & Baber, 2012). Due to this issues, authorised responders is a necessity to activate appropriate response operations in coordinating actions (Valecha, Sharman, Rao, & Upadhyaya, 2013).

Task-flow

Coordination in disaster are aimed at solving the problem of integrating different tasks, executed by different people with various roles and responsibilities, at different time and location with the aim of getting something done or solved. This may include activities of search and rescue of disaster victims, providing relief to affected victims or evacuation process. The aims of disaster management are to help victims that may include complex processes and ambitious goals that require many people, units and organisations work together (Boin & Bynander, 2015). Coordination of interdependent tasks is complicated as there is a need to have a guidance or managers in aligning actions among interdependent parties. Establishing a structured collaboration is required in making organisational units and disaster personnel in working together during the disaster. The structured collaboration will consist of different actors, including local citizens, organisations, disaster agencies and NGOs. This collaboration may include responders who never experienced disaster or working together before. Responders involved in a disaster will brings different knowledge and experience, to be shared with other responders. Agencies that perform normal tasks such as police and firefighters will help to manage the disasters alongside their conventional role. Responses of agencies involved in the London bombings is often identified as an example of effective coordination (Eyerman & Strom, 2008). The first stage of an incident will be the most chaotic stage, as the process of disaster management starts by identifying and collecting information from various

organisations. Each organisation involved in the disaster will have some information that will be shared with other agencies in initiating coordination activities among the agencies. There is a small chance of any single organisation possessing all available information of the disaster as different organisations will hold their own 'pieces of the puzzle'. First responders that arrive at the incident site will aim to collect as much local information as they can, in order to have a proper assessment of the situation and to decide an appropriate response. Typically, each agencies personnel will be defined by the disaster training they receive, Standard Operating Procedures (SOP) as their guidelines and experience in managing the disaster. The first responder must be able to transfer the information they obtained to the other agencies' personnel, in establishing a shared awareness and understanding of the incident. All agencies should be aware of the procedures in requesting information from and presenting information to other agencies. Failure of 'push' and 'pull' information can be contributed by lack of awareness between agencies in understanding each other's roles, methods and processes (Mcmaster & Baber, 2012). The concept of information exchange can be compared to the supply and demand of information, which need to be balanced. Responders typically have different sets of information (supply) and they may not pass the information correctly or effectively to other agencies who desire the information (demand). The highly dynamic and uncertain situations in disaster can cause information asymmetry as poor information exchange can restrict effective coordination (T. A. Steelman & McCaffrey, 2013). In addition, information exchange in disaster have grown to be more promising as groups created by agencies use interactive and accessible communication tool in sharing information. The use of these tool may eliminate the traditional way of exchanging information during disaster (Muhren & Walle, 2010). Information portal that is equipped with quality information should stress on the ease of access in getting all the necessary information. A reliable and good portal should be created in improving the cooperation and ensuring the usability of information being passed.

Technology

In understanding the processes being carried out in a disaster, similar to the focus of this research, three critical terms exist in disaster management, namely, coordination, communication and control (L. K. Comfort, 2007). Information and communications needs for disaster management is complex and diverse, reflecting the various needs and objectives for information and communication that occur at different times, location and types of disasters. The responders and their roles will be supported by various information system that promote interactions between responders and the information systems. Disaster operations as illustrated in the Hurricane Katrina showed that there is a need for a revised and stronger national capacity that established by creating a common knowledge base for collective action in extreme situation. Disaster manager recognised this need by building a 'common operating picture' that is essential for clear communication and coordination of actions among agencies that respond in providing relief to victims. In this research regarding technology used in disaster management, emphasised on the importance of having a central communication in enabling effective mitigation and response in natural disasters. Various information communication technologies (ICTs) have been used to support communication in disaster operations to help agencies and victims to share and process real-time information, establish communication channels and to coordinate collaborative efforts among all the participating disaster agencies (Dorasamy & Raman, 2011; Helena, 2011; Webersik, Gonzalez, Dugdale, Munkvold, & Granmo, 2015). Technology used in disaster to achieve adequate level of information sharing among the agencies at different locations with different level of jurisdictions. Information that is shared have different characteristics; language and jargon used, size, scope and channels

used to distribute the information. Responders involved will be able to participate in the communication and understanding the shared information based on training received, years of shared experience, professional interactions and responsibilities given during the disaster. Warning or alert systems has been considered as an important technology in providing alerts and to instruct public about a crisis, to divert them form any imminent danger. Malaysia is one of the countries that still use a siren as basic system, although this may not be an effective alert for population with hearing problems (Aman, 2012). Mobile or smart phone usage in disseminating information and to alert the public about disaster has been increasingly used. However, the use of mobile phone in assisting disaster agencies need to be properly planned and how much detail of its use need to be considered by authorities. In addition of using technology in help to share information, communication is considered as the basis of collaborative decision-making during disaster because it is responsible for the "transfer, receipt, and integration of knowledge across participants" (Weber & Khademian, 2008). Decision making during a disaster relies on the communications infrastructure established by the government or agencies responsible for it. It enables the agencies and communities to respond effectively to any impending disaster (L. K. Comfort & Haase, 2006; Raju & Becker, 2013; Salmon, Stanton, Jenkins, & Walker, 2011). Information is relayed to all agencies involved using selected technologies that ensure timely updates and clear report on the status of operations at different location is passed to responder involved. Information received at the right time during a disaster is to mobilise coordinated actions among the agencies. Systems used in disaster communication can extends to include support, feedback and correction of error that focus on providing relief from the disaster.

Competency

Researchers in the disaster management posits that in order to encourage technology penetration and to enable the use of information systems in dealing with disasters, a broader view of general abilities of people in managing, facilitating and using ICTs including inter-organisational application are critically important. The dynamic nature of disaster requires all responders' organisation to effectively communicate in making informed decisions, and to include the participation of public and local communities to have a coordinated effort to mitigate, prepare for, respond to, and recover from disasters (L. Comfort et al., 2004). Due to the need of sharing accurate and timely information under time pressure, organisations are expected to benefit from the use of ICTs in improving communication and to help with coordination efforts during a disaster. This is being supported by Zhang (Zhang, Zhang, Comfort, & Chen, 2016) who emphasised on interorganisational communication in the occurrence of a disaster. It is critical for first responders to be able to utilise available resources including communication tool or information systems in disseminating information. The communication among the agencies can be supported by having a proper identified platform or technology infrastructure that provide a common platform for responders to communicate using a common language and jargon of disasters. Responders should be trained in the correct way of communicating with other agencies, including learning the Standard Operating Procedures (SOP) of other agencies and to trust information being sent through the systems. The initial reaction of the responders need to evolve into coordinated action in facilitating the victims through the entire disaster phases. A good coordinated collaboration will be determined by the responders' functionality and trust that they put into the communication (Boin & Bynander, 2015). A similar scenario can be seen from the Great East Japan Earthquake in 2011, where there was an issues with trust that resulted from collaboration with people from heterogeneous backgrounds (Murayama & Nishioka, 2013). However, Reynolds & Seeger (2005) pointed out that a disaster agency requires a crisis communication role similar to a

public relations (PR). The skilled crisis communicator should be able to brief other stakeholders involved in the disaster by strategically defending the agencies position in any uncertain situation. Any responders that are responsible to explain a disaster scenario are always presented with a team of press that eager to know more about the disaster, including the cause of the disaster, why and what is being done in response. Thus, crisis communicators from each agency should serve as spokesperson or disseminator of information, and able to prevent or lessen the negative outcomes of a crisis. They are responsible in sending and receiving plethora of information from any agencies during the disaster with the main aim of protecting the organisation, stakeholders or any industry from failing. The availability of competent staff in disaster that is able to manage the disaster is very scarce. Organisations can only function effectively under stress, if timely and valid communications are present. Working in a team is essential in ensuring proper information are being passed to other stakeholders. Decisions made by the management should be adapted and followed as individuals (L. K. Comfort & Haase, 2006). As cited by Comfort (2007), individuals and groups require the capacity to harness individual actions into a coherent process of response and recovery. Assistance from individuals and organisations must be accepted using proper structure of communication and being approved instantly by the authority. A common operating picture need be established in creating a symmetry in information processes; operations personnel are free to request or listen to feedback from any levels of the communication structure.

Social Media

Social media refers to the organisation objectives in using social media to share information during disaster and to identify the ownership of the social media platform in disaster management. Social media popularity and easy accessibility has enabled it to be a new form of information resource when a disaster happens. For example, data about Haiti earthquake in 2010 was obtained from multiple social media sites such as Twitter, Flickr, Facebook and blogs (Gao et al., 2011). A study on seventeen large Australian organisations used Facebook and Twitter in handling communication during crisis (Roshan, Warren, & Carr, 2016). Coordination in disaster relies on timely, real-time information that will help to facilitate efficient relief and recovery to victims affected. Information sourced from crowd is made available through social media, and these enable disaster agencies to contribute to a unified source of information customised for the group. Ianella & Henricksen (2007) also pointed out the use of information systems, specifically Incident management systems in informing disaster response team with real-time information about the incident and available resources in facilitating the coordination efforts among multiple disaster agencies. Technology devices in the form of GIS and GPS has allow organisations to receive satellite information and produce accurate location information on the disaster-struck areas. Information obtained through GIS or GPS can assist during evacuation procedures in identifying critical victims that need to be evacuated first. Earlier studies have recognised the significance and importance of ICTs in improving information dissemination and reduce communication costs, that has encouraged the integration of information technology into decision-making in emergency scenarios (L. K. Comfort, 2007; Dorasamy et al., 2011; Hu & Kapucu, 2016). ICTs can be used to mitigate high levels of complexity and uncertainty in dealing with disasters. Social media usage has also been used to support participation from local citizens in emergency management. All affected victims or disaster managers has started to use Twitter or Facebook in sharing information during disaster. The increasing usage of social media can be seen during Katrina, as the volunteers set up Wiki to allow victims to connect and expediting the evacuation process (Boin & Bynander, 2015). Social media usage has been increasingly used as a tool to support communication during disaster. In the case of 2014 flood, it was reported that flood victims in

Kelantan used social media as medium to ask for assistance. Facebook and Twitter were used to send messages to public in asking for relief to be provided immediately. Typically, during a disaster, traditional forms of communication, such as television or radio could not be utilised due to loss of signal or unavailability of networks. This resulted in dependency on social media by the affected victims as they rely on messages that carries information from circle of contacts or friends for them to obtain the latest news of the disaster. Victims tend to be more willing to share information with the aim to help other victims' by providing their own contents immediately using social media (Ahmad, Zani, & Hashim, 2015). Social media have been considered as one of the important medium for communication in disaster. In 2013, Twitter introduced a new service called Twitter Alerts that publish latest information from credible organisations when other traditional communication channel is not accessible. These alerts will be highlighted on the subscribers' home timeline and are instantly sent as mobile notification. Following the success of Twitter Alert, Facebook launched a similar service called Safety Check that allows users affected by crises to communicate that they are safe and check the status of their friends during a crisis. The role of victims affected by disaster has evolved to be the content provider using social media that help others in getting the latest information when traditional media are not accessible. Although information received through social media has the risk of not being accurate or even contain rumours, affected victims willing to accept any information received as they require any kind of information relating to the disaster in making proper arrangement in dealing with it (Murthy & Gross, 2017).

Government

Disaster is an event that may require a community to cope using their own resources in dealing with the aftermath of the effect. It is an event that able to rattle the normal function of a community and cause variety of losses, including human and economic (Ahrens & Rudolph, 2006). Sometimes, this depends on the country's disaster management structure in dealing with the disaster. Disasters have been managed with priority given to coordination process throughout the disaster phases. A successful coordination is made possible by having a collaboration between a functioning emergent network and authorities arriving on the scene. There is a proper structure of labour, a shared mission, cooperation among all responders, and a minimal degree of legitimacy (Boin & Bynander, 2015). The structure of this coordinated response is almost similar to the characteristics of an institution or a nation. Coordination in disaster will be executed in any levels of disaster management (L. K. Comfort et al., 2004). Disaster activities will be performed by multiple disaster agencies, and this showed that there is a need to manage dependencies among all the agencies involved in a disaster. Multi-agency coordination will deal with different processes, information, applications and other technology that belong to each of the agencies involved. Coordination in disaster management is supported by effective communication among all the disaster agencies. Kapucu (2006) stated that to encourage interorganisational communication and the trust to enable coordination of response operations, all responders involved should be provided with incentives and information. This can be implemented by the disaster managers or non-profit managers in encouraging better collaboration among all the agencies involved.

Policy

Disaster risks exists due to no commitment given to sustainable development practices. A country's institutional matrix is critical in determining its development outcome. Disaster relies on policy created by the governance structure of a country, which includes constraints structuring political, economic and social interaction. It is made up of both formal, such as laws and rights, and informal constraints such as customs and traditions. The governance structure

will be determined based on the institutional matrix that consists of individual actors, organisations, and policy makers (Ahrens & Rudolph, 2006). The significance of policy-making is directly influenced by the quality of actual policies and their effective implementation, which can be seen in the disaster management practices. Policies related to disaster will support and ensure a successful disaster operations execution. An efficient governance structure is crucial in formulation of overall economic development strategies, which lead to the creation of policy implementation in single policy areas like disaster. Using the concept of governance in disaster, it can be used to enhance disaster operations and procedures that is used to set up a proper framework of creating public policies to manage disaster. The governing body may include the government, the public administration as well any agencies or communities that participate in disaster activities. By having an established governance framework, a better disaster policy is created based on the concept of coordination and control. It will generally improve the flow and exchange of information among all the affected stakeholders. Policy also would help in developing a fair and structured tasks assignment for all the stakeholders in disaster management. This can lead to clear institutional rules and assignments of competencies of each stakeholder. Thus, it is crucial for a disaster operation to be governed by an established policy by the government and other stakeholders in disaster. In addition, policies created also need to be reviewed and open to enquires from the public and agencies involved. This can help the responders in learning and improving their tasks during the disaster, and also to get recommendations for new legislation and requirements for disaster operations (Mcmaster & Baber, 2012).

Conclusion

The main contribution of this research was the identification of the indicators of infostructure for disaster management. To describe the capability of infostructure, our literature review confirmed the presence of closely related concepts that supports the three processes of disaster management, the 3Cs (coordination, communication and control). The identified seven indicators for infostructure capability will assist in the development of a measurement tool. The proposed tool is able to assess the infostructure performance in managing disaster in Malaysia that focus on electricity supply industry.

Theoretical Implications

The assessment of infostructure in disaster management can be performed by using a model that aim to allow the disaster organisations processes or activities being measured. Two earlier researches by Santos and Borges (2008) and Makela (2013) focused only on information systems. The proposed assessment is crucial as currently, there is no measurement for all aspects of infostructure; information, system and technology.

Assessment of an organisation's competency could be done using the concept of maturity model that is commonly used to describe stages and improvement path. Maturity model is commonly used to assess and identify the current maturity levels of certain processes in an organisation.

The introduction of a customised assessment for disaster processes will allow agencies to adapt and change to the needs of having better disaster activities.

These models typically divided into increasing maturity levels, and this enable the organisation to monitor their performance and plan on how to reach the next level. Most maturity model such as Business Process Management Maturity Model or Business Process Maturity Model is developed to have a sequence of levels (or stages) that will form a desired or anticipated path from initial state to a more mature level, which allow possible improvement to be identified. CMMi is used as a foundation for this research as it represents five levels of maturity that

serves as improvement for organisational processes (Adrian Doss, Tesiero, Gokaraju, McElreath, & Goza, 2017).

Only two maturity models existed for disaster management and it is not catered to all areas of disaster (Mäkelä & Virrantaus, 2013; Santos, Borges, Canos Cerda, & Gomes, 2011). This has supported this research that a customised maturity model should be developed that catered to the 3Cs processes and goals in handling disaster.

Practical and Social Implications

The research has identified seven indicators that are designed to assess the capability of infostructure in managing disaster. It has used the case of infostructure in electricity company in providing a better understanding of the assessment tool.

Limitations and Suggestions for Future Research

The research has provided an avenue for future research in developing tool to measure infostructure improvement. The customised infostructure maturity model can provide a better insight for a disaster agency in measuring their activities. Once the model is completed, it need to be validated as it is important to verify the value that the tool provides as it will be an ongoing process to understand the assessment of infostructure usage in disaster management in Malaysia.

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