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DESIGN AND VALIDATION OF INFOSTRUCTURE MATURITY MODEL SURVEY THROUGH RASCH TECHNIQUES

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ABSTRACT

Disaster in Malaysia originated from either natural causes or manmade reasons. It can bring catastrophic impact to a nation, in terms of human, economic or environment. Disaster management essentially relies heavily on information where all agencies involved need to ensure proper information is being disseminated in the event of a disaster. Information is needed in ensuring an effective disaster relief efforts. Hence, this paper aims to design and validate an instrument which measures the infostructure used in disaster management from three dimensions, Coordination, Communication and Control, namely the 3Cs. The instrument validation involved three (3) stages: (i) content validity, (ii) expert validation, and (iii) pilot test using Rasch Model with winstep software. This study proved that twenty-two (22) respondents are balanced for responding to fifty-seven (57) items in Rasch measurement model.

Keywords— *Coordination; Communication; Control; Rasch Analysis*

1. INTRODUCTION

Information is considered among the most important resources as it can be obtained or learned from something or someone. Information in disaster can be extracted from the people affected directly or indirectly from the disaster, especially in how a person understand the disaster situations.

Information commonly generated or obtained from agencies involved directly during the disaster or local communities that indirectly provide information to the disaster agencies. Information is compiled and disseminated to the agencies involved in determining the extent and location of impacts, which may help in understanding and determining the amount of relief required by the victims affected by the disaster.

In the context of disaster management, a new term of infostructure has been defined to encompasses all aspect of information used in disaster.

Infostructure in the domain of disaster management is defined as information created and used in activities of disaster management that includes soft structures elements that promote information sharing by delivering content and resources to stakeholders via a coordinated approach. The created information that equipped with ICT (information and communication technologies) infrastructure, including structure and technology is ready to be passed to all relevant disaster agencies [1].

The infostructure in the context of disaster management need to be measured as the agencies need to see the improvement on how the infostructure is being used throughout the entire phases of disaster management. In the occurrence of a disaster, information is crucial in ensuring the right response is delivered to the victims at the right time.

A study on disaster management has already emphasized on decision support and information sharing across multiple disaster management (DM) agencies. The right and accurate information is crucial for the government and disaster agencies in supporting communities and sectors affected during disaster as it is essential for all involved to respond in a timely and effective way. DM operations are information-intensive activities that require all activities during disaster to be supported by access to quality information.

The aim of this study is to provide a solution by introducing a maturity model as an assessment tool for infostructure usage in disaster management. A suitable maturity model is developed in recommending possible improvement in the usage of infostructure in disaster management. The proposed maturity model is specifically for the use of electricity company in managing disaster that may affect the company operations. Three selected processes in disaster management, coordination, communication and control are identified as the model dimensions.

The remainder of this paper is structured as follows: Section 2 summarizes available assessment approaches for disaster management. The research methods used for designing the maturity model are described in Section 3, while the results and findings is described in Section 4; and the final section summarizes the findings and concludes the study.

2. RELATED WORKS

2.1 Maturity Model

Maturity is a concept being applied in many aspects of product or process improvement. Literally, the word maturity carries the meaning of 'ripeness' or 'full develop', which convey the notion of development or improvement from some immature state to some more mature and disciplined state. Throughout the process to become a mature state, the subject may pass through a number of intermediate states which can be either stages or levels. Maturity has being applied to wide ranges of activities, which may include software improvement [2], organizational agility [3], business intelligence [4], innovation [5] or the famous business process management maturity model [6].

This study is applying the maturity concept of Capability Maturity Model (CMM) that was developed in assessing the process of software development [2]. Software development process in CMM has been categorized into several levels of maturity, where it has been defined as "the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective". CMM uses a cumulative set of "key process areas" which all must be fulfilled as the maturity level increases from Level 1 to the next level, until it reach the maximum of Level 5. This is described as a 'staged' representation, and leads to the attribution of a single level for maturity in the range 1-5. The levels are labelled 'Initial', 'Repeatable', 'Defined', 'Managed' and 'Optimising'. The model describes a five-level evolutionary path of increasingly organized and systematically more mature processes.

The principal area of using a maturity model is it enables an organization to understand the behavior or trait exhibited by an organization at a certain level of maturity. By understanding the typical traits at that level, it provides an opportunity for the improvement process to take place since what may what might be regarded as good practice (and bad practice) can be codified and translated into characteristics of certain level. By learning and understanding the traits at each level, an organization can improve on their process and will be able to move to the next level.

Commonly, maturity model that have been proposed or developed, share a similar characteristics, which mainly include defining a number of dimensions or process areas at several discrete stages or levels of maturity. Each stages or levels will have its own description of characteristics performance. Some of the typical components that can be seen in a maturity model may include:

- A number of levels (typically 3-6)
- A description or label for each level to identify the level of maturity
- A generic description of each level
- A number of elements or activities for each process areas

Each levels of the maturity model will carries different activities and need to be scored in assessing the performance or maturity of the process. The result from the maturity assessment will reveal the performance of the organization and help them to move to the next level. A maturity model typically will list the process areas or activities that they need to perform in order to improve their process. Sometimes, a maturity model can be considered like a checklist for an organization in identifying what process need to be performed in order for them to move to the next level.

By comprehending the nature and use of a maturity model, it can be utilized as a tool to ensure continuous evaluation and comparison. In the context of disaster management, maturity model can help to support the decision making of agencies involved in disaster. Agencies involved in disaster can identify the levels of maturity of infostructure used in disaster, and strive to improve the disaster operations by improving the infostructure usage in disaster.

By definition, maturity model are commonly used to measure competency and to evaluate the capabilities of an organizations in certain discipline. These models refer to the natural lifecycle of the discipline it represented. Taking this definition, the maturity model can be used as evaluation metric in evaluating and comparing the process for Infostructure used in disaster management, as it is used for increasing the capability of Infostructure application in the area of control, coordination and communication [7].

The main objective of an organization's evaluation is measure its competency and capabilities, where the result of the evaluation can be used as an evaluative and comparative basis for improvement. Disaster management organizations have been assessing its capabilities in dealing with disaster in different aspects. These assessments have been directed to the resources used in disaster management which may include personnel, equipment, information and communication technologies (ICT) or even coordination capability.

By having a proper assessment of infostructure usage in managing a disaster, agencies involved can adapt to the changing needs and improve their process to suit with the demand of activities in disaster management. According to several literatures that have been reviewed, most of the assessment in disaster management are focusing on information systems used or the coordination among agencies involved in a disaster [8]–[12]. There is no assessment developed to assess all the three aspects of infostructure; information, system and technology. All three aspects of infostructure is integrated into the maturity model and the complete maturity model will be used in measuring the performance of the selected disaster management processes.

In an attempt for organization to be able to assess the infostructure needed in disaster management, a model whose objective is to allow the assessment of organization's infostructure was considered. Most of assessment methods available is limited to information systems, and they are focusing on the final result of the information systems used to support the disaster management activities, rather than on how the outcome is achieved. The maturity model developed from this research will be tailored specifically for infostructure as explained in earlier section.

3. METHODOLOGY

The research methodology is shown in Figure 1.

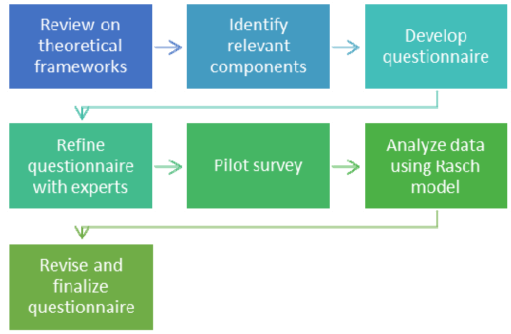

Figure. 1: Research Methodology

This research begins with the analysis of theoretical concepts. This includes the selected three dimensions that will be incorporated in the maturity model [13]: coordination, communication and control, namely identified as the 3Cs. The initial conceptual model is further formulated based on these components which are then designed as the latent constructs with identified questionnaire items. Based on the development of the questionnaire, the 3Cs component was further broken down into 7 indicators or items, namely actors or responders, taskflow, technology, competency, social media, government and policy [14]. Some reviews from the disaster management experts have been carried out, both from academic and practitioner. In order to proceed with the research, a pilot study has been conducted with the purpose of verifying the items as a mean of item quality control. The results are then analyzed using Rasch measurement model that can help to identify misfit items or persons. Misfit items or persons can be removed and amended, to improve the questionnaire. A revised questionnaire will be used in further study.

3.1 Measurement Method

Construct validity is considered as the most important in developing a specific questionnaire for a research as there is a need to ensure the quality of the questions or items used. Construct validity refers to the degree to which a test assesses the underlying theoretical construct it is supposed to measure. In any self-developed questionnaire, there is a probability that there exist any abnormality of the measured latent traits, or whether there are any items that could trigger incorrect responses. It is important to perform a quality assessment on a self-developed questionnaire before the questionnaire can be used for the study it was intended for or for the results to be used in further analysis.

The self-developed questionnaire was checked for its reliability using Rasch model. Rasch use a scaling methodology by examining the hierarchical structure, unidimensionality and additivity of questionnaire items [15]. Rasch model is a unique approach of mathematical modeling based upon a latent trait and accomplishes measurement of persons and items on the same scale, where it is used to analyze categorical data as a function of the trade-off between person ability versus item difficulty [16]. Rasch focuses on constructing the measurement instrument with accuracy rather than fitting the data to suit a measurement model with of errors.

Rasch principle states that a person having a greater ability should have a greater probability to answer an item correctly or solving any item in questions; and any person, whether they are good or weak will have better chances in answering easier item correctly compared to difficult items [16]. The reliability in Rasch model is determined by using three measures: Cronbach Alpha, Person Reliability and Item Reliability. Reliability measures shows whether similar results can be obtained when the same study is repeated using same instruments and to ensure that the questionnaire able to measure what is meant to be measured. The model fitness is measured on the person fitness and item fitness based on acceptable point measure correlation, outfit and infit mean square, and infit and outfit Z-standardized value. Cronbach Alpha is one of the common measure of internal consistency used in determining the reliability of a questionnaire that use multiple Likert questions. Thus, this study applies Rasch measurement model to analyze the instrument reliability and validity, hence provide valuable findings.

3.2 Instrument Design

Questions have been constructed based on literature review on the three selected processes; coordination, communication and control. Initially, the questions were constructed in English but due to the background of the respondents, which mostly work in government agencies, the questions was translated to Bahasa Melayu (Malay Language). The translation was done with the guide and help of a language lecturers that oversaw the entire translation process from English to Malay Language. The questions that were translated was further revised in a manner intended to make them straightforward and easy to understand by the respondents.

Length of the questionnaires has been considered carefully and the entire questions are intended to be completed in a maximum of thirty (30) minutes. The questionnaire answering time was tested by giving several tester respondents to answer the survey. The constructs and constructs indicators or items of the questionnaire were modified to ensure it can be understood by potential respondents. The constructs are divided into four selected processes; they are Coordination, Communication and Control. All three constructs are selected processes that are critically important in the entire four phases of disaster management; namely Mitigation, Preparedness, Response and Recovery.

3.3 Instrument validation

The instrument validation involved three (3) steps: (i) content validity, (ii) expert validation, and (iii) pilot test using Rasch Measurement Model with winstep software. The three steps are expected to produce reliable and valid items for the questionnaire designed to assess infostructure usage in disaster management.

It was stated in a paper by Azrilah et al. [17] that Rasch model addresses the five principles of measurement model, estimating precision of data collected in a test, the ability to afford linear equal scale, overcome missing data, detecting fitness of data or presenting reliability of data obtained from the test. In this study, two (2) principles are used from Rasch model, to detect the fitness of data and provide the reliability of the test used.

The first step of the instrument validation was conducting the content analysis of the questionnaire. The content was analyzed to ensure that it has all the constructs required for the questionnaire, which are coordination, communication and control. Elements of infostructure must be present in all three (3) selected processes of disaster management. The developed survey is validated by adopting the method used by Khoja et al. [18] which used a mixed methods approach of sequential exploratory design. This research applied face validity approach using two group of experts. The process of validation is done by measuring the face validity of the survey instruments, whether the items appear on questionnaire is what the scale supposed to measure [18]. The face validity is aimed in ensuring the content and wording used in the survey are free of errors and also to revise and examine the questions in terms of meaningfulness, relevance and clarity [19].

The experts chosen are competent in the domain of disaster management, both from academic and practitioner. Reviews from academicians is required as they have the experience and knowledge related to survey instruments and involve in disaster management research. The experts chosen in this study were from Universiti Teknologi Malaysia (UTM) and Universiti Tenaga Nasional (UNITEN). In the other hand, practitioners input is essential in implementing the face validity as they have first-hand knowledge in on practices as well with experiences in managing real disaster. Practitioners that helped with the validation of the questionnaire work in National Disaster Management Agency of Malaysia (NADMA) that oversee the operation of entire disaster agencies in Malaysia.

After correcting the instrument as suggested by both experts from academician and practitioners, a pilot study was conducted. Finally, data obtained from the pilot study were analyzed to measure the validity and reliability of the questionnaire using Rasch measurement model with Winstep software. Rasch Model using Winstep software was chosen as it able to analyze the questionnaire responses by revealing the ability and attitude of respondents as well as difficulty of items [16].

3.4 Administration

The questionnaire was administered to twenty-two (22) respondents from two government disaster agencies. Both of the agencies are considered as the main responders during the event of a disaster. For this study, the researchers contacted the State Director of the agencies to obtain permission for conducting study. Subsequently, staff from the two agencies were contacted by the State Director to hold a meeting for the questionnaire to be given. In the meeting, staff were called to answer the questionnaire and they were asked for their willingness to provide valuable response.

3.5 Data Analysis

The respondents from the agencies filled in the questionnaires blindly in encouraging the consistency of the staff in giving response based on the fact they experienced during their disaster operation. Fifty-seven (57) items from three dimensions were analyzed. These items resulted from content validity and expert validation for constructs and the validity of the contents asked in the questionnaire. According to content validity and expert validation, the fifty-seven (57) items are expected to measure the infostructure usage in all three processes of disaster management, which are coordination, communication and control.

The result was used to examine the reliability and validity of the questionnaire, Statements on the questionnaire were designed to be coded as numerical responses with Likert Scale that ranges from 1 to 5. Data were collected using a structured questionnaire with the five-point Likert scale. To answer the survey, respondents will indicate their agreement with each indicators using a five-point scale from 1 (anchored with “Strongly disagree”) to 5 (anchored with “Strongly agree”).

The questionnaire comprised of three (3) sections, in which the first section is the respondent profile, the agencies profiles the respondent belongs to and the current infostructure usage in the agencies. Section 1 require the respondent to state their length of working in the agencies and position they hold in the agencies. Names and address of agencies is not made compulsory in encouraging the respondents’ participation in answering the questionnaire. Section 2 ask on the disaster agencies profile, which include the nature of the agencies in managing disaster, total time in managing disaster, phases of disaster management the agencies is involved, and the ability or expertise of the agencies in managing disaster. For this section, most of the questions only require the respondents to tick suitable answers that has been provided by using tick boxes.

This paper will only focus on Section 3, which contain items that ask for the respondents experience in using infostructure during disaster. Section 3 is questions that provide answers in the form of Likert Scale from 1 to 5, from “Strongly disagree” to “Strongly agree”. In this section, it contain fifty-seven (57) items which the respondents has to answer all questions.

Each questions is categorized into a few topics, with the main categories being the three selected processes in disaster management, namely, coordination, communication or control. It consists of seven (7) topics and all the topics will have its own set of indicators that range from 2-5 indicators, which will be treated as individual items for convenient of measurement and analysis.

The sample comprised of twenty-two (22) staff from two different disaster agencies. Both of agencies that participated in the questionnaire has experienced the same nature of disaster at the same time. The respondents were coded freely by giving them numbers that is incremented. The items are keyed in according to their marks. The data then is ran into WinSteps analysis software version 3.92.1, one of the software for Rasch measurement model.

3.6 Theoretical Framework Review

3.6.1 Identification of Components in Infostructure

The selected processes in disaster management that is the focus of this questionnaire are known as the 3Cs, namely identified as coordination, control and communication, as stated in a paper by A. Latif and Arshad [8]. Each components is discussed briefly below in Table 1, followed with detail description of the components.

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Table 1: Brief Description of the Selected Processes [14]

PROCESSES	DEFINITION
Coordination	A disaster is a complex environment that requires activities of operations being done by multiple organizations. These organizations will be involved in decision-making that use reliable and relevant information. These critical information are collected from relevant agencies that is dictated by the National Security Council of Malaysia.
Communication	Communication that relies heavily on technology is important in disaster management as it can be used as one of the medium in disseminating information to the public in any phases of the disaster, from the mitigation to the relief phase.
Control	Control is required to govern the stakeholders that are involved in a disaster management. Typical control includes guidelines of Standard Operating Procedure (SOP) that will ensure sound coordination and clear roles and responsibilities in coordination and communication.

1. Coordination

Coordination is required in any disaster activities, as multiple agency will respond to any event of a disaster. Without coordination, vital information could not be shared across agency and this may delay their collaborative work in performing decision makings and action.

The study focus on disaster that affect electricity company in Malaysia that uses hydro to generate electric. One of the common disaster that may happen is flood as it use hydro to generate electricity. As flood is an regular occurrence that happen annually especially during monsoon seasons, Malaysia has introduced an amendment to the 1997 Directive No. 20 that saw the establishment of National Disaster Management Agency (NADMA) in 2015 that oversee the coordination among government agencies in tackling disasters. Coordination is crucial in ensuring all assistance to disaster victims are channeled more effectively and orderly.

Any disaster including flood need to be coordinated in ensuring information relating to the disaster can be disseminated to all relevant agencies. Without these information, the right types of rescue and relief activities could not be provided to the victims.

2. Communication

Disaster relies on communication technology in passing the information to all the agencies involved during a disaster, as well as delivering the disaster information to the public. It also help in providing education to the public on how to respond if a disaster hit.

According to Nazir et al. [20], information created for an agency is not shared across agencies. This is one of the factor of why a rescue activities cannot be done efficiently as all agencies need to have the right information at the right time to ensure proper resources are being channeled to the disaster victims.

The information flow from one agency to another is neither well-defined nor well-documented that caused the information-sharing process are not transparent among the agencies involved. Lack of communication across agencies can be seen from the recent flood disaster that hit Malaysia where information are created for a particular agency, without sharing the information with others that might facilitate the disaster management process [20].

3. Control

Disaster management relies heavily on collaborative efforts that is joined by numbers of agencies, and each agencies have its own roles and responsibilities. In Malaysia, disaster management effort is divided into three levels, with different stakeholders with specific roles and responsibilities.

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This structure was based on Directive No. 20 that was published by the National Security Council of Malaysia [21]. By listing roles and responsibilities, along with the authority of each level and agencies under these levels, it is evident that proper governance structure is crucial is governing the stakeholders that are involved in a disaster management.

The maturity model is largely influenced by the three components explained earlier, and Table 1 shows the components' relevant items and their source of references.

Table 2: Description of the seven indicators

Components	Indicators/Items	Description	Sources
Coordination	Actors/Responders	The actors or responders who have the authority in managing disaster in the organization	Chen et al. (2008) [22], E. Raju (2013) [23], Bharosa (2012) [24]
	Task-flow	It revolves with the process of doing decision making, procedures in disseminating disaster information, processes developed for coordination	
Communication	Technology	The availability and connectivity of Internet and the choice of communication tool	Seppanen (2015) [25], Alexander (2014) [26], Comfort (2006) [27]
	Competency	It ask on people capability in the organization, and terminology used in communicating across agencies	
	Social Media	Goals in using social media in relaying information, and ownership of the used social media channel	
Control	Government	Initiative executed by the government and legal framework used for disaster	Kyoo-Man Ha (2015) [28]
	Policy	Governance aspects of disaster which mainly focus on policy making	

4. THE INITIAL CONCEPTUAL FRAMEWORK

4.1 A Maturity-based model for assessing infostructure in disaster management

This study defines a maturity model to assess the infostructure required throughout the entire stages of disaster management. The model aims to assist any disaster agencies in understanding the infostructure required in facilitating the DM activities, specifically for better coordination and communication, through the visualization of the infostructure needed. As indicated in the earlier section, maturity models allow an organization to assess its improvement in terms of increasing maturity levels, following the concept of CMMi model that is used to measure software improvement (Paulk et al., 1993).

The infostructure used in DM is analyzed from three different aspects that make up an infostructure, which are information, systems and technologies. The models will have three different dimension that consists of the four DM phases (mitigation, preparedness, response and recovery), area of concern for DM that we considered as the key areas and the increasing maturity levels. An Infostructure Cube (IC) as shown in Figure 2 is created for a better understanding in assessment of an infostructure, which include the three dimensions, namely the DM phases, area of concern and the maturity levels. Each level has requirements or criteria that must be complied with by the organizations, for it to achieve that particular level. Once an organization has reach a certain level, it will know the criteria or requirements it need to achieve a higher maturity level.

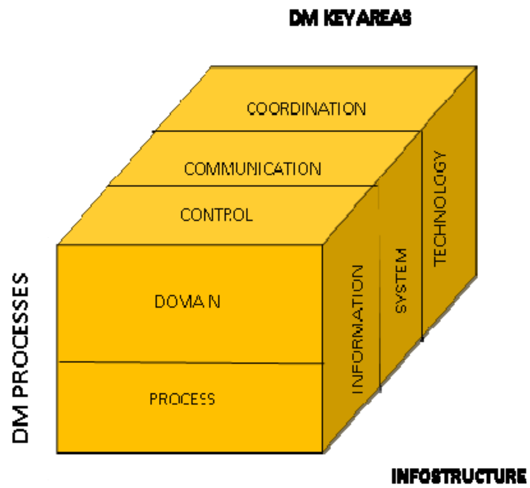

Figure 2: Infostructure Cube

The structure of the maturity model is organized into domain, followed by processes with specific category over defined maturity levels. The maturity model levels indicates the different stages of maturity of infostructure in DM. In the maturity models of CMMi, the software development measurement develops from the maturity level, "Initial", to the highest level, "Optimized", through "Managed", "Defined", and "Quantitatively Managed".

The next step of the model creation is based on the review of the theoretical frameworks, where three selected processes has been identified for the inclusion in the questionnaire, as listed in Table 1, which are coordination, communication and control. Table 2 shows the processes' relevant items and their source of references. Figure 3 illustrates the corresponding components or indicators reflected in the questionnaire. Actors or Responders and Taskflow belong to Coordination, Technology, Competency and Social Media belong to communication and the last component, control have Government and Policy.

Actors or responders are the people in charge or responsible in managing disaster in that particular disaster agency. These actors will be responsible in making decision during a disaster, including who is responsible in delivering information and determining the processes of operation in that agency.

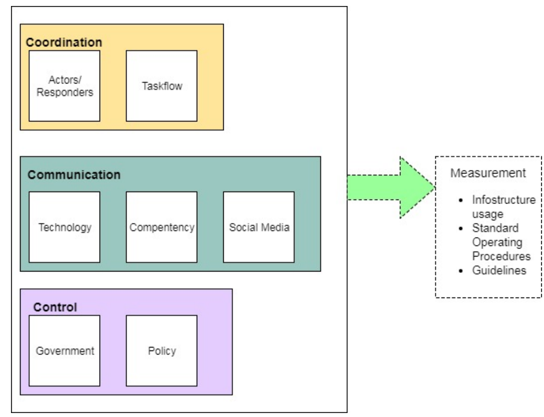

Figure 3: The corresponding components or indicators reflected in the questionnaire

The second process, coordination relates to technology, competency and social media. It relies on the use of technology in ensuring there is an effective communication during a disaster, which include access to communication tool and the ability of the agency staff in using that tool.

The success of the model is also largely influenced by the control process which relates to government and policy making.

The seven identified components become the latent construct of the initial framework. A total of fifty-seven (57) items were considered for the questionnaire, which developed according to the three steps mentioned in earlier section.

5. RESULTS AND DISCUSSION

Analysis tool Winsteps Version 3.92.1 was used to examine the data. Rasch analysis can be carried out several times until a satisfactory results can be obtained. The summary statistics as shown in Figure 2 reveals excellent person reliability measures and Cronbach alpha with 0.99 values. For reliability, a value of greater than 0.7 shows high reliability. Outfit and infit mean square is 0.85 and 0.94 respectively, and this is very close to the expected value of 1. Z-standardized value is 0.4, and this is also close to value 0 and within the normality range: $-2 < Z < +2$.

The summary of measured items, also shown in Fig. 2, shows the overall fitness of the instrument whether it fits with Rasch model. Item reliability with 0.4 is quite fair. Item mean square values are very also close to 1 and within the expected range of $0.5 < x < 1.5$. Z-standardized value is .1; it is expected to be at norm and within the normality range -2 < Z <+2. This indicates overall fit to the Rasch model.

SUMMARY OF 21 MEASURED (NON-EXTREME) PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	245.1	56.8	5.15	.34	.94	-.1	.85	-.4
P.SD	29.1	.4	2.28	.10	.46	2.5	.45	2.4
S.SD	29.8	.4	2.33	.11	.47	2.5	.46	2.4
MAX.	283.0	57.0	9.51	.73	1.87	5.3	1.68	4.1
MIN.	141.0	56.0	-1.64	.20	.06	-4.8	.04	-5.1

REAL RMSE .39 TRUE SD 2.24 SEPARATION 5.72 PERSON RELIABILITY .97
MODEL RMSE .36 TRUE SD 2.25 SEPARATION 6.31 PERSON RELIABILITY .98
S.E. OF PERSON MEAN = .51

MAXIMUM EXTREME SCORE: 1 PERSON 4.5%

SUMMARY OF 22 MEASURED (EXTREME AND NON-EXTREME) PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	246.9	56.8	5.44	.41				
P.SD	29.6	.4	2.59	.33				
S.SD	30.3	.4	2.65	.33				
MAX.	285.0	57.0	11.47	1.83				
MIN.	141.0	56.0	-1.64	.20				

REAL RMSE .55 TRUE SD 2.53 SEPARATION 4.62 PERSON RELIABILITY .96
MODEL RMSE .52 TRUE SD 2.53 SEPARATION 4.84 PERSON RELIABILITY .96
S.E. OF PERSON MEAN = .56

PERSON RAW SCORE-TO-MEASURE CORRELATION = .95
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .99 SEM = 3.02

SUMMARY OF 57 MEASURED (NON-EXTREME) ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	95.3	21.9	.00	.52	1.00	-.1	.85	-.3
P.SD	2.5	.3	.67	.01	.48	1.3	.49	.9
S.SD	2.5	.3	.67	.01	.48	1.3	.49	.9
MAX.	100.0	22.0	2.34	.55	2.55	3.1	2.77	2.7
MIN.	87.0	21.0	-1.17	.51	.41	-2.5	.33	-1.6

REAL RMSE .56 TRUE SD .36 SEPARATION .65 ITEM RELIABILITY .29
MODEL RMSE .52 TRUE SD .42 SEPARATION .82 ITEM RELIABILITY .40
S.E. OF ITEM MEAN = .09

Figure 4: Summary statistic (first run)

Rasch analysis principle stated that negative correlation gives a perception that there could be something wrong with an item or a person. A close examination of the person misfit order shows that person R16 has negative point correlation (-0.1), as shown in Figure 4. This candidate can be considered to be removed for an increase in the reliability. Person R16 was removed from the data set, and Rasch analysis was done with the new set of data. Summary statistics for the second run is shown in Figure 7. Person reliability stays at 0.99 while item reliability has a slight improvement with a value of 0.47. This indicates an increase of reliability as compared to the previous result before the removal of data. Item mean square values are 1 and Z-standardized values are 0.1, which are still within range. This again confirms the overall fitness of the instrument with Rasch model.

MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.
6.79	.30	1.87	5.3	1.68	3.7	A .25	.31
9.51	.73	1.72	1.1	.34	-.8	B .47	.17
5.53	.28	1.47	4.3	1.60	4.1	C .21	.28
-1.64	.20	1.18	1.0	1.23	1.2	D .09	.37
6.37	.28	1.17	1.7	1.21	1.8	E .62	.30
5.68	.28	1.17	1.9	1.19	1.6	F-.01	.29
5.68	.28	1.08	.9	1.15	1.3	G .38	.29
4.60	.31	1.15	.8	1.10	.5	H .36	.24
6.37	.28	1.06	.6	1.05	.5	I .40	.30
4.60	.31	1.03	.2	.97	-.1	J .26	.24
8.49	.48	.99	.1	.73	-.4	K .32	.23
6.53	.29	.99	-.1	.96	-.3	j .32	.31
6.62	.29	.92	-.7	.90	-.7	i .41	.31
7.17	.32	.80	-1.2	.74	-1.3	h .57	.30
4.40	.33	.80	-.9	.80	-.8	g .25	.23
4.42	.33	.79	-1.0	.77	-.9	f .26	.24
3.96	.36	.74	-.9	.63	-1.3	e .00	.22
3.94	.36	.70	-1.1	.70	-1.0	d .06	.22
2.94	.39	.09	-4.5	.05	-4.9	c .47	.25
3.09	.39	.07	-4.8	.04	-5.0	b .00	.24
3.09	.39	.06	-4.8	.04	-5.1	a .00	.24

Figure 5: Person misfit order

SUMMARY OF 21 MEASURED (EXTREME AND NON-EXTREME) PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZS
MEAN	246.6	56.8	5.51	.42				
P.SD	30.3	.4	2.68	.33				
S.SD	31.0	.4	2.75	.34				
MAX.	285.0	57.0	11.61	1.83				
MIN.	141.0	56.0	-1.67	.21				

REAL RMSE .56 TRUE SD 2.62 SEPARATION 4.70 PERSON RELIABILITY .
MODEL RMSE .53 TRUE SD 2.63 SEPARATION 4.93 PERSON RELIABILITY .
S.E. OF PERSON MEAN = .60

PERSON RAW SCORE-TO-MEASURE CORRELATION = .95
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .99 SEM = 2.9

SUMMARY OF 57 MEASURED (NON-EXTREME) ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZS
MEAN	90.9	20.9	.00	.54	1.00	-.1	.85	-
P.SD	2.5	.3	.73	.01	.52	1.3	.53	1
S.SD	2.6	.3	.74	.01	.52	1.3	.54	1
MAX.	96.0	21.0	2.36	.57	2.52	2.9	2.95	2
MIN.	83.0	20.0	-1.39	.52	.37	-2.4	.29	-1

REAL RMSE .59 TRUE SD .44 SEPARATION .76 ITEM RELIABILITY .
MODEL RMSE .54 TRUE SD .50 SEPARATION .94 ITEM RELIABILITY .
S.E. OF ITEM MEAN = .10

Figure 6: Summary statistic (second run)

Rasch item maps shows the distribution of item difficulties aligned with the distribution of person abilities measured in terms of logit scale, a common measurement used for both [16]. As shown in Figure 7, the person-map illustrates that all the items are considered easy to endorse by all persons. Respondents at the higher scale are more easily agreeable to all items, which may see them in choosing scale of 5 (strongly agree) in answering the items, such as person of R20, while those at the bottoms are less agreeable with the items. There is one item free at the bottom of the map, which means that he or she hardly agrees with all the items.

```
MEASURE       PERSON - MAP - ITEM
                   <more>|<rare>
   10              R20  T+
                   R2    |
                         |
    9                    +
                   R4    |
                         |
    8                    +
                        S|
                   R5    |
    7              R21   +
            R10    R7    |
            R12    R6    |
    6                    +
            R1     R22   |
                        M|
    5                    +
            R15    R19   |
            R17    R9    |
    4       R13    R8    +
                         |
                         |
    3 R14   R18    R3   S+
                         |
                         |   B3_
    2                    +
                         |   G1_
                         |T  B3_  B3_  F1_
    1                    +   B2_  C2_
                         |S  B2_  D1_  D2_  E2_  F1_  G1_
                        T|   B3_  C1_  E2_  G1_  G1_  KR1
    0                    +M  C1_  C1_  C1_  C2_  C2_  D1_  D2_  E1_  E2_  F1_  G1_  K
                         |   B1_  B1_  B2_  D1_  D1_  D2_  E1_  E2_
                         |S  A1_  A1_  B1_  B1_  B1_  B2_  B2_  C1_  D1_  D2_  KO2  K
   -1                    +   A1_  A1_  KO1
                         |T  A1_  B1_
                   R11   |
   -2                    +
                   <less>|<freq>
```

Figure 7: The Variable Map

The data set was also run for Cronbach's Alpha to check for its reliability statistics, which resulted in 0.972, as shown in Table 3. Cronbach's alpha is also used as it is the most common measure of determining internal consistency or reliability of a questionnaire. It is most commonly used for questionnaire that use multiple Likert questions, which in this study is using five-point Likert scale to form the scale. Result from the Cronbach's alpha analysis can determine if the scale is reliable, and as the result is 0.972, which indicates a high level of internal consistency for the scale used for the questionnaire.

Table 3: Cronbach's Alpha run using SPSS

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.972	.973	57

The next step of determining the reliability of the model is to examine the unidimensionality, which is they key component of content validity. All the items did not have any negative point measure correlation, and therefore all items will be retained.

6. CONCLUSION

Disaster management is an area which need further research, especially in the domain of information management as all the processes involved require information for it to be executed effectively. This research begins with the initial model development by first identifying the relevant components based on the literature review of the domain, and further, we proceed by developing questionnaire for the constructs. The identified components were based on earlier research conducted which are the 3Cs: coordination, communication and control.

The quality of the items is verified using Rasch analysis to ensure the fitness of the item constructs. Rasch analysis help to provide perception on the model development whether it is being built with the right components, and whether the items fit a construct. The study help to confirm that the reliability and validity of the measurement instruments can be improved by removing misfit person or items. The analysis had shown that there is no excessive amount of misfit items or persons, henceforth, it can be concluded that the items are reliable to be used in further study.

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