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ORIGINAL ARTICLE

Development of Flood Disaster Preparedness Activity (FDPA) Items: A Preliminary Study Using Rasch Analysis

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ABSTRACT

Introduction: Not only does flood affects the household community, but it also has an impact on business entities, particularly small and medium enterprises (SMEs) located in flood-prone areas. In order to assist SMEs to prepare for a flood disaster effectively, the set-up of a disaster preparedness plan is essential. The purpose of this study is to develop a validated instrument for identifying the different levels of disaster preparedness among SMEs in their readiness to face a flood disaster. **Methods:** In this preliminary study, 26 items of flood disaster preparedness activities (FDPA) reviewed from works of literature were adopted and adapted to be randomly administered to 30 respondents (SME business owners) located in the Temerloh province, Malaysia, which is identified as a flood-prone area. A Rasch analysis technique was used to identify the psychometric properties of the instrument. **Results:** Using the Rasch measurement analysis technique, the instrument used was able to categorise the SMEs into two level of preparedness: low and moderate. About 25 items were found to possess good psychometric features in determining the flood preparedness level of SMEs despite the lack of items on measuring high-level preparedness activities. **Conclusion:** The results of this preliminary study have served to highlight the strength of the instrument and gaps identified for further improvement in the near future.

Keywords: Flood, Disaster preparedness, Small and medium enterprises (SMEs), Rasch analysis

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INTRODUCTION

In recent years, Malaysia has experienced increasingly frequent flood events, where the magnitudes are estimated to further increase attributable to the rising sea level following climate change. The flood disasters in the eastern part of Peninsular Malaysia (e.g. Kelantan, Terengganu, and Pahang states) are commonly associated with the annual seasonal monsoon from November to January, which causes rivers to overflow and flood the surrounding area (1).

As the primary focus of flood disaster is the community and household properties in dealing with flood disasters, industrial business activities, particularly SMEs, are often second-rated. According to the Asian Disaster Reduction Centre, 90% of surveyed small businesses went bankrupt due to the production damage and supply chain disruption in the March 2011 earthquake and tsunami (2).

SMEs in Malaysia were defined into two categories (1) manufacturing sector (sales revenue not more than RM50 million or full-time employees, not more than 200 workers and (2) services and other sectors (sales revenue not more than RM20 million or full-time employees, not more than 75 workers) (3).

SMEs are significantly important to the growth of any economy. In Malaysia, 98.5% (907,065) business establishments in the country were made up of SMEs and estimated to contribute 37% to the country's gross domestic product (GDP) in the year 2017 (4). Nevertheless, these businesses are always vulnerable to disaster risks, due to the lack of awareness, information and necessary funds to adopt any actions to reduce the risks (5). The scheme to prevent risks of small businesses, however, is not systematically developed and implemented.

Disaster preparedness is defined as "a state of readiness" to respond to a disaster or crisis. The activities includes reactive and proactive reaction comprised a list of

activities, programs, and systems that are developed before any crisis to prepare, support and intensify response to emergency or disaster (6). Disaster preparedness act as one of the key components of disaster management cycle refers to activity conducted not only to save lives, but also to minimise damages to properties and lessen the effects of a crisis event, including long-term disturbances of business activities (7).

The role of disaster preparedness has been theorized to reduce the vulnerability of disaster risk (8–11). Thus, disaster preparedness is a set of activities taken to reduce disaster effects and promote immediate response to disaster events and part of a business continuity plan. In this study disaster preparedness consist of activities planned to mitigate the hazards risk (flood) in consideration of life safety and business protection aspects. Business protection is the ability of the business owners to undertake emergency actions in order to protect property and contain disaster damage as well as engagement in early recovery activities. Employee protection is regarded as a general concept of life safety protection (protecting the employees and others to perform an immediate action in preventing injury and death). To the best of the researchers' knowledge, there are no standard tools and checklist intended to measure flood preparedness activities designed to cater for small-scale businesses in Malaysia.

Several checklist or instrument observing disaster preparedness on industries includes preparedness activities such as provision of information on disaster to employee and customer (written, meeting or training), conduct disaster drill and exercise, provide emergency supplies (e.g. food, fuel and batteries, cellular phone, emergency radio and power generator), first aid kit, engage in structural (e.g. flood walls) and non-structural mitigation (e.g. securing computer) actions, establish emergency and recovery plan, access and evaluate disaster vulnerability and initiation of early recovery (e.g. purchase insurance and made arrangement for alternative location) (7,12–18).

Established in literature, the preparedness efforts focus of general all-hazard preparedness. Irrespective of the agent causing the disaster, households, businesses, and community organisations roughly response in the same manner. The approach begins by assessing what various risk (different type of disaster hazards) have in common in respect of response demands. Then, the different approach was only set out later focusing on specific contingencies plan that applies to other types of disaster (19).

Although it is useful to acquire data on preparedness activities conducted by SMEs, the instrument to measure the preparedness must be specific, valid, and reliable to measure preparedness activities conducted by the SMEs. Then only the data can help in understanding whether and to what extent the SMEs adopted proactive behaviours to adaptively deal with disaster risks.

In addition to measuring preparedness, the activities should be differentiated into a different level of difficulty to assess the level of preparedness of SMEs. This is also a part of developing a good instrument that able to measure a wide range of items difficulty level. Ignoring this caused the latent construct (referring to items) highly redundant with one another. Despite improving the internal consistency it would likely create an overly narrow scale that does not assess the construct optimally (20). Thus, it is very crucial the process of instrument development involve repeated observation of the data on a test (analysis of items) as well as the categorization of items level (21).

Moreover, it is also noted from a study conducted by Sadiq (22) that the preparedness efforts were made up of passive and active hazards adjustment. Passive hazards adjustment is likely to be conducted by the organization compared to active hazards adjustment. Characterization of hazards adjustment into two group takes into consideration weightage of each item (different level of difficulty) in order to compare the degree of commitment towards preparedness between organisation. Specifically, this will help characterize the level of preparedness and help to identify the gaps of any inadequate activities in different level to be addressed. The good instruments need to measure the wide range of level or abilities of the target population instead of focusing on either extreme ends (easy or difficult) of the task, item or characteristics only. Thus, this preliminary study intends to develop and validate an instrument which measures flood preparedness level among SMEs.

MATERIALS AND METHODS

Review of literature - disaster preparedness activities

Over the past decade, several studies have explored preparedness activities of SMEs and factors associated with the engagement in preparedness activities (7,15,17,18,23). In order to measure the engagement of disaster preparedness activities in businesses, previous scholars (7,12–18) have developed a set of items categorised as preparedness activities based on the existing practice. The preparedness activities are as summarised in Table I.

In addition to the preparedness activities listed in Table I, Sutton and Tierney (19) emphasised eight dimensions of disaster preparedness; each comprises several activities. The eight dimensions of preparedness are: (1) hazard information; (2) management supervision and direction (e.g. disaster training, drill); (3) response plan agreement; (4) complementary resource; (5) protection on the life survival; (6) protection on the properties or assets ; (7) crisis adjustment (coping mechanisms); and (8) initiation of recovery.

Table I. Previous study on disaster preparedness activities for business.

Category	Related study							
	Dahlhamer & D'Souza, 1995	**Tierney, 1997**	**Kreibich et al, 2007**	**Sadiq, 2010**	**Han & Nigg, 2011**	**Howe, 2011**	**Chikoto et al., 2013**	**Sadiq & Graham, 2016**
Types of hazards	Earthquake/ Flood	Earthquake	Flood	Earthquake	Earthquake	Hurricane/ Flood	Earthquake	Natural disaster
Unit of analysis	All types of business organisation (Business owners)	All types of business organisation (Business owners)	All types of business organisation (not stated)	Public, private, and non-profit organization (professional managers)	All types of business organisation (Business owners)	All types of business organisation (Business owners)	Non-profit, private, & public organisations (Business owners & manager)	All types of business organisation (All level of employee)
Preparedness activities/preparedness measurement								
-Attend meetings or receive written information	✓	✓		✓	✓	✓	✓	✓
-Talk with employees on preparedness	✓	✓		✓	✓	✓		✓
-Brace shelves, equipment	✓	✓						
-Purchase insurance	✓	✓	✓		✓	✓		
-Store food or water, office supplies, fuel or batteries	✓	✓			✓	✓		
-Learn first aid	✓	✓			✓			
-Obtain first aid kit or extra	✓	✓			✓			✓
-Develop an emergency plan	✓	✓	✓		✓	✓		✓
-Develop a recovery plan	✓	✓			✓	✓		✓
-Develop emergency contact list								✓
-Have engineer assess building	✓	✓			✓			
-Conduct drills or exercises	✓	✓	✓		✓			
-Involved in preparedness or response training programs	✓	✓		✓	✓		✓	✓
-Made arrangements for alternative location	✓	✓	✓		✓	✓		
-Obtain an emergency generator	✓	✓			✓	✓		✓
-Arranged site visits by experts to better prepare for disasters				✓			✓	✓
-Provided information to customers on disaster issues				✓			✓	✓
-Access and evaluate vulnerability to disaster				✓			✓	✓
-Engaged in non-structural mitigation measures (e.g., securing computers)				✓		✓	✓	✓
-Engaged in structural mitigation measures (e.g., flood wall)			✓	✓		✓	✓	✓
-Provide cellular phone or emergency radio					✓			

Note: ✓ notation means the preparedness activities were mentioned by scholars in their study

Sutton and Tierney (19) used the terms "dimensions" and "activities" to describe the disaster preparedness concept. As understood by communities studying disaster, preparedness concept involving variety of dimensions and also known as constructs. This dimensions or constructs always supported by several preparedness activities that lead to disaster preparedness. The dimensions or construct act as a basis or context for the preparedness activities based on the aim and target set for achieving preparedness goals. The preparedness activities made up of tangible and measurable actions in order to complete the preparedness goals.

Common approach measuring preparedness action in previous study was a simple arithmetic addition of preparedness list which does not address or assign weightage to the different preparedness activities. Realizing the potential of under and over-estimation, this study further determines and classify the weightage of preparedness items to measure preparedness levels. The classification of preparedness items into several level is by determining the respondent ability and capability

engaged in disaster preparedness activities incorporated into the Rasch theory of measurement. This was based on a study conducted by Sadiq (22) to separate hazards adjustment (preparedness activities) two category; active hazard adjustments (such as held disaster training, arranged visit by consultant, engagement with structural and non-structural mitigation measures) from indirect (passive) hazard adjustment (such as mentioned potential hazards in meetings and discussing short term and long term response in meeting).

Application of Rasch analysis in measuring disaster preparedness

Rasch was based on the concept of item response theory. Item response theory enables the mathematical model prediction of the probability of success (performance) of a person towards task (item), depending on the person's "ability" and the task "difficulty". In Rasch, both person ability and item difficulty are defined and plotted on the same logit scale. The knowledge on the person abilities can be used to predict the performance of the individual or organization. This is the benefit of using a mathematical function to predict the probability of success and performance level. In addition, Rasch produces analysis estimating the individual respondent's trait level, thus enable test developer to understand whether the scale provides more precise estimation on the item characteristics at the lower, middle, or upper end on the linear distribution (20).

Although Rasch allows only one dimension of measurement and assumes equal item discrimination for each of items in the constructs, the limitation can be easily addressed where the items violated the Rasch assumption can be distinctively identified and removed from the measurement to increase the model fit. Measuring the score of preparedness activities by using the Rasch analysis is the alternative to the computation of score by adding raw data. The total raw score is only a general figure for certain observations as a result from the computation of the average score. Raw score cannot be measured as it is still in the ordinal form and is statistically not able to be used to generate inference. No special weightage is assigned and all the activities are considered to have the same degree of level.

In the Rasch, a turn of event is seen as a chance, meaning that a likelihood of happenings later will form a ratio data (24). Rasch used logit as the measurement unit, thus transforms the results into a linear correlation. The Rasch measurement model idea generally describes as the following basis of theorems (25):

i. An individual who has more abilities has a more probability of rightly answering all the items given.
ii. An effortless (disaster preparedness) item is probably to be answered (adopted) accurately by all individuals.

In the case of measuring disaster preparedness engagement, an organisation that has more abilities to prepare for disaster has a greater probability to adopt or implement all types of disaster preparedness activities. Meanwhile, an organisation that is not prepared for disaster always has difficulties to adopt in most types of disaster preparedness activities.

Abilities of the organisation to prepare for disaster events (engagement in most of preparedness activities) are associated with the strength of its adaptive capacity that influence by the several factors such as social, economic, political, and psychological factors (16). These factors have been observed to indirectly reflect the preparedness patterns of the organisation (7,12–18). For example, organisation with better resources, knowledge and manpower at their proposal are predicted to be better prepared befitting the Rasch concept; organisation with a higher level of preparedness would be able to adopt most of the preparedness actions.

Sample and location of study

A total of 34 respondents (business owner's and manager) participated in this study. Business manager regards as decision's makers, however the other level of employee excluded in this study. Four respondents were excluded due to missing data and response bias. Thus, only 30 respondents proceeded for further analysis process. The list of SMEs businesses was obtained from the database of SMEs in the province of Temerloh, Pahang (26). The SMEs were first categorised into two categories: (1) retail and wholesale, and (2) services. A random selection of SMEs was sampled from the list. The respondents in this preliminary study serve as the representatives to test the construct validity of the instrument developed. The sample size for preliminary study was suggested to be between 10-30 respondents (27,28) .

This survey was conducted September 2017. A recent heavy rain on January 2017 has resulted on flood affecting six states worst being the state of Pahang and Johor, where flood level rose up to 1.5 metres in some part of the area (29). Temerloh is the second largest town in Pahang, being selected in light of its experience with several major flood events. Temerloh re-experienced the worst-hit flood in the province after about 43 years since the 1971 flood (30). This worst-hit flood had caused all the areas in Temerloh to become completely submerged, including areas that were categorised as flood-free zones. Besides Kuantan, Temerloh is the most populated town with SMEs parallel with their role as a second largest town in Pahang. Hence, Temerloh was selected in this study characterized as town with high population of SMEs as well as have experienced frequent and major case of flood occurrence.

Instrument

A set of questionnaire surveys was designed based on the elements of employee protection and business

continuity adopted and adapted from previous researches (7,15,17,18,23). Overall, this survey was divided into two sections. The first section collected information on the demographic characteristics of SMEs, such as annual income, year of establishment, sector of business, ownership status of the premise, number of current workers, and availability of franchise or branch. The second section, on the other hand, determined flood preparedness activities carried out by the SMEs as follows:

i. Sub-category 1: Employee protection – Item numbers 1 to 16 (evacuation planning, emergency communication, shelter need, emergency supply, and safety aspect).
ii. Sub-category 2: Business protection – Items 17 to 26 (information protection, inventory protection, structural protection, early recovery, and overall planning).

A five-point Likert scale – strongly disagree (5), disagree (4), not sure (3), agree (2), and strongly agree (1) – was employed in this survey. Table II categorises each of the FDPA in ten constructs of items. The FDPA items were developed based on the selection of the preparedness activities related to flood disaster that comprised of employee and business protection. Overall, this instrument consists of 2 dimensions of preparedness activities (employee protection and business protection) with 10 constructs.

Table II: List of preparedness activities questions in this survey

Protection category	Constructs	
	Evacuation planning (EV)	
BP	EV_1	Establish a procedure for shut down and building evacuation
EP	EV_2	The existence of the emergency shelter
EP	EV_3	The existence of emergency transport
EP	EV_4	Conduct drills or exercises
EP	EV_5	Involved in preparedness or response training programs
	Emergency communication (EC)	
EP	EC_6	Inform worker on warning procedure
EP	EC_7	Establish a communication plan
EP	EC_8	Establish procedure call for immediate assistant
EP	EC_9	Attend meetings or receive written information
	Shelter needs (SH)	
EP	SH_10	Supply emergency shelter
EP	SH_11	Provide a safe location if necessary
	Emergency supply (ES)	
EP	ES_12	Provide disaster emergency kit
BP	ES_13	Provide backup power generator
	Safety Aspect (HS)	
EP	HS_14	Provide first aid training
EP	HS_15	Arranged site visits by consultants or experts to better prepare for disasters
EP	HS_16	Electrical/equipment install above the flood elevation
	Information protection (IP)	
BP	IP_17	Establish procedure to secure data
BP	IP_18	Prepare backup for documents
	Inventory protection (IV)	
BP	IV_19	Protect equipment
BP	IV_20	Provide a waterproof container for protection of material
	Structural protection (ST)	
BP	ST_21	Install flood wall barrier
BP	ST_22	Provide sandbag
BP	ST_23	Clean and clear drain from any obstacle
	Early recovery (ER)	
BP	ER_24	Made arrangements for alternative location
BP	ER_25	Purchase flood insurance
	Overall planning (OP)	
BP	OP_26	Establish specific flood emergency plan

Note. Business Protection (BP) and Employee Protection (EP)

Data analysis

The FDPA items plotted using Winstep Software for the Rasch analysis to determine the different levels of preparedness amongst the SMEs. The data was first loaded into Microsoft Excel software and then exported to Winstep version 3.72.0. Rasch-equivalent Cronbach's alpha statistic was obtained in order to establish a comparison with a conventional method to estimate the reliability of the instruments (31). The results of the Rasch analysis were carefully examined based on the standard criteria and guidelines recommended by Rasch Analysis experts such as Fisher (32).

Level of preparedness is categorized into two category which is (1) high level of preparedness and (2) low-level of preparedness. The distribution of the SMEs with high and low level preparedness were plotted parallel with the easy, moderate and difficult activities (items) in a linear graphical scale (Fig.1). The SMEs at difficult ends (high preparedness) shows commitment to all of the easy, moderate and difficult preparedness activities, and have least affected/low impact of disaster. SMEs at the other far ends (low preparedness) showing commitment only to easy preparedness activities to lessen disaster impacts.

Rasch analysis was being used instead of factor analysis for construct validation due to its ability to measure the item difficulty and includes the separation index to promote the separation of items and SMEs into different level of preparedness, whereas factor analysis measure factor loadings on each of the item and construct merely to determine the convergent validity of the item and discriminant validity of the construct.

The analysis in this study undertook several steps

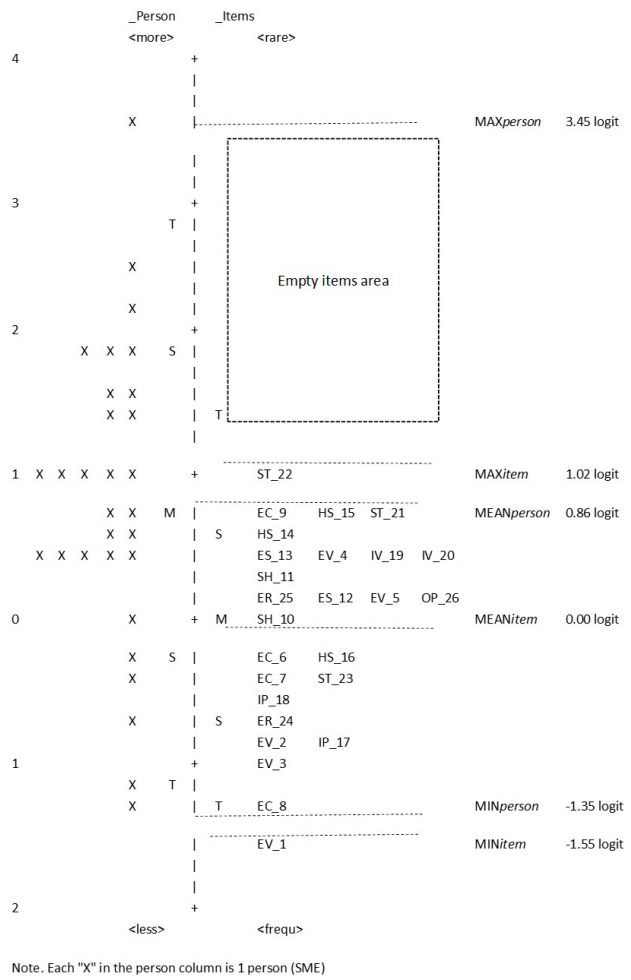

Figure 1: The PIDM according to person-item distribution

for assessing: (1) summary statistics to determine the quality of data, (2) goodness-of-fit of items for internal scale validity; while (3) monitoring unidimensionality, and (4) sensitivity to detect levels of preparedness on the item. Principal Component Analysis (PCA) was used to identify the unidimensionality of the construct and to check for the psychometric properties of the construct. Unidimensionality is critical in ensuring that the instruments used measure the intended parameters of interest in one direction.

Table III shows the Rasch analytic tests used to certify reliability and unidimensionality of the instrument in this study. Most of the results were concluded based on the rating scale instrument quality criteria suggested by Fisher (32), followed by Aziz et al. (20) and George (33).

RESULTS

Summary statistics

Summary statistics in Table IV shows quality of the data gathered from SMEs located in the flood-prone area at Temerloh, Pahang. The summary statistics shown in Table IV conclude that the instrument fulfils the requirement of good instruments by having high-reliability indices of 0.89 (SMEs) and 0.83 (preparedness activities). The Cronbach's alpha (α) score was 0.92, indicating a high inter-item consistency.

Table III: Analytic tests conducted in Rasch model approach

Elements	Statistical approach	Criteria
Identify quality of data and instruments	Items reliability	*Good reliability value between 0.81 and 0.9
Identify inter-item consistency	Cronbach Alpha (α)	Good Alpha (α) value more than 0.8 (George 2011)
Verify that all items contribute to the unidimensionality construct and are not redundant	Item goodness of-fit statistics	*Good MnSq values between 0.5 and 2.0
Verify that the unidimensionality construct explains most of the variance in the sample tested	Principal component analysis	*Good variance explained between 60 and 70%
Verify that the scale distinguishes at least 3 levels of SME engage in preparedness on the sample tested (sensitivity)	Person-separation index	*Good separation index able to separate 3 to 4 group
Verify that the items distinguishes at least 3 levels of difficulty in preparedness activities (sensitivity)	Item-separation index	*Good separation index able to separate 3 to 4 group
Verify that the items measure in one direction	Point Measure Correlation (PMTEA Corr)	All positive value indicate all the statement in positive form and not bi-direction

Note.*Based on Fisher (2007) Rating Scale Instrument Quality Criteria.

In terms of separation index, the items generated an adequate separation index, which allowed the classification of the organisations (SMEs) into different group categories. Although the ideal separation index is 6 (25), the separation index (2.92) in this study indicates that the SMEs can be segregated up to three categories of preparedness level: high, moderate, and low levels. On the other hand, the separation index for the items (2.21) shows that the FDPA items allowed segregation of up to two categories: easy preparedness activities and moderate preparedness activities.

Furthermore, the PCA in this model was able to detect the ability of the instrument to measure unidimensionality, which explained most of the variances in the sample test (34). In this model, the "explained variance" by

Table IV: Summary statistics of the organization and items.

	Organization (SMEs)	Items (Preparedness activities)
Mean	0.86	0.00
Standard deviation index (*Sdi*)	1.01	0.68
Maximum	3.45	1.02
Minimum	-1.35	-1.55
Standard error	0.19	0.14
Reliability index	0.89	0.83
Separation index	2.92	2.21
Cronbach alpha (α)	0.92	0.92

Note. Both are plotted in Person item distribution maps (PIDM) - indicate distribution of item in logit scale of PIDM

the measure corresponds to the Rasch dimension and "unexplained variance" resembles other dimension and random noise (35). Raw variance explained by measures (43.8%) met the minimum requirement (25) but was considered as poorly explained by the variance of the population (as it was less than 50%) (32). The PCA was also able to identify the presence of any additional explanatory dimension in the construct (36). In this study, the total unexplained variance was 56.2 %. Unexplained variance in the first contrast was 8.9 %, which was considered as good (below the ceiling value of 15%) (32).

Measure of flood preparedness item

Results in Table V showed that the Infit and Outfit Mean Square (MNSQ) was positive, which indicates overall fitness of the items. All of the items showed good MNSQ values of more than 0.5, except for item OP_26 (overall planning) (0.47), which is sensitive to outliers. Similarly, the Point Measure Correlation (PTMEA Corr) of all the items also showed a positive value, which means that all the item constructs (questions) are measure in a positive direction of the statement. The use of a negative direction of a question to trick respondents is not acceptable as it brings about misleading results.

Person-item distribution map (PIDM)

A person-item distribution map PIDM map allows the item difficulties (preparedness items) and person abilities (SMEs engagement) to be directly compared. It acts as a ruler for showing the difficulty of the different preparedness activities and their corresponding level as well as the ability level of SMEs on implementing the preparedness activities.

In this study (Fig. 1), the person is shown on the left side, whilst the items are plotted on the right side of the ruler. The 'items' represent the preparedness activities and 'person' represents SMEs/organisations. SMEs that are poorly prepared for flood disasters (not ready for the preparedness activities) were located at the bottom of the map, whilst SMEs that were adequately prepared (agreed with most of the activities) were at the top of the map.

Both the items and persons are graphically represented on the same logit scale to clearly show if the task (items) fit the ability of the persons (37). In this study, the mean for the items was set at 0.00 logit and the resulted mean for person was 0.86 logit. The person (SME) at the top of the PIDM indicates the ability to conduct all the

Table V: Items statistics: Correlation order

Entry number	Total score	Measure	Model S.E.	INFIT		OUTFIT		PT-MEASURE		Preparedness actions
				MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.	
22	96	1.01	0.24	1.19	0.8	1.14	0.6	0.61	0.64	ST_22
9	98	0.9	0.24	0.87	-0.5	1.07	0.4	0.5	0.64	EC_9
21	98	0.9	0.24	1.19	0.8	1.14	0.6	0.64	0.64	ST_21
15	99	0.84	0.24	0.78	-0.9	0.8	-0.8	0.77	0.64	HS_15
14	101	0.73	0.24	0.59	-1.8	0.61	-1.7	0.76	0.63	HS_14
4	105	0.49	0.25	0.95	-0.1	1.05	0.3	0.56	0.62	EV_4
20	105	0.49	0.25	1.19	0.8	1.13	0.6	0.67	0.62	IV_20
11	106	0.43	0.25	0.87	-0.5	1.01	0.1	0.63	0.62	SH_11
13	106	0.43	0.25	0.56	-2	0.6	-1.6	0.84	0.62	ES_13
19	106	0.43	0.25	0.99	0	0.92	-0.2	0.65	0.62	IV_19
12	110	0.18	0.25	0.53	-2.1	0.51	-2.1	0.78	0.61	ES_12
26	110	0.18	0.25	0.47	-2.5	0.44	-2.5	0.78	0.61	OP_26
5	111	0.11	0.26	0.97	0	1.08	0.4	0.55	0.6	EV_5
10	111	0.11	0.26	0.76	-0.9	1.09	0.4	0.61	0.6	SH_10
25	111	0.11	0.26	1.05	0.3	1.01	0.1	0.6	0.6	ER_25
6	114	-0.09	0.26	1.26	1	1.55	1.7	0.47	0.59	EC_6
16	114	-0.09	0.26	1.31	1.2	1.23	0.8	0.57	0.59	HS_16
23	117	-0.3	0.27	1.32	1.2	1.18	0.7	0.48	0.58	ST_23
7	118	-0.38	0.27	0.87	-0.4	0.8	-0.6	0.68	0.58	EC_7
18	119	-0.45	0.27	1.07	0.3	0.97	0	0.52	0.57	IP_18
24	122	-0.68	0.28	0.76	-0.8	0.79	-0.6	0.53	0.56	ER_24
2	123	-0.76	0.28	0.89	-0.3	0.86	-0.4	0.58	0.55	EV_2
17	124	-0.84	0.29	0.88	-0.4	0.73	-0.8	0.64	0.55	IP_17
3	125	-0.92	0.29	1.45	1.5	1.7	1.9	0.29	0.54	EV_3
8	129	-1.27	0.3	1.14	0.6	1.02	0.2	0.36	0.52	EC_8
1	132	-1.55	0.31	2.03	3.1	1.87	2	0.29	0.5	EV_1

preparedness activities (items) that are located below them.

DISCUSSION

The reliability index scores (both organisation and items) were above 0.8, which indicates enough items to measure the different levels of person abilities (preparedness activities) and enough persons (respondent) to measure the different levels of item difficulties (preparedness level), respectively. The Rasch Analysis employed in this study suggested that the items were able to be segregated into two categories when the separation index for the items was 2.21. However, the separation index for the organisation almost segregated the SMEs into three categories with the score value of 2.29. This has resulted in the distribution of the items in PIDM as illustrated in Fig. 1 to show empty spaces (gaps) at the difficult ends.

As reported by previous study (38), new items are required in order to fill up the gaps which address the difficult or high-level tasks of preparedness activities. Additional items can be added to increase the item spread as well as improving the separation and reliability of the items (21). The additional items introduced into the instruments in this study are expected to be able to differentiate preparedness level into three categories.

The implication of dividing the activities into three categories according to its level of difficulty will help SMEs determined their level of preparedness based on the activities that have been conducted. Having knowledge on where or how they currently fare on their flood preparedness levels, business owners could benefit by making plans on the preparedness activities in progressive ways beginning from low-level activities to higher level activities.

The PCA value in this study was only 43.8%. However, it is still considered to meet the unidimensionality criteria of at least 40% (25). The score for the unexplained variance by the first contrast predicted as a random noise in the Rasch. It may not associate with the presence of any others dimensions exits in the measurement of the instruments by Rasch measure (39). The PCA value showing slight improvement after deleting OP_26 items increase to 44.2%.

The PTMEA Corr values for all the items were positive, which indicates the items were measured in one direction. However, there are three items that have low values of PTMEA Corr of less than 0.3. This indicates that the items (EV_3, EC_8, and EV_1) did not fulfil the criteria (40). The three items showed low scores of PTMEA Corr value and were deemed to be modified or deleted. This means that the items (preparedness activities) could not distinguish or was unable to discriminate the ability of the respondents (SMEs). The PTMEA Corr value should exceed 0.3 to contribute to the measurement of preparedness activities of SMEs (41).

Based on the PIDM in Fig. 1, there were eleven (11) items that were categorised as easy preparedness activities, whilst the remaining fifteen (15) items were moderately difficult preparedness activities (Table VI). The cut-off point for these two categories corresponded to the mean of the item (0.00 logit) in Fig. 1. The easy preparedness activity was EV_1 (establish a procedure for evacuation and cessation of operation) with a measure of -1.55 logit, whereas the most difficult preparedness activity was ST_22 (provision of sandbags during flood events) with a measure of 1.02 logit.

The analysis shows that the items in the map were not distributed appropriately as some of the items were redundant (e.g. items EC_9, HS_15, and ST_21), indicating a similar level of item difficulty. Moreover, there were insufficient items at the difficult ends to represent activities that can be categorised as a high level of preparedness.

The difference of the empty item area [highest SME (Maxperson) with the last item, ST_22 (Maxitem)] was 2.43 logit, whereas the difference between the first item (EV_1) with the last item (ST_22) was 2.57 logit. The PIDM map shows huge gaps in the empty item area, which were almost equal to the distribution of the existing items.

Therefore, the development of items categorised as high level preparedness activities is required to obtain three levels of disaster preparedness: low, moderate, and high levels of preparedness. This is in parallel with Linacre's finding (36), which suggested that adding new items to the construct will also improve the precision of person measurement.

Based on Table VI, the easiest preparedness activity to be conducted was "establish a procedure for evacuation and cessation of operation"; whereas the highest moderately difficult preparedness activity was "provide sandbags" to temporarily prevent flood water from entering the premise.

The FDPA construct fit the measurement model. However, several items need to be revised primarily due to redundancy (the most prominent being items IV_19 and IV_20) because they are of the same construct (inventory protection). It is highly recommended for the same construct to have different levels of difficulty. Moreover, it is recommended for item OP_26 (establish a specific flood emergency plan) to be deleted as it shows a low value of (Outfit and Infit) MNSQ. This is due to the establishment of a specific flood emergency plan with regard to already being well planned or prepared for a

Table VI: Preparedness activities categorized as easy

Question	Preparedness Activities
	Easy preparedness activities
EV_1	Establish procedure for evacuate building and stop operation
EC_8	Establish procedure call for immediate assistant
EV_3	Identified emergency transport
EV_2	Identified emergency shelter
IP_17	Establish procedure to secure data
ER_24	Made arrangements for alternative location
IP_18	Prepare backup for documents
EC_7	Establish communication plan
ST_23	Clean and clear drain from any obstacle
EC_6	Inform worker on warning procedure
HS_16	Electrical/equipment install above the flood elevation
	Moderately difficult preparedness activities
SH_10	Provide supply for emergency shelter
ER_25	Purchase flood insurance
ES_12	Provide disaster emergency kit
EV_5	Involved in preparedness/response training programs
OP_26	Establish specific flood emergency plan
SH_11	Provide safe location if situation needed
ES_13	Provide backup power generator
EV_4	Conduct drills or exercises
IV_19	Brace shelves, equipment
IV_20	Provide waterproof container for protection of material
HS_14	Provide first aid training
EC_9	Attend meetings/receive written information
HS_15	Arranged site visits by consultants or experts to better prepare for disasters
ST_21	Install flood wall barrier
ST_22	Provide sand bag

flood disaster.

This paper is part of the main study to assess the construct validity of flood preparedness items developed (adapted) from the review of literature. The instrument tested in this study showed gaps of items to demonstrated high-level flood preparedness activities. It was noticed as a weakness and limitation of this study. It is recommended that additional preparedness item of high levels in nature be added in the instrument to address the gap. In addition, based on the comments received from the respondents, there is also a need to improve the Likert scale response in order to directly measure the abilities or engagement in preparedness activities.

As mentioned earlier, a study conducted by Sadiq (22) categorized preparedness into two category which is passive and active hazards adjustment This active hazards adjustment is the best example to be described as the higher level of preparedness activities. As an example, in this study, the "provision of sandbag" is the most difficult activities to be implemented by the SMEs. The additional item may be included in the future is such as "the provision of emergency boat" to be set as a high level of preparedness.

Overall, the FDPA construct met the minimum assumption of Rasch. However, additional construct should be includes to widen the range of measurement. The refinement of the instrument is recommended to be used on further study. This instrument also reliable to be adopted on research measuring preparedness level on the other types of disaster in the same setting (small-scale business). Moreover, most of the preparedness activities develop in this study were based on general all-hazards disaster preparedness action and only a few items were customized for the flood hazards. The adoption of this scale to others industry also recommended to include additional preparedness measure regards as high-level preparedness as well as additional specific contingencies measure applied to the related industry.

CONCLUSION

This study serves as a baseline to develop a psychometric sound instrument that is able to be used to measure the level of flood preparedness activities of SMEs in further studies. The FDPA items in this study showed a good reliability index with high inter-consistency between items. About 25 FDPA items were remained in the further stage of data collection with item OP_26 deleted.

Although the 25 FDPA items were found to possess good psychometric features based on the Rasch analysis, some adjustments will be further required for them to be used for measuring the flood preparedness level of each SME. Specifically, more items need to be added to fill in the gaps for preparedness activities (items) in the category of high preparedness activities in order to improve the usability of this instrument. The proper benchmark on measuring high level of preparedness activities is seem to be missing. The high preparedness benchmark is important to identify how much effort and resources would be required for the preparedness activities (high level preparedness activities).

The content validity of the instrument also need to be further review. The content validity assessment with the expert panel in the related fields (such as emergency manager, SMEs representative and emergency and rescue practitioners) help to refine the items in more comprehensive manner. The qualitative and quantitative judgement on the items by the expert panel will help further to identify the items gaps (missing items) and perfecting the available items.

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