FACTOR AND RELIABILITY ANALYSIS OF DISASTER PREPAREDNESS INSTRUMENTS

Patrick G. Galleto and Evelyn Campiseno

Abstract

The purpose of the paper was to evaluate the psychometric properties of the Disaster Preparedness Survey Questionnaire to measure and examine the disaster preparedness in the province of Zamboanga del Norte. The specific validation processes included the content and face validity, construct validity using factor analysis, reliability and internal consistency using test-retest reliability and Cronbach's alpha correlation coefficient. The exploratory factor analysis revealed three factors, namely: disaster knowledge, disaster awareness, and disaster preparedness. The items on the questionnaire revealed factor loadings ≥ 0.5. Reliability processes also revealed high correlation and consistency of the responses. Moreover, test-retest statistic examination revealed stability of the responses at two time points apart. The final questionnaire which consisted of 150 items was found valid and reliable.

Keyword and Phrases: *factor analysis, reliability analysis, disaster preparedness*

Introduction

Disaster preparedness instrument is the response to knowledge and awareness that sometimes, at some level, things go haywire. Emergency preparedness ranges from making sure the safety to some sort of doomsday scenario. It consists of activities and measures taken in advance to ensure effective response to the impact of hazards. However, several barriers prevent disaster preparedness due to some extent the lack of knowledge and awareness on the occurrence of disasters may it be natural or human induced hazards, and the tools to assess the disaster preparedness among the people.

Green (2014) asserted that no institution reaches a total state of preparedness. He further pointed out that there is no cookbook recipe that every institution follows and leads to adequate preparedness. Levitin (2014) also stressed that, in an institution, the basic components of an adequate disaster response system should be defined, and the steps necessary to build disaster preparedness capacity should be established. He further emphasized that if institutions have put all the pieces in place for general disaster preparedness, they have taken the first and most important step toward preparedness for responding to a disastrous event.

According to Eriksson et. al (2007), disaster preparedness has to be approached holistically because it is difficultto isolate preparedness from other components of disaster management such as reduction, response, and recovery. The need of assessing the knowledge and awareness among individuals at the local level towards holistic disaster preparedness should be enforced. It is important, therefore, that a disaster preparedness instrument should be developed and validated with an end view of adopting a valid and reliable instrument to assess disaster preparedness particularly at the local communities. Eriksson et. al (2007) added that local communities should be at the centre

of disaster preparedness since they are the first victims of natural hazards and the first respondents.

Hence, this study was conducted to ascertain the reliability and validity of the Disaster Preparedness Survey Questionnaire. The instrument is designed to aid investigators and practitioners in measuring and researching the disaster preparedness and readiness among individuals particularly in the province of Zamboanga del Norte. The use of the instrument will greatly serve the province in assessing the knowledge and awareness of the people about human induced and natural disasters and the disaster risk preparedness and management. Most importantly, the results of this study will provide the people, line agencies, government organizations, and non-government organizations to make plan of actions to prevent, mitigate, and manage disaster risks.

Methods and Materials

This study examined the validity and reliability of the Disaster Preparedness Survey Questionnaire following the processes, to wit:

Content validity was undertaken to ascertain whether the content of the questionnaire was appropriate and relevant to the study purpose. Content validity indicates the content that reflects a complete range of the attributes under study and is usually undertaken by seven or more experts (Pilot & Hunger, 1999; DeVon et. al, 2007). To estimate the content validity of the instrument, the researchers clearly defined the conceptual framework of disaster preparedness by undertaking a thorough literature review and seeking expert opinion. After the conceptual framework was established, seven purposely chosen experts in the field of science, questionnaire design, and disaster preparedness were asked to review the draft of the instrument consisting of 155 items to ensure that the instrument was consistent with the conceptual framework. Each reviewer independently rated the relevance of each item on the instrument to the conceptual framework using a 4-point Likert scale, namely: 1-not relevant, 2-somewhat relevant, 3-relevant, and 4-very relevant. The Content Validity Index (CVI) was used to estimate the validity of the items (Lynn, 1996).

Face validity was also determined to indicate that the questionnaire appears to be appropriate to the study purpose and content area. It evaluated the appearance of the questionnaire in terms of feasibility, readability, consistency of style and formatting, and the clarity of the language used (Trochim, 2001 & DeVon et. al, 2007). Hence, face validity is a form of usability rather than reliability. In determining the face validity of the instrument, an evaluation form was developed to help respondents assess each question in terms of the clarity of the wording, the likelihood that the target audience would be able to answer the questions, and the layout and style. Twenty five faculty members of Jose Rizal Memorial State University, Main Campus, Dapitan City were randomly selected and completed the face validity form on a Likert scale format, namely: strongly disagree-1, disagree-2, agree-3, and strongly agree-4.

Construct validity was also obtained to determine the degree to which the items on the instrument relate to the relevant theoretical construct (Kane, 2001 & DeVon et. al, 2007). Construct validity employed factor analysis since each indicator of Disaster

Preparedness Survey Questionnaire consisted of multiple items. Factor analysis was used to cluster items into common factors, interpreted each factor according to the items having a high loading on it, and summarized the items into a small number of factors (Bryman & Cramer, 1999). Loading refers to the measure of association between an item and a factor (Bryman & Cramer 2005). A factor is a list of items that belong together. Related items define the part of the construct that can be grouped together. Unrelated items, those that do not belong together, do not define the construct and should be deleted (Munro, 2005). A total of 150 personnel of the Municipal Disaster Risk Reduction and Management Council of the 25 municipalities of the province of Zamboanga del Norte (6 personnel per municipality) were selected to comprise the sample size for factor analysis.

Exploratory Factor Analysis, a particular factor analysis method, was used to examine the relationships and dimensionality among variables without determining a particular hypothetical model (Bryman & Cramer, 2005). An appropriate sample size was obtained for the current study to enable factor analysis to be undertaken considering two criteria, namely: Kaiser-Meyer-Olkin (KMO) sampling adequacy; and factor loadings and the correlation between a variable and a factor (Hayes, 2002). In performing exploratory factor analysis, principal component analysis was used to ensure that all the variance of a variable (total variance) is analyzed. According to Bryman and Cramer (2005), two main criteria are available to determine how many factors should be retained, namely: the Kaiser criterion to select those factors that have an eigenvalue ≥ 1.0 (Heppner et. al, 2006), and a Scree Plot to depict the descending variances that account for the factors extracted in graph form. The factors that lie before the point at which eigenvalues begin to drop can be retained. Varimax, the most commonly used orthogonal rotation was undertaken to rotate the factors to maximize the loading on each variable and minimize the loading on other factors (Field, 2005; Bryman & Cramer, 2005).

The final version of the instrument was subjected to reliability testing. Reliability refers to the ability of a questionnaire to consistently measure an attribute and how well the items fit together (DeVon et. al, 2007). Two estimators of reliability were used, namely: internal consistency reliability and test-retest reliability which both were used to examine the reliability of the instrument.

Internal consistency examined the inter-item correlations within an instrument and indicated how well the items fit together conceptually (DeVon et. al, 2007). Cronbach's alpha was computed to examine the internal consistency of the instrument as well as the unidimensionality of the items in the instrument. Internal consistency was undertaken by administering the instrument to 28 heads of the Municipal, City, and Provincial Disaster Risk Reduction and Management Council in Zamboanga del Norte.

Test-retest reliability, on the other hand, was estimated by administering the same tool to the same sample on two different occasions on the assumption that there was no substantial change in the construct under study between the two sampling time points (Trochim, 2001; DeVon et. al, 2007). A high correlation between the scores at the two time points indicates that the instrument is stable over time (DeVon et. al, 2007). Test-Retest reliability of the instrument was undertaken by administrating again the questionnaire to 28 heads of the Municipal, City, and Provincial Disaster Risk Reduction and Management Council in Zamboanga del Norte five days after the first administration

of the instrument. Because ordinal data were obtained from the questionnaire using a four-point Likert scale rated from strongly disagree to strongly agree and the scale was not continuous, non-parametric statistical tests were deemed to be more appropriate than Pearson Correlation Coefficient (Steven, 2005). Therefore, the analysis of the responses between the test and the retest was conducted using Wilcoxon Non-Parametric Statistical Test to determine whether there were any significant differences between the responses at each time point.

Results

Content Validity of the Instrument. Three (3) items in the draft were deemed to be invalid because they yielded CVIs below 0.87 and the items were removed from the questionnaire. Based on the CVI, a rating of three or four indicates that the content is valid and consistent with the conceptual framework (Lynn, 1996). For example, if five of eight content experts rate an item as relevant (3 or 4), the CVI would be 5/8=0.62 which does not meet the 0.87 (7/8) level required, and indicates the item should be dropped (Devon et. al, 2007). These items were "Are you aware that excessive heat is dangerous?" which reviewers considered it to be similar to another item "Do you know the danger of excessive heat?", "Do you know the meaning of La Nina and El Nino?" which was related to "Do you know what La Nina is?" and "Do you know what El Nino is?", and "Do you know the Republic Act that governs disaster in the country?" was the same as "Do you know the laws that govern disaster management in the Philippines?". All items that were retained in the draft obtained CVIs ranging from 0.87 to 1.0.

Face Validity of the Instrument. All respondents rated each parameter at three or four on a Likert scale of 1 – 4. Ninety-six (96) percent indicated that they understood the questions and found them easy to answer, and ninety-two (92) percent revealed that the appearance and layout are acceptable to the intended target audience. However, two items were found with the same number (item 36) and typing errors were spotted particularly for items 130 and 144. Corrections were then entered into the draft of the instrument for the next analysis.

Factor Analysis. Factor analysis summarizes the covariance structure in a few dimensions of the data. It emphasizes the identification of underlying "factors" that might explain the dimensions associated with large data variability. To ensure an appropriate sample size to undertake the factor analysis, the KMO sampling adequacy on the instrument was calculated and was found 0.92. Field (2005) posited that a value close to one indicates that factor analysis will yield distinct and reliable factors. Steven (2005) described the value greater than 0.9 as superb. Given that the KMO of the first analysis of the instrument was 0.92, the sample size of 150 was considered to be adequate to enable factor analysis to be undertaken.

The principal component factor analysis revealed 67.8% of the total variance of the factors in the draft of the instrument which means that the computed variance explained the common factors and considered reasonable (Field, 2005). The communalities (eigenvalues) of the items on the instrument were all greater than 0.5. This means that the factors with Varimax rotation were deemed to be the most statistically and conceptually appropriate for the instrument. Likewise, factor loadings were all greater

than 0.5 except for two (2) items whose factor loadings were less than 0.5 and these items were deleted from the questionnaire. Steven's (2002) Guideline of Statistical Significance for Interpreting Factor Loadings provided that a validation process with participants of 100 should have factor loading of 0.51. Since the validation process of the instrument included 150 participants and factor loadings were all greater than 0.5, hence, the items retained in the instrument were all accepted.

In the final analysis, a Scree plot shown in Figure 1 revealed three (3) factors which categorized the items in the instrument. That is, the two tests indicated three (3) different number of factors, namely: disaster knowledge, disaster awareness, and disaster preparedness. According to Steven (2002) and Field (2005), the Scree plot and eigenvalues are accurate to determine how many factors should be retained.

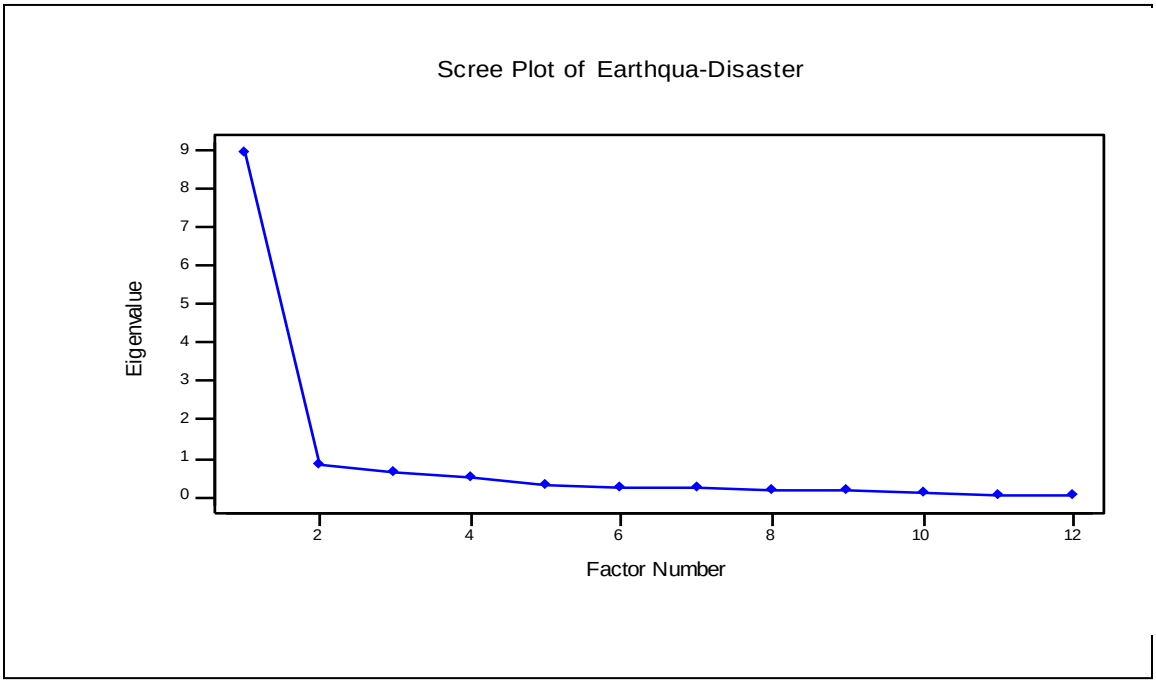

Figure 1 The Scree Plot of the Factors of the Disaster Preparedness Questionnaire

Internal Consistency Reliability. Cronbach's alpha was computed for the revised Disaster Preparedness Survey Questionnaire after construct validation was obtained. The Cronbach's alpha correlation coefficient was 0.995 which indicated a high correlation and revealed the questionnaire as consistently reliable. Opinions differ about the ideal alpha value. Some experts recommended that the alpha should be at least 0.90 for instruments used in clinical settings(Nunnally & Bernstein, 1994). Others suggested an alpha of 0.70 which is acceptable for a new instrument (DeVellis 1991; DeVonet. al, 2007). The alpha computed for each of the twelve (12) factors also exceeded the minimum value for a new tool. In totality, all factors were greater than 0.70 which indicated highly reliable.

Test-Retest Reliability. The Disaster Preparedness Survey Questionnaire was administered again to the twenty-eight (28) heads of Municipal, City, and Provicial Disaster Risk Reduction and Management Council and Wilcoxon Non-parametric Statistical Test showed no significant difference between the two tests. Result means that there was no substantial change in the construct under study between the two sampling time points. The finding is supported by DeVon et. al (2007) who averred that high correlation between the scores at the two time points indicates that the instrument is stable over time.

Discussion

The veracity of any research depends on the accuracy of the instruments used especially when exploring complex phenomena such as disaster preparedness. The results of the validity testing of the instrument indicated that the instrument is an accurate measure of disaster preparedness. The processes involved to validate the instrument were rigorous and appropriate. While face validity is the lowest form of validity, it provided important information about the operation of the questionnaire by people vulnerable to disaster. Content validity helped assess the relevance of the questionnaire to the concept of disaster preparedness defined for the study. Factor analysis assessed the theoretical construct of the instrument. The internal reliability reached the recommended level and test-retest indicated stability of the responses to the items on the instrument over time. Most importantly, this paper reported the validity and reliability of the instrument to measure disaster preparedness along the occurrence of earthquake, landslide, tsunami, volcanic eruption, tropical cyclone, storm surge, floods, thunderstorm, tornado, extreme climatic variability, human-induced hazards, and disaster readiness. Moreover, the instrument as a valid and reliable research tool can be generalized to a wider and diverse population of people in Zamboanga del Norte especially those who are vulnerable to disasters. However, to strengthen the rigor of the questionnaire for further research, the researchers recommended that convergent and discriminant validity be undertaken to examine the similarity and differences of the instrument with other disaster preparedness tools. It is also recommended that structured equation modelling (SEM) and confirmatory factor analysis be undertaken in a larger sample to support the generalizability of the questionnaire.

Literature Cited

Bryman, A., and Cramer, D. (1999). Quantitative Data Analysis with SPSS Release 8 for Windows. A Guide for Social Scientists. London: Routledge.

Bryman, A., and Cramer, D. (2005). Quantitative Data Analysis with SPSS12 and 13. A Guide for Social Scientists. East Sussex Routledge.

DeVellis, R. F. (1991). Scale Development: Theory and Applications (Applied Social Research Methods Series, Vol. 26). Newbury Park: Sage.

DeVon, H. A., et al. (2007). A Psychometric Toolbox for Testing Validity and Reliability. Journal of Nursing Scholarship, 39 (2), 155-164.

Eriksson, Mats G. et. al (2007). Disaster Preparedness for Natural Hazards: Current Status in Nepal. Retrieved May 9, 2014 from http://www.iris.edu/hq/files/about_iris/governance/ds/docs/PreparednessInNepal.pdf

Field, A. P. (2005). Discovering Statistics using SPSS. London: Sage.

Green, Gary B. (2014). *Disaster Planning: An Ongoing Community Effort*. Disaster Planning Drills and Readiness Assessment. Retrieved May 8, 2014 from http://archive.ahrq.gov/news/ulp/btbriefs/btbrief2.htm

Hayes, S. C. (2002). Acceptance, Mindfulness, and Science. American Psychological Association, D12, 101-105.

Heppner, P. P., et. al (2006). Development and Validation of a Collectivist Coping Style Inventory. Journal of Counseling Psychology, 53(1), 107-125.

Kane, M. (2001). Current Concerns in Validity Theory. Journal of Educational Measurement, 38, 319-342.

Levitin, Howard W. (2014). Conventional Disasters versus Bioterrorism. Disaster Planning Drills and Readiness Assessment. Retrieved May 8, 2014 from http://archive.ahrq.gov/news/ulp/btbriefs/btbrief2.htm

Lynn, M.R. (1996). Determination and Quantification of Content Validity. Nursing Research, 35, 382-385.

Munro, B. H. (2005). Statistical Methods for Health Care Research. Philadelphia: Lippincott, Williams & Wilkins.

Nunnally, J. C. and Bernstein, I. H. (1994). Psychometric Theory. New York: McGraw-Hill.

Pilot, D., and Hunger, B. (1999). Nursing Research: Principles and Methods. Philadelphia: Lippincott Williams & Wilkins.

Stevens, J. (2002). Applied Multivariate Statistics for the Social Sciences (4th Edition). Mahwah, NJ: Lawrence Erlbaum Associates.

Trochim, W.M.K. (2001). The Research Methods Knowledge Base. Cincinnati: Atomic Dog.