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THE DEVELOPMENT OF INFOSTRUCTURE MATURITY MODEL FOR APPLICATION IN DISASTER MANAGEMENT

[1]ALIZA ABDUL LATIF, [2]NOOR HABIBAH ARSHAD,[3]NORJANSALIKA JANOM

[1]Lecturer, Department of Information Systems, Universiti Tenaga Nasional, MALAYSIA

[2]Assoc. Prof., Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, MALAYSIA

[3]Lecturer, Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, MALAYSIA

E-mail: [1]aliza@uniten.edu.my, [2]habibah@tmsk.uitm.edu.my, [3]norjan@tmsk.uitm.edu.my,

ABSTRACT

Disaster management aims to reduce the impact of disaster by having a good management of resources and responsibilities in providing better coordination and collaboration. Organizations involved in disaster need to be able to measure its competency and capabilities in ensuring the right response is given during disaster. Successful disaster management relies heavily on right information to be used at the right time by the right agencies. Based on the concept of continuous process improvement and the Capability Maturity Model (CMM), in this paper, an infostructure maturity model is constructed. This paper highlights the constructs of infostructure that will be applied to disaster management, and later to propose a suitable measurement using the concept of maturity model. It can be used to assess the infostructure components of information, systems and technologies. The research also aims to serves as a foundation to produce a complete infostructure maturity model for application in the disaster management area.

Keywords: *Information management, Information Sharing, Capability Maturity Model, Maturity Assessment.*

1. INTRODUCTION

Disaster management is the management of resources and responsibilities of all related agencies in dealing with emergencies that aim to lessen the impact of disasters. Disaster management may include various aspects of planning and responses in typically four phases of disasters, namely mitigation, preparedness, response and recovery. It requires proper communication process and effective coordination in helping organizations in managing disaster operations.

Several studies have reported that disaster management fails due to lack of resources, lack of coordination and poor communication that impact the performance of organizations in dealing with disaster operations [1, 2]. These three factors are heavily associated with information, which is the most important asset or resources in managing disaster operations. Information is crucial in supporting interactions between related agencies in disaster response operations as well in developing coordination among them, alongside the use of knowledge, skills and equipment. In one of the phases of disaster management; the response phase, Seppanen et al. [3] has defined critical information as the minimum information that is needed for a successful collaboration among agencies in disaster management.

In Malaysia, disaster management is based on a mechanism which is directly placed under National Security Council (NSC) in the Prime Minister's Department. The main purpose of Directive No. 20 is to coordinate all activities related to disaster [4]. By having this guideline, NSC can identify the governance structure responsible in coordinating disaster management activities. Although Malaysia relies on this document for their disaster operations, there is no evaluation of the activities or resources that are needed to support an effective disaster management. In Malaysia, the only measurement in disaster management that has been done was based on the work of Chan [5] that evaluated the adequacy of institutional arrangements of flood hazard using the 'criteria approach'. His study assessed four specific criteria of institutional arrangement that includes legislation, organizational structures, attitudes and policies. However, the problem is that the existing evaluation methods only cater for area of institutional arrangements and do not clearly identify the challenges in managing disaster. They do not produce quantitative data for the evaluation and the improvement of identification and

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collection of critical information. Therefore, a suitable measurable methods are needed in the area of disaster management, especially for information that is considered as one of the resources needed in a successful disaster management. The purpose of this paper is to investigate the components of infostructure and how it can be measured and applied to disaster management.

This paper is organized as follows: in the next section, we look at the concepts of information management in disaster management, and overview of maturity models. The third section will discuss on how maturity models can be applied in disaster management, followed by discussion on the constructs of infostructure that will be used in the maturity model, then follows the conclusion, and finally proposals for empirical research

2. FOUNDATIONS AND CONCEPTUAL BACKGROUND

In this section, we present the concept of disaster management, and how does information are critical in supporting disaster management. Existing maturity models for disaster management will also be discussed in this section.

Information management in Disaster management

Disaster management is the management of resources and responsibilities of disaster agencies in dealing with emergencies, throughout the entire stages of disaster. A successful disaster management will require access to core information that enhances the efficiency and effectiveness of responses and coordination among all the agencies involved [6, 7]. Systematic information is the basic ingredient needed in ensuring a proper integration of disaster preparedness until to the stage where relief can be provided to the affected communities.

The main objective of disaster management is to restore and reduce impact of the disaster, and this can be made possible by having accurate and appropriate information. In the study of key elements in disaster research, Janssen [8] clarifies that multi-agency disaster management requires efficient collaboration in enabling an effective and quick response to a disaster. Disaster management is a complex task environment that requires several organizations to work in a team and makes decisions based on available information. Relevant information needs to be collected from multiple sources, verified for accuracy and shared to enable efficient collaboration. This is supported by several studies that highlighted the need of quality information in ensuring coherent disaster coordination among relevant agencies [6, 9, 10].

Key challenges of information management in disaster management mainly caused by lack of information sharing amongst relief agencies, having limited access to information and lack of resources which lead to coordination and communication problems. In all four stages of disaster management, information are required in providing relief to the victims. In the initial stages of disaster, the main objective is to save lives and provides assistance to injured persons, and information need to be relayed to first-response organizations such as fire departments, police or medical organizations. Accurate and correct information need to be delivered on the right time to ensure the victims get the best possible aid. During the recovery period, information is required to provide help to victims; which may be the resources needed getting employment, starting business or getting medical care. In all distinct phases of disaster management: mitigation, preparedness, response and recovery, different types of information is required for different needs and objectives.

Information management is considered as a great challenge in disaster management as it come with the stress of managing a disaster, making decisions that deals with life and to promote coordination amongst multiple disaster agencies. Information need to be supported by technical elements of having a system and technology that provides the means by which information can be shared and used across systems and organizations.

As this paper is focusing on the infostructure for disaster management, information applied in disaster management need to be supported by system and technology. These are the elements contained within the definition of infostructure, namely, information, system and technology [11]. There are a number of studies that provide evidences stating that most of the research in disaster management focusing on the establishment of information systems in dealing with disasters [10, 12, 13]. The need for better and reliable information system in disaster management is because of the amount and complexity of information gathered during a disaster as it will be generated from multiple sources at different time. This information need to be collected, processed and disseminated to the right agencies at the right time. However, information need to be facilitated by systems and technology in ensuring the right response is delivered to the affected individuals. Identification of the right information, system and

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technology is crucial in ensuring responses are delivered to the victims. Thus, a reliable and valid measures of the three key constructs will help to build a better disaster management model.

Maturity Models

Maturity models (MM) has been accepted as a widely accepted tool in guiding the development of improvement program to transform an organization to a better state based on best or common practices [14]. Maturity models model the development of an object over time. The object can range of anything from a technology, a business initiative or a process. Maturity models refer to a natural lifecycle application.

Each object specified develops from immature and inconsistent status to mature and disciplined status through multiple stages of maturity over time. This statement is also supported by [15-17] which had assumed that maturity models commonly will include a sequence of levels (or stages) that together form an anticipated, desired or logical path from an initial state to maturity. Table 1 briefly summarizes the most important characteristics of MMs.

Table 1: Characteristics of MM

Characteristics	Description
Objective of maturity assessment	MMs used across multitude of domains to assess maturity, Most frequent objects assessed are processes [14, 18], and management capabilities like business processes [17] or knowledge management [19].
Level	Maturity level can be represented as a number of cumulative stages that starts from a higher stages to the low one. Different model may have different number of levels. However, stages need to be distinct and well-defined, with logical progression through stages [17].
Maturity principle	Maturity can be considered as a lifecycle approach, where each entity in the model develop through the levels overtime until it reach perfection. MMs can be continuous or staged. In continuous model, the concept of 'process areas' is used where the organization can develop itself simultaneously in different process areas. As for staged model, it requires that all elements of one distinct level are achieved [20].
Assessment	Maturity assessment can be conducted using qualitative (e.g. interviews) or quantitative method (e.g. survey) [21].

A few studies have reported a few criticisms on maturity models although they are quite popular with some of IS research areas like Business Process Management or Knowledge Management. These studies had discussed what actually makes maturity models useful, which may include to the process of maturity model design, qualities or components of maturity models as design products [15]. For the process of maturity model design, De Bruin et al. [17] propose six phases comprising of scope, design, populate, test, deploy and maintain phase [17]. It was intended to guide the design of a descriptive maturity model and its advancement from prescriptive and comparative purposes.

Maturity models have been designed to assess the maturity of a selected domain based on a more or less comprehensive set of criteria. The most popular way of evaluating maturity is a five-point Likert scale with '5' representing the highest level of maturity [17]. This method has been introduced by CMMI [14] and followed by most maturity models that have been developed throughout the years. Some examples of existing maturity models are included in Table 2.

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Table2: Examples of Maturity Models

Model Name	Domain	Developer	Scale used to measure maturity	Year Developed
Capability Maturity Model Integration CMMI	Software Development	Carnegie Mellon Institute	Five point Likert scale	Early 00's
Control Objectives for Information and Business Related	IT Management	IT Governance Institute	Five point Likert scale	1996
Business Process Management	Management	Business Process Management Group	Five point Likert scale	Early 00's

In the field of disaster management, only two academic literature was found that explain the use of MM in disaster [13, 22]. Both of these paper came up with maturity model that are used to assess maturity level of information technologies in the key area of collaboration in disaster management.

MM developed by Mäkelä [22] is a customized model that were constructed based on literature review of maturity models and collaboration in disaster management, and feedbacks obtained from participating organizations in the disaster management exercises. The structure of the maturity model is organized into key areas and their sub-areas over five maturity levels that suit the disaster it represent. This MM helps to assess the capability of collaboration of all participating organization during the disaster.

The proposed model developed by Santos [13] is to assess the maturity level of emergency organization's response capacity in dealing with disaster. However, this model focused on the aspect of information technology used to provide response in a disaster. The model was built based on the concept of abstraction levels which are organized hierarchically. Each element of this abstraction will be divided into maturity levels that correspond the level of emergency organizations' response capacity.

Based on these two MMs, the structure and construction process of the two models are different, although they are used to assess the same domain, disaster management.

3. DEVELOPING THE CONCEPTUAL INFOSTRUCTURE MATURITY MODEL

In this study, based on the two existing disaster management related maturity model described earlier, an infostructure maturity model (IMM) is constructed. It will be based from the perspective of disaster management process that relates to the area of information management, and infostructure is integrated into the model. The infostructure components is integrated into each disaster management selected processes for accomplishing each objectives in the processes on every maturity level.

The proposed model will include maturity level and disaster management processes that are assimilated with infostructure. Based on the literature review and the capability maturity model (CMM), the infostructure maturity model (IMM) divides the selected disaster management processes into five maturity levels as shown in Figure 1.

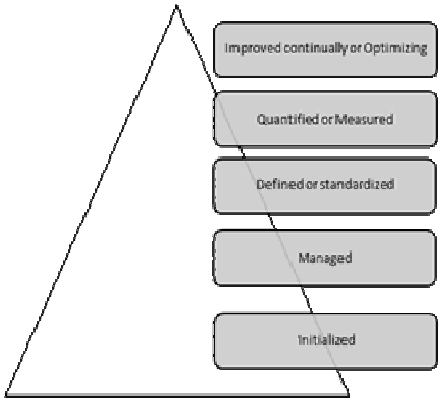

Figure 1: Conceptual Infostructure Maturity Level

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Each maturity level has its objectives and specific disaster management activities to ensure the accomplishment of the objectives specified.

Infostructure that is used in this study was has been defined as information created to be used for disaster management that includes soft structures elements that promote information sharing by delivering content and resources to stakeholders via a coordinated approach [11]. The ready information will be equipped with ICT (information and communication technologies) infrastructure that include structure and technology, and distributed to all relevant agencies during a disaster.

Constructs of Infostructure

This section will explain the three constructs that made up an infostructure and how it relates to disaster management. All three constructs is integrated into the maturity model and the complete maturity model will be used in measuring the performance of the selected disaster management processes.

Information

According to Iannella [10], it is crucial in disaster management "to deliver the right information to the right people in the right format in the right place at the right time". This information may be acquired from the locations of the disaster, nature of the damage, and from the victims on the site, in different formats and nature. The need for information changes continuously during disaster and specific information is required in different phases of the disaster management [8].

Information is one of the critical resources in supporting disaster management, and several literatures have discussed the importance of having proper and good information in managing a disaster. Quarantelli [23] stated that information is one of the issues that always emerges in a disaster management, and supported by the finding of Bharosa et al. [9] that explained that a high level of information quality is highly critical in a disaster response. Information is necessary in ensuring an effective communication in a disaster management, as it is crucial in coordinating all the activities involved in the entire disaster management phases.

Structure

Information used during a disaster need to be delivered to all the stakeholders involved. The delivery of the information need to be supported with a proper ICT infrastructure, as explained in Chan et al. [24]. It the case of implementing an e-government, there is a need for the adoption of modern systems of ICT in fulfilling the demands of the public in using the ICT initiative.

Infrastructure that is used in an emergency situation is to ensure information in the disaster area are being collected and disseminated to the right people. According to Asama et al. [25], in a mission, devices is developed to support networking and a system is built to integrate the information collected into GIS (Geographic Information Systems). Various types of robot technology are also being developed to ensure information can be quickly collected and communicated to the relevant disaster agencies.

Technology

Technology is being used to support disaster management by using information and communication technology (ICT) to manage information and resources in the event of a disaster. Technology is used to facilitate the process of disaster management by providing the means by which data, information and knowledge can be used and shared among related agencies. Information and resources are essential for a disaster management and will require technology to facilitate the existing processes in managing them during emergencies. Communication technology is one of important technology used in disaster, as it is one of the essential components in sharing real-time information as well as local knowledge and experiences. It also depend on agreed policies and regulations to induce the supply and demand for much needed telecommunications.

4. CONCLUSION AND FUTURE WORK

Disaster management have been a primary concern for many countries that are dealing with disaster. However, based on the literature review of this study, only limited academic research has been initiated in applying infostructure for a successful disaster management.

Drawing upon the characteristics of a maturity model and relevant literature of information in disaster management and infostructure, the concept of maturity for infostructure was explored and defined. This paper has reported the exploratory results of a larger research that aims to critically examine the factors for building a specific CMM model for managing infostructure in disaster management.

However, the proposed IMM is only limited to infostructure components and need to be extended

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to selected processes within the disaster management. By integrating the infostructure components and processes in disaster management, it can provides a fundamental framework for entities involved in disaster management to assess the process performance level or maturity, but also to identify the existing problems and planning for achievement of a better maturity levels. In next phase of the research, the aim is to produce a complete infostructure maturity model that relates directly to selected processes during a disaster.

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