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DISASTER RESILIENCY FRAMEWORK AMONG THE RESIDENTS OF FLOOD PRONE AREAS IN DAVAO REGION: AN EXPLORATORY FACTOR ANALYSIS

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ABSTRACT
Flooding is a frequently occurring and highly destructive natural disaster that inflicts significant economic harm and has a profound impact on human lives across the globe. People residing in proximity to rivers and canals are at a heightened risk of encountering the consequences of floods, which may include harm to their property, contraction of diseases, and other associated impacts. Various initiatives have been identified in literature that aim to promote disaster resilience, including emergency responses during the delivery of humanitarian aid, the active involvement of local institutions in providing prompt assistance, flood response strategies that are primarily carried out at the household level, the stockpiling of emergency supplies, and structural measures such as dredging, widening of streams and channels, building of levees, and embankments. The purpose of this study is to conduct an Exploratory Factor Analysis that can identify the most basic and straightforward hypothetical factors or constructs which can provide an understanding of the disaster resiliency among individuals living in flood-prone areas of Davao Region. The research utilizes the Kaiser-Meyer-Olkin (KMO) test to evaluate the suitability of the data, the Bartlett's Test of Sphericity to examine the null hypothesis that the variables in the data set are independent or unrelated to each other, and the Kaiser's Criterion and Scree Test to help determine the number of factors that should be retained. After analysis, the study identified five factors as significant, which are Prepositioning of Life-saving Resources, Flood Perseverance Measures, Proper Coordination with Local Government/Authorities, Response Strategy, and Flood Effects Prevention Measures.

Keywords:
Disaster Resilience, Flood Risk, Exploratory Factor Analysis, Flood Prone Areas, Kaiser-Meyer-Olkin test, Bartlett's test, Kaiser Criterion test, Scree Test

INTRODUCTION

Recently, there has been significant interest in the concept of urban resilience, which refers to efforts made by different parties to tackle challenges of urbanization and climate change in developing countries. This includes the avoidance or reduction of natural disaster impacts in cities (Joerin, Shaw et al. 2012). Various perspectives are currently discussing the emerging term of resilience, and there are ongoing debates, interpretations, and re-interpretations surrounding its meaning. The term resilience has different characteristics based on the discipline, and it is multifaceted (Handayani, Fisher et al. 2019).

Climate change and disasters are urgent and critical issues that have significant long-term implications for the environmental and socio-economic sustainability of many nations across the globe. Recent reports indicate that severe weather events, such as heatwaves, droughts, and intense precipitation, are projected to become more frequent and severe, exacerbating the impacts of climate change. In addition, the proportion of individuals at risk of flooding has increased worldwide, particularly in Asia and Africa, where extreme rainfall and flooding are expected to occur more frequently, primarily due to long-term forecasts of increased monsoon rainfall. The need to address and mitigate these challenges has never been more pressing, requiring a coordinated and sustained global effort (Munpa, Kittipongvises et al. 2022). Compared to those living in other areas, individuals residing in coastal regions face greater danger from disasters such as floods. To minimize the loss and potential

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decline in quality of life, it is necessary to construct and improve resilience to such disasters. Identifying and acknowledging the factors that contribute to disaster resilience, as well as developing methods to measure, maintain, and enhance it, are crucial steps (Khalili, Harre et al. 2015).

RELATED LITERATURE

Risks In Flood Prone Areas

Flood effects are categorized into direct and indirect damages. Floodwater physically touching humans, property, or other objects causes direct damages. In contrast, indirect damages result from direct impacts and occur outside the flood event, either in space or time. Whether they can be measured in monetary terms or not, both direct and indirect damages can be classified as tangible or intangible. Man-made capital or resource flows that can be easily valued in monetary terms cause tangible damages. In contrast, assets that are not traded in a market and are difficult to quantify in monetary values cause intangible damage. (Merz, Kreibich et al. 2010)
Floods impact human lives and cause severe economic damage throughout the world, making them one of the most recurring and devastating natural hazards. Scientists in hydrology and natural hazards are concerned about the occurrence of flooding due to the high number of people affected globally and the significant proportion of individual fatalities caused by such events. Flood risks will not subside in the future and climate change will exacerbate the frequency and intensity of floods in many regions, posing a threat to many parts of the world. Social and economic development, such as urbanization, is increasing the potential for flood-related casualties and damages in many regions by putting pressure on land use. Consequently, the impacts of global change on climate, severe weather in the form of heavy rains and river discharge conditions, are expected to increase the frequency and severity of flood hazards. (Ouma and Tateishi 2014)
A Climate-related Disaster Community Resilience Framework conducted in households revealed that residents living near rivers and canals face a greater risk of experiencing the impacts of floods, including property damage, disease contraction, and other effects. Individuals with limited adaptive capacity have been unable to increase their ability to cope, despite previous experiences with flood-related disasters. Hence, the ability to withstand, manage, and recover from future climate-related disasters, particularly floods, is restricted by their limited adaptive capacity (Yaro, Teye et al. 2015).

Resilience Approaches In Flood Prone Areas

The harm inflicted upon those affected by disasters is sought to be minimized by emergency operations during the implementation of humanitarian aid. Two effective methods to achieve this are identified; pre-deploying essential emergency resources in areas susceptible to disasters, and supplying emergency supplies to victims after the occurrence of a catastrophe (Zhang and Cui 2021).

In responding to floods, the significance of collaborating with authorities is also emphasized. The active participation of local institutions in providing prompt assistance and rescue can significantly decrease the vulnerability of communities and the impact of natural disasters, such as floods. A notable difficulty in handling flood disasters is the lack of coordination between agencies in executing the disaster management cycle. As a result, the absence of authoritative coordination and involvement can trigger significant adverse consequences for both individuals and financial resources (Muzamil, Zainun et al. 2022).

Moreover, the physical characteristics of buildings, including their type, age, and plinth height, are identified as determinant of the amount of destruction caused by flooding. Buildings made of durable materials, newer construction, and those with higher plinths experienced less severe flood damage. In contrast, greater flood damage was experienced by buildings constructed of natural materials, older buildings, and those with lower plinths. Households have improved the condition of walls, strengthened the entire structure, and raised their homes to address their physical vulnerabilities. Flood response strategies are mostly undertaken at the household level, with limited efforts at the community level (Fatemi, Okyere et al. 2020).

Additionally, a significant difference between survival and demise can be made by being ready to rescue oneself and others within a community and household before outside help arrives. It has also been shown that the adverse effects of emergency situations can be greatly reduced by adequate preparation at home. Emphasizing household preparedness is critical because it is an integral part of any community and individual response. Therefore, the responsibility for reducing risks and damages by stockpiling emergency supplies, devising emergency plans, and obtaining accident insurance should be taken by households (Chen, Xu et al. 2019).

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Heavy rainfall in many cities often leads to local flooding, with one major cause being the blocking of drainage facilities by garbage. It is essential to regularly clean and maintain these facilities to ensure their reliable operation. Also, to mitigate urban floods caused by overbank flow, structural measures such as dredging, and widening of streams and channels, levees, and embankments may be implemented. These measures detain or divert run-off, reducing the risk of flooding. Meanwhile, to alert communities at risk, flood warning systems should be in place, and forecasted information should be converted into practice by disseminating warning messages. The success of such a system is dependent on people's familiarity with emergency response to incoming floods and their knowledge of flood risk (Tingsanchali 2012).

RESEARCH OBJECTIVES

The primary objective of this research is to identify the Disaster Resiliency Framework of the Residents Living in the Flood Prone Areas in Davao Region. Specifically, this study will use factor analysis on a survey to pinpoint the main components that measure the resiliency framework of the respondents.

METHODOLOGY

This research is an Exploratory Factor Analysis (EFA). Its objective is to detect the most fundamental and simple hypothetical factors or constructs that can clarify the variation found among a group of measured variables (Watkins 2018).

The research uses a 30-item researcher made questionnaire utilizing an ordinal scale response system. Each item in the questionnaire is anchored on the research idea of determining the disaster resiliency framework of the participants with regards to flooding. One hundred and fifty (150) participants who were residing in flood prone areas were randomly selected as research respondents. A set of data gathered from these respondents corresponds the primary data for this research. This data was then tallied, summarized, and subjected to statistical treatment.

One of the statistical methods used in this research was the Kaiser-Meyer-Olkin (KMO) test. KMO is a tool designed to assess the appropriateness of data for factor analysis by evaluating the adequacy of the sample size. It examines the sampling adequacy for each variable in the model as well as for the model as a whole (Shrestha 2021).

The Bartlett's Test of Sphericity is used in this research to test the null hypothesis that the variables in the data set are independent or unrelated to each other, and hence not suitable for structure detection. If the test produces a significant value of less than 0.05 level of significance, it suggests that the variables are not independent and a factor analysis might be useful for analyzing the data (Silva, Sabino et al. 2014)

The study also employs two other methods, Kaiser's Criterion and Scree Test. The Eigenvalue Criterion, also known as Kaiser's criterion, and the Scree test are techniques utilized to determine the number of initial unrotated factors to extract. The Eigenvalue is the ratio of common variance to the specific variance explained by a particular extracted factor (Shrestha 2021).

RESULTS AND DISCUSSION

This section presents the outcomes derived from using the statistical software SPSS. The study involved 150 respondents residing in flood-prone areas of Davao Region. The factor analysis process included three main stages: a) assessing the appropriateness of the data, b) extracting factors, and c) rotating and interpreting the factors (Shrestha 2021).

a) Assessing the Appropriateness of the Data

To examine the resiliency framework of individuals living in flood-prone areas, the study employs the Kaiser-Meyer-Olkin to determine the data's suitability for factor analysis. Additionally, Bartlett's test of Sphericity, correlation matrix, and determinant score are used to evaluate the data's appropriateness for carrying out factor analysis (Pett, Lackey et al. 2003).

Table 1 shows that the KMO statistic has a value of 0.706, which is above the threshold of 0.6. This suggests that the sampling is sufficient, and the data is appropriate for factor analysis.

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Correspondingly, table 1 also shows the result of Bartlett's test of Sphericity. It shows a p value that is less than .05 level of significance ($p < .05$) which means that the variables presented are intercorrelated, thus suitable for factor analysis.

Table 1: Kmo And Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.706
Bartlett's Test of Sphericity	Approx. Chi-Square	1725.874
	df	435
	Sig.	.000

b) Extracting Factors

After obtaining the data from the first extraction, the researcher has to decide the optimal number of factors that should be kept to accurately reflect the data and its correlations. The aim is to select a sufficient number of factors to properly portray the data, while discarding factors that are not significant from a statistical or theoretical standpoint (Beavers, Lounsbury et al. 2013).

The retention of a factor depends on how much variance it can explain. The Kaiser Criterion is a widely used eigenvalue method that suggests retaining factors with eigenvalues of one or greater (Costello and Osborne 2005). In this manner, table 2 shows nine factors having Eigenvalues of equal to or more than 1.0.

Cattell's Scree Plot is a visual display of factors and their eigenvalues, where the x-axis denotes factors and the y-axis shows the eigenvalues. Determining the cutoff point for the scree plot is a subjective process, requiring the retention of only those factors that appear before the bend in the elbow (Fabrigar, Wegener et al. 1999). Thus, figure 1 visually revealed only two factors suitable for retention considering the first elbow or seven factors to be taken in reference to the second elbow in the plot.

To evaluate the initial extraction, it is advisable to use several criterion methods and compare the suggested factors to be retained. It is acceptable to vary the number of factors and compare the solutions. In the end, the decision regarding the number of factors to be retained should rely on how easily understandable and meaningful they are within the research's context (Beavers, Lounsbury et al. 2013). Consequently, table 2 depicts only five (5) factors retained, as shown under the "Extraction Sums of Squared Loadings" column, as the parameter in the criteria factor in SPSS was set to five factors only. This means that only five factors are to be finally extracted.

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Table 2: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.84	19.454	19.454	5.84	19.454	19.454	3.71	12.37	12.37
2	3.02	10.056	29.509	3.02	10.056	29.509	3.36	11.214	23.585
3	2.22	7.394	36.904	2.22	7.394	36.904	2.83	9.418	33.002
4	2.08	6.934	43.838	2.08	6.934	43.838	2.58	8.587	41.589
5	1.8	6.004	49.842	1.8	6.004	49.842	2.48	8.252	49.842
6	1.57	5.248	55.09						
7	1.33	4.446	59.535						
8	1.13	3.753	63.288						
9	1.1	3.662	66.95						
10	0.98	3.262	70.212						
11	0.82	2.744	72.956						
12	0.8	2.652	75.608						
13	0.77	2.554	78.162						
14	0.68	2.262	80.425						
15	0.63	2.084	82.509						
16	0.56	1.874	84.383						
17	0.55	1.829	86.211						
18	0.53	1.77	87.981						
19	0.45	1.507	89.488						
20	0.4	1.333	90.82						
21	0.39	1.283	92.104						
22	0.37	1.247	93.351						
23	0.34	1.135	94.486						
24	0.32	1.078	95.564						
25	0.28	0.948	96.512						
26	0.27	0.886	97.398						
27	0.25	0.839	98.237						
28	0.2	0.67	98.907						
29	0.19	0.616	99.523						
30	0.14	0.477	100						

Extraction Method: Principal Component Analysis.

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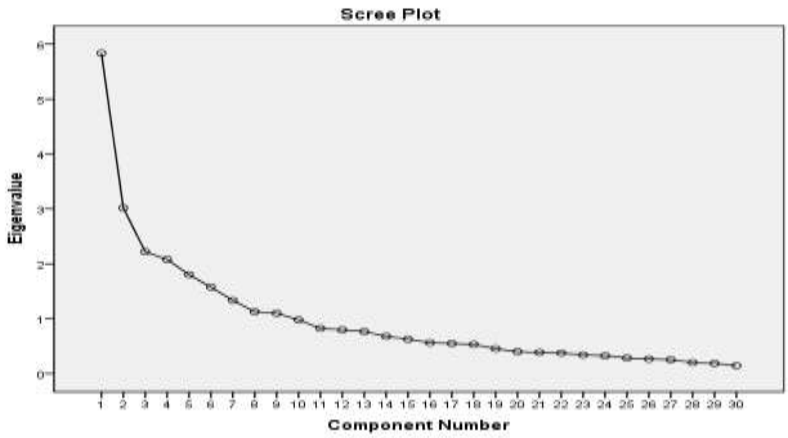

Figure 2: Scree Plot

c) Rotating and Interpreting the Factors

Adequate identification of each factor is necessary for proper interpretation of the factor. Conceptual coherence is crucial for both the items and the factors (Costello and Osborne 2005). There is, however, some variation in the literature on how to rotate and interpret factors (Beavers, Lounsbury et al. 2013). Different sources suggest different thresholds for what constitutes a "strong" factor loading, with some saying .50 is sufficient (Costello and Osborne 2005) and others suggesting .60 or higher (Guadagnoli and Velicer 1988). However, generally a loading of .70 or above is ideal, since it indicates that roughly half of the variability of an item is explained by the factor. To be a good indicator of a factor, an item should have a loading of .70 or higher and not show significant loading on another factor above .40 (Beavers, Lounsbury et al. 2013). Moreover, to be regarded as a reliable and stable factor, it must comprise no less than three to five items with considerable loadings (Costello and Osborne 2005).

The current study utilized principal component analysis for the extraction method and varimax with Kaiser normalization for the orthogonal rotation method. Factor loading values presented in Table 3 illustrate the association between each variable and the underlying factors. Factor loading refers to the correlation that exists between the factor and the item (Tavakol and Wetzel 2020).

As shown in the Rotated Component Matrixes below, this study set the factor loading threshold of .50, hence, the following factors are extracted:

Factor 1, as shown in table 3, is categorized as "Prepositioning of Life-saving Resources" which contain four items illustrated by the possession boat, life vest, other floating devices, food, and drinking water. This component accounted for 12.37% of the overall variance, with an eigenvalue of 5.836.

Table 3: Rotated Component Matrix with Grouped Attributes of Prepositioning of Life-saving Resources

Factors	Attributes		Loadings
Prepositioning of Life-saving Resources	1	We have our own boat and other floating device that we can use during flooding.	0.501
	2	Our barangay has pre-positioned boats, life vest, and other floating assets that can be used during flooding.	0.704
	3	We have stored extra food ration to be consumed only during flooding.	0.705
	4	We have stored extra drinking water to be used only during flooding.	0.545

"Flood Perseverance Measures" constitute component 2 as depicted in table 4. Included in this factor are initiatives that help the residents of flood prone area endure through flood incidents. These are storing medicines, first aid kits, extra cash and evacuation map, installation of route signages, strengthening house

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structures, and immediate repair of flood damages in houses. The overall variance described for this factor is 11.214% with an eigenvalue of 3.017.

Table 4: Rotated Component Matrix with Grouped Attributes of Flood Perseverance Measures

Factors	Attributes		Loadings
Flood Perseverance Measures	5	We have stored medicine to be used only during flooding.	0.591
	6	We have stored first aid kit that can be utilized during flood emergencies.	0.52
	7	We save and keep extra cash to be used only to purchase our needs during and after flooding incidents.	0.603
	8	We have a map showing the proper and safe way going to the evacuation area during flooding.	0.646
	9	Our community has posted signages showing the proper way towards the evacuation center.	0.756
	10	We strengthen the structure of our house to make it resist flooding.	0.732
	11	We immediately repair the damaged part of our house after flooding.	0.579

“Proper Coordination with the Local Government/Authorities” component, the third factor, shown in table 5, comprise schemes like voluntary evacuation, community drainage maintenance, organizing rescue team, and government financial assistance. This factor accounted 9.418% of the total variance with an eigenvalue of 2.218.

Table 5: Rotated Component Matrix with Grouped Attributes of Proper Coordination with the Local Government/ Authorities

Factors	Attributes		Loadings
Proper Coordination with the Local Government/ Authorities	13	We voluntarily evacuate when there is heavy flooding as advised by the barangay LGU.	0.68
	14	Our community implements a regular drainage system and canal maintenance and clean-up.	0.663
	15	Our community has an organized and well-trained emergency rescue team.	0.742
	16	We receive financial and other kinds of assistance from our barangay LGU immediately after flooding.	0.633

The fourth factor is marked “Response Strategy”. As represented in table 6, it contains six items, viz. evacuation plan, securing documents, standby generator set, reserve emergency resources, flood control, and emergency hotline. This component accounted 8.587% of the total variance with an eigenvalue of 2.08

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Table 6: Rotated Component Matrix with Grouped Attributes of Response Strategy

Factors	Attributes		Loadings
Response Strategy	17	Our family formulated a systematic flood - evacuation plan prioritizing children, elderly, and PWD's.	0.639
	18	We place important papers in water-resistant document holders.	0.757
	19	Our barangay LGU has a generator set that can be utilized when there is electricity failure during flooding.	0.75
	20	We prepared flashlights, battery operated radio, matches, candles, batteries, and other emergency supplies that we can use during flooding.	0.561
	21	Our LGU has implemented flood control projects in our community.	0.617
	22	Emergency hotline numbers are being posted all over our community.	0.637

As shown in table 7, factor 5, tagged as "Flood Effects Prevention Measures", comprises aspects like flood IEC campaign, flood drill, weather monitoring, extending house levels, and early warning signals. The overall total variance explained for this factor is 8.252% with an eigenvalue of 1.8.

Table 7: Rotated Component Matrix with Grouped Attributes of Flood Effects Prevention Measures

Factors	Attributes		Loadings
Flood Effects Prevention Measures	23	To prepare for flooding, our barangay LGU has conducted flood Information, Education, and Communication campaign.	0.526
	24	Our barangay LGU conducted flood drill to all its residents.	0.653
	25	We monitor the weather forecast regularly in order to anticipate flood.	0.753
	26	We progressively constructed a second floor on our house to overcome the effects of flooding.	0.777
	27	Our community has installed an Early Warning System such as siren that will sound the alarm when water level reaches a critical point.	0.654

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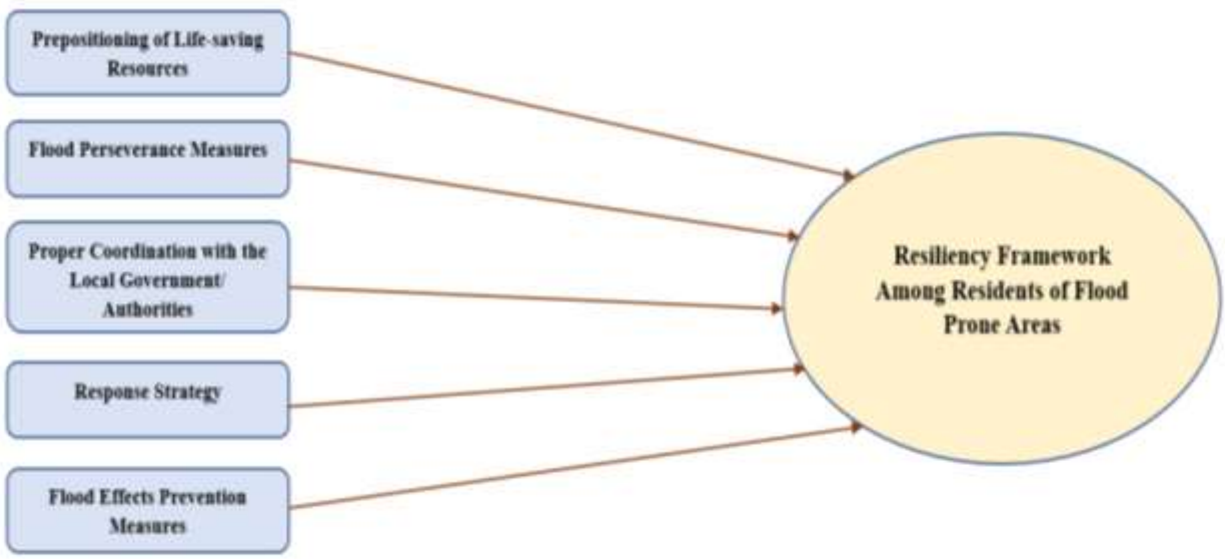

Figure 2: The Flood Resiliency Framework of Residents Living in Flood Prone Areas of Davao Region

CONCLUSION

To measure the resiliency framework of residents in flood-prone areas, principal component analysis and varimax orthogonal factor rotation method were used to extract the primary factors. As a result, this research has obtained valuable insights on the resiliency framework of flood prone area residents. This enables the researchers to concentrate on a smaller number of manageable factors about flood resiliency framework instead of dealing with a large number of parameters. The major factors that were identified in this study include the "Prepositioning of Life-saving Resources", "Flood Perseverance Measures", "Proper Coordination with Local Government/Authorities", "Response Strategy", and "Flood Effects Prevention Measures".

The study's findings, however, cannot be extended to the larger population, therefore, it may be necessary to conduct a more comprehensive investigation about disaster resiliency framework among residents of flood prone areas. Additional study is necessary to thoroughly examine the topic and ensure that decisions about flooding matters are well-informed and supported by sound evidence.

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