Service Quality Assessment of a Local Government Unit's Disaster Response using Factor Analysis

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Abstract

The Philippines is one of the Asian countries most vulnerable to natural disasters according to Climate Change Vulnerability Index, and has been under the Pacific Typhoon Belt due to its location. As a result, the Philippines is highly vulnerable to typhoons and flooding. Tarlac, a province in the Philippines, is a frequently flooded location due to its geographic features. With this, this study aimed to assess the service quality of La Paz Tarlac LGU's disaster response by analyzing the underlying factors that explain the correlational pattern between a set of measured variables using SPSS software . The researchers evaluated this by getting the points of view of both LGU employees and residents of the area. Through Analytic Hierarchy Process (AHP), the complex information in multi-criterion decision-making was dealt with. As a result, the alternative solutions with the most significant weight among others for each criterion are as follows: "Standard Operating Procedure on Disaster Management," "Drill and Trainings," and "New and Improved Disaster Reduction Technologies," respectively. By clustering variables, factor 1 is linked with the Efficiency of LGU's Disaster Response. The second aspect relates to the Readiness of LGU Personnel for Disaster Operations. Factor 3 is connected with Effective Disaster Plan Dissemination.

Keywords
Analytic Hierarchy Process (AHP), Factor Analysis, Disaster Management, Service Quality, Disaster Response

1. Introduction
According to the United Nations Office for Disaster Risk Reduction, disasters affect approximately 100 million young people, including children, each year. Natural catastrophes kill an estimated 45,000 people worldwide, accounting for an average of 0.1% of all deaths during the last decade, ranging from 0.01 to 0.4%. Since the 1980s, the total number of disasters has nearly doubled. The 2020 Ecological Threat Register (ETR) reveals that since the 1960s, the number of natural disasters has increased by 10. The world had the most significant number of natural disasters in 2005, with 442 events, more than 90,000 fatalities, and 160 million people needing immediate assistance. Disasters can hit any country, regardless of economic standing; however, underdeveloped countries suffer the worst consequences. Developing countries have limited capacity to plan for calamities and emergencies and deal with disasters when they occur (Al Kurdi 2021).

The Philippines has been named one of the Asian countries most vulnerable to natural disasters by the Climate Change Vulnerability Index. Due to its geographical location, the country is under the Pacific Typhoon Belt. As a result, the Philippines is highly vulnerable to cyclonic storms and flooding. During the wet season, when the country is most susceptible to floods, the country experiences an average of 19-20 typhoon occurrences per year (Kurata et al. 2022). Its location within the Pacific Ring of Fire makes it even more vulnerable to disasters. With numerous disasters

occurring in the Philippines yearly, the government has enacted policies supporting disaster risk reduction and management (DRRM) development through Presidential Decree (PD) no. 1566 and Republic Act (RA) no. 10121. Furthermore, agencies have been established to implement these guidelines and develop programs on the four pillars of DRRM: disaster prevention and mitigation, disaster preparedness, disaster response, and disaster rehabilitation and recovery (Gundran et al. 2022). However, disaster plans, like practice drills, may lack testing to assess their effectiveness before threats strike. In disaster management, the Philippines scores poorly, notably in cash usage, information management, leadership, monitoring, collaboration, and coordination with diverse stakeholders (Dariagan et al. 2021).

Tarlac, a province in the Philippines, is a frequently flooded location due to its geographic features. Although the province is primarily a huge flat plain, it is bordered by towering mountains on its east and west sides which made it one of the provinces with a high risk of flooding and landslides (Mohammed 2018). In Tarlac province recently, Typhoon Karding destroyed crops worth more than P560 million, according to a report from the TPDRRMO (Tarlac Provincial Disaster Risk Reduction and Management Office). Victoria town was heavily impacted, with 1,441 residences partially damaged and 90 homes destroyed. In terms of agriculture, Guiang claimed that 24,763 hectares (ha) of rice fields belonging to 19,981 farmers in the province's 16 municipalities and Tarlac City lost P532.5 million worth of rice about to be harvested. Corn worth P17.6 million and high-value crops worth P34.4 million were also lost. Additionally, the Provincial Engineer's Office reported that 10 provincial roads, bridges, and government buildings were damaged, with an estimated restoration cost of P16.25 million. Repairs to the flood control systems established in the province's several towns would cost another P70.5 million (Cardinoza 2022).

The researchers aim to evaluate the efficiency of the disaster response provided by the La Paz Tarlac LGU by examining the underlying factors. The data will be gathered through surveys and interviews with government employees and residents. The perspectives of residents and LGU staff were gathered by the researchers to assess this. Data collected will be analyzed using SPSS software for the factor analysis and Analytical Hierarchy Process (AHP) to modify and realign their response depending on the results from the survey. The disaster response will be benchmarked to other areas to improve the service offering of the target LGU.

1.1 Objectives

This study aimed to assess the service quality of La Paz Tarlac LGU's disaster response by analyzing the underlying factors. The researchers assessed this by getting the points of view of both LGU employees and residents of the area.

The following are the specific objectives of this study:

1. To utilize SERVQUAL dimensions and perform factor analysis and AHP in assessing the service quality of a local government unit’s disaster response.
2. Benchmark to other areas’ disaster response to improve the service offered by the target LGU.

2. Literature Review

Due to its location on the "Pacific Ring of Fire" and along the Pacific typhoon belt, the Philippines is prone to many different types of natural disasters, such as typhoons, earthquakes, floods, volcanic eruptions, landslides, and fires (CFE-DMHA 2021), and are the natural disasters that will be highlighted in this study. According to Statista (2021), earthquakes have the highest risk index score among them, followed by tropical cyclones. Some of these disasters that the Philippines encountered recently was Super Typhoon Haiyan, locally known as “Typhoon Yolanda.” On November 8, 2013, this typhoon struck the Visayas region of the Philippines. The storm is still one of the fiercest and most devastating typhoons ever, with winds exceeding 315 km/h (Eadie 2019). Its damage inspired the Philippines to improve communication and institutionalize the roles and duties of national and international players to enhance its disaster management structures and resources further. Thus, greater communication and cooperation during more recent floods, typhoons, and landslides helped to lessen the effects on lives and livelihoods (CFE-DMHA 2021).

Another disaster that the Philippines faced was the Mount Pinatubo eruption. Located in Western Luzon, the Philippines' Mount Pinatubo volcano last erupted in 1991 (the first time in 600 years), wreaking havoc on the region, specifically in Tarlac, Zambales, and Pampanga (Mercado et al. n.d). About 100,000 people were homeless due to the heavy ashfalls, and hundreds of thousands more were compelled to escape the area. Hundreds more people perished in evacuation camps in the weeks following the eruption due to illness. In late August 1992, Pinatubo erupted once more, killing over 72 people (Britannica 2022). Although Mount Pinatubo's huge eruptions in 1991 were the greatest

in the world in decades, volcanologists' predictions in the months before the eruptions led to evacuations of the area, saving thousands of lives and reducing property damage (Samphantharak 2019). In disasters like this, disaster response is crucial in ensuring the safety of affected people within the vicinity.

Despite efforts to minimize risks, several nations struggle to build population resilience to extreme hazards. Lack of plans and policies to address land-use practices, limited resources in at-risk communities, and insufficient incentives for the government to invest in sustainable mitigation measures are contributing factors (Toinpre et al. 2018). However, building a disaster management plan requires effort from the government and also the efforts of the residents. The effects of disasters can be mitigated if community members are prepared with fundamental knowledge about these dangers and are imbued with experience in developing countermeasures. Therefore, every capable barangay resident should participate in Disaster Risk Reduction (DRR) initiatives. When DRR is integrated into all key policy domains, resilience becomes everyone's business (Oldham and Astbury 2018). Barangay officials must be trained in these competencies before they may allow these activities. Social and economic growth is promoted through disaster risk reduction, especially to assure the future sustainability of progress (Hoffmann and Muttarak 2017). This will be accomplished effectively if community members collaborate and maximize available resources efficiently.

During disaster response operations, disaster response plans have necessary steps that focus on needs assessment, search and rescue, relief operations, and early recovery (NDRRMC 2020). Disaster preparedness is shifting from a risk-focused approach to an integrated and systemic approach based on resilience thinking. Risk communication and perception are interrelated factors that influence how individuals prepare for disasters, how policies are developed, and what they do. Both factors contribute to enhanced risk awareness in communities, making them better prepared (Parida et al. 2021).

While many factors influence what effective disaster management can look like, three fundamental factors appear to be most closely aligned with the ability to guide or influence the behavior of individuals or the course of events while maintaining peace, security, and order. These three factors are governance, leadership, and trust. In disaster management, good governance is critical (Crosweller & Tschakert 2021).

The government plays a critical role in disaster preparation and response. Typhoon mortality is associated with the effectiveness of government reaction. It has a direct impact on the success of catastrophe risk reduction programs. On the other hand, the ability of the local community to respond to disaster preparedness is critical. Beliefs on how preparedness and adaptation to prevent typhoon danger and threat are crucial in typhoon preparation. Since typhoons often happen in the Philippines, it is essential to reduce the risks and dangers they pose (Kurata et al. 2022).

Mohammed (2018) researched the catastrophe response in Tarlac City. The CDRRMO and City Engineering Office is crucial to the city's catastrophe response. Among the activities indicated are the production of situational reports, emergency warning systems, and press releases as a basis for the actions of interested authorities, as well as the execution of the actual search, rescue, retrieval, and relief operations. The city gives victims temporary shelter, food or relief supplies, quick health exams, kid and woman-friendly spaces, emergency kits, and medicine.

According to the Ravago et al. study, while communities may be well prepared for the likelihood of another disaster, recovery is not guaranteed. The frequency and severity of natural disasters can negate and impede full recovery. One policy challenge is the need to find and implement a cost-effective solution. Long-term prevention measures, cleanup efforts, and the restoration of power and water supplies were discovered to increase the likelihood of recovery significantly. This serves as a starting point for local governments to evaluate their disaster preparedness plans and tactics in the case of another crisis (Ravago et al. 2020).

Good governance is defined as an ideal state orientation that achieves national goals, as well as functional elements of effective and efficient governance to achieve these goals (Mamuaya et al. 2018). Mamuaya et al. also added that effective governance entails managing a strong, accountable, and efficient state government while maintaining excellent relationships between the government, the private sector, and society (Mamuaya et al. 2018).

The quality of service an organization provides influences its ability to retain clients, its image and reputation, and its ability to make money. Because services are intangible, heterogeneous, perishable, and inseparable, measuring quality is difficult. Customer feedback is the most accurate indicator of how good a service is (Talavera 2020). In 1988, Parasuraman et al. developed a modified version of the SERVQUAL model, which only has five dimensions:

tangibility, reliability, responsiveness, assurance, and empathy. Each of the five dimensions was precisely described by Parasuraman as follows: The ability of service providers to deliver the promised service dependably and accurately is referred to as reliability. Responsiveness is the willingness to assist and provide prompt service to customers. Assurance describes how well employees know their jobs, how polite they are, and how well they can make people trust and believe in them. Empathy includes being caring and providing individualized attention (Ocampo et al. 2019). The researchers in the present study will adapt these five dimensions. Additionally, the researchers will also consider "fulfillment" which was used in the study of Ighomereho (2022) in assessing e-service quality. The study defined this as the output of service delivery performance, focusing on what customers need and what they get in return.

In the Philippines, a study looked at how the local government units (LGUs) responded to the pandemic using the SERVQUAL Dimensions. The exact dimensions used were assurance, reliability, tangibility, empathy, and responsiveness to determine service quality and how it affected customer satisfaction (Bucu et al. 2021).

The SERVQUAL model omits two important criteria: service delivery and the price-quality relationship. The service characteristics used to assess service quality may not be an exact measure of service quality. Interviewing respondents before and after using the service, known as the "gap indicator," has real drawbacks. To be more specific, the SERVQUAL scale is a valuable but insufficient quality indicator (Nguyen 2021).

Inadequate comprehension of the five dimensions and misinterpretation or biased interpretation by the researchers may skew the results. This study uses the Analytical Hierarchy model to generate a pairwise comparison of the five service quality parameters based on expert opinion. AHP is a powerful and well-known way to compare different criteria. It ranks, weighs, and prioritizes the criteria based on experts' opinions (Boukhari et al. 2018).

Numerous studies worldwide also employ a combined AHP-SERVQUAL methodology to quantify perceived and expected service quality (Alam and Mondal 2019). In this study, the researchers plan to utilize SERVQUAL and AHP to assess the service quality of a local government unit's disaster response. This study helped the municipality of La Paz, Tarlac, target its resources to improve how it responds to disasters. It showed that it understood what its residents wanted and were better prepared to recover from natural disasters in La Paz, Tarlac.

3. Methods

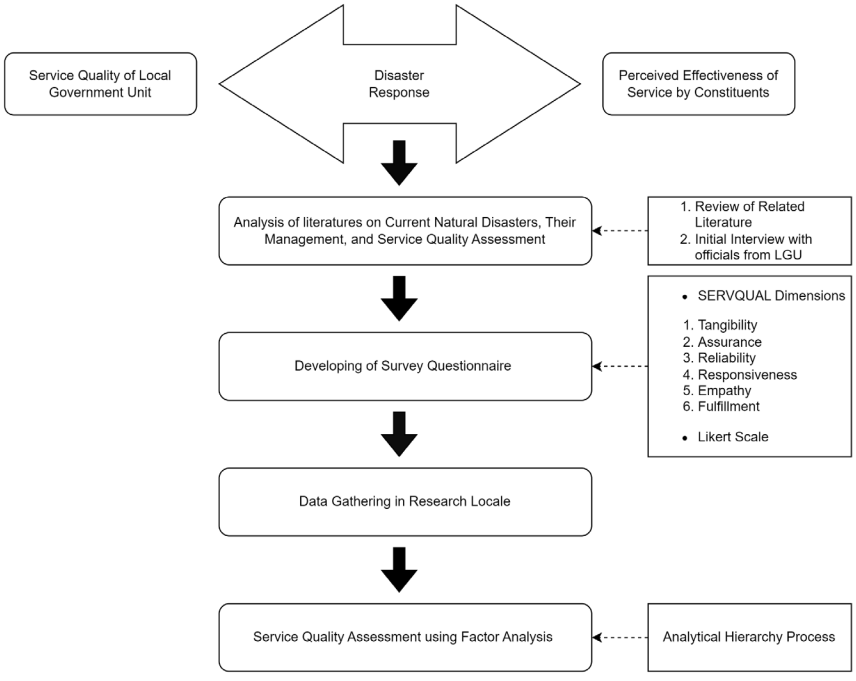

Figure 1. Conceptual framework

This study evaluated the disaster response in the Local Government Unit of La Paz, Tarlac. Owing to the lack of information regarding the quality of disaster response services in La Paz, the researchers utilized a global literature search to design the research. In this study, the weights of the six SERVQUAL dimensions: Tangibility, Reliability, Responsiveness, Assurance, Empathy, and Fulfillment are determined by a thorough review of the relevant literature about the questionnaire items, methods, validity, and reliability of the questionnaire. The survey tool has a minimum of 70 respondents to determine its validity. The number of respondents was adopted from the paper of Alam and Mondal (2019) which used the SERVQUAL models and AHP models to assess their study regarding the sanitation service of railway slum of Khulna city. After collecting the data, these were cleaned and analyzed with appropriate statistical tools. The researchers utilized SPSS software for the factor analysis. Factor analysis aims to find the underlying variables, or factors, that explain the correlational pattern between a set of measured variables. When reducing the number of manifest variables, factor analysis is frequently employed to find a small number of factors that account for the majority of the variance. Additionally, factor analysis can be used to develop theories about the causal processes or to choose variables for further investigation. Through Analytic Hierarchy Process (AHP) this dealt with complex information in multi criteria decision making. It is useful to select options depending on a variety of factors.

4. Data Collection

The researchers conducted the study in La Paz, Tarlac, Philippines. The data were collected from the local government employees and the residents of the area coming from its 21 barangays. The study focused on the mentioned location since it is one of the frequently flooded locations due to its geographic features Moreover, face-to-face interviews with local government officials and face-to-face and virtual dissemination of survey questionnaires were conducted for data gathering.

5. Results and Discussion

5.1 Graphical Results

The researchers gathered 208 respondents from the municipality of La Paz, Tarlac through a survey conducted in November 2022. Using Principal Component Analysis, the disparities between Perceived and Expected service of 17 statements across 6 SERVQUAL categories were reduced to three components. Table 1 illustrates that the first three components have eigenvalues that are greater than 1. According to the rule of thumb, only these factors are likely to indicate underlying factors. Additionally, as shown in Figure 2 - Scree plot, component 1 has a significantly greater eigenvalue than the other components. Components 2 through 4 with eigenvalues of at least one are still regarded as significant factors.

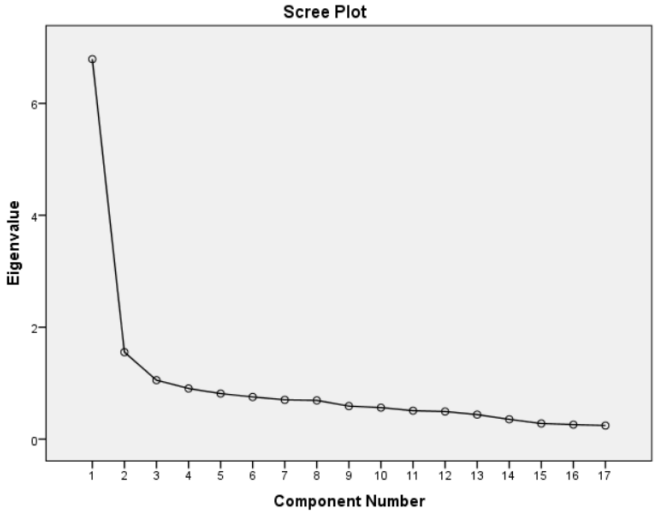

Figure 2. SPSS - scree plot

Table 1. Initial Eigenvalues

		Initial Eigenvalues				Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %	Component	Total	% of Variance	Cumulative %
1	6.789	39.937	39.937	10	0.563	3.314	84.830
2	1.554	9.143	49.080	11	0.509	2.993	87.824
3	1.054	6.199	55.279	12	0.493	2.903	90.726
4	0.906	5.330	60.609	13	0.439	2.580	93.306
5	0.814	4.790	65.399	14	0.355	2.086	95.392
6	0.754	4.433	69.832	15	0.280	1.645	97.038
7	0.703	4.135	73.967	16	0.260	1.530	98.568
8	0.693	4.074	78.041	17	0.243	1.432	100.00
9	0.591	3.474	81.516				

Table 2. SPSS - Rotated Component Matrix

	Component		
	1	2	3
EMP 3	0.766		
EMP 1	0.747		
RES 3	0.700		
FUL 3	0.643		
REL 4	0.630		
REL 1	0.585		
EMP 2	0.584		
TAN 3		0.743	
REL 3		0.724	
RES 2		0.703	
ASS 1		0.702	
TAN 2		0.625	

ASS 2		0.466	0.415
ASS 3			0.675
FUL 2	0.415		0.645
TAN 1			0.611
FUL 1	0.553		0.597

The Rotated Component Matrix in Table 2 shows that EMP3, EMP1, RES3, FUL3, REL4, REL1, and EMP2 are all used to measure the first component. The factor loading of FUL1 and FUL2 is higher in component three than in component one. TAN3, REL3, RES2, ASS1, and TAN2 are used to measure the second component. In component two, TAN2 has a larger factor loading than in component three. ASS3 and TAN1 are used to assess the third component.

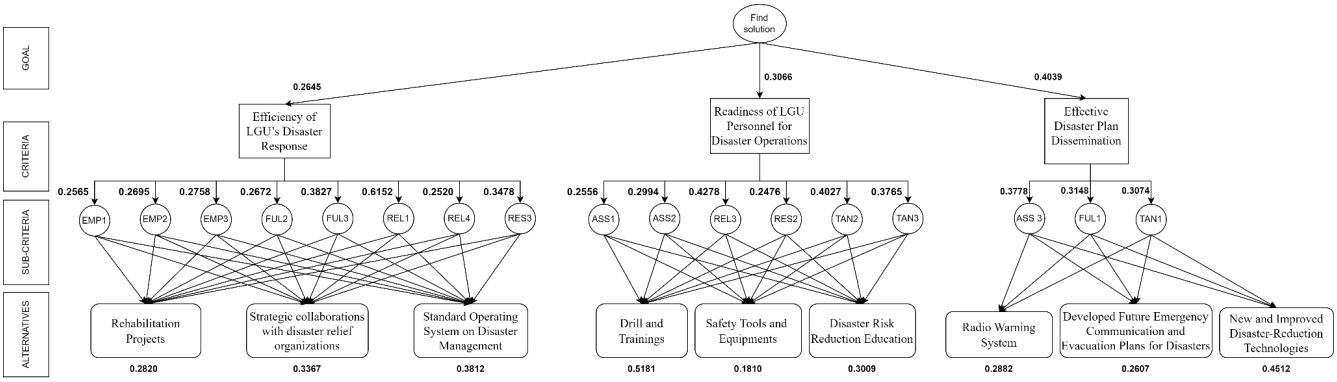

Figure 3. Block diagram of the AHP model

The criterion weights were determined using the Analytical Hierarchy Process (AHP), a multi-criteria decision-making technique developed by Saaty in the 1970s. The researchers used the AHP Tutorial of Teknomo (2011) as a guide in computing the weighted average of each criterion and alternative. The intensity scale is measured equal (1) to extreme favors (9) and this was used to assign weights from the collection of attributes, with the higher intensity indicating better performance.

As seen in Figure 3, the researchers have three (3) criteria: Efficiency of LGU's Disaster Response, Readiness of LGU Personnel for Disaster Operation, and Effective Disaster Plan Dissemination. Each criterion has three (3) alternative solutions with corresponding weights. As a result, the alternative solutions with the greatest weight among others for each criterion are as follows: "Standard Operating Procedure on Disaster Management," "Drill and Trainings," and "New and Improved Disaster Reduction Technologies," respectively.

According to the interviewed La Paz MDRRMO officer, there is no existing standard operating procedure. When disasters come to their municipalities, rescuers respond reactively instead of having established pre-planned operations. Moreover, for the drill and training project of the municipality, they only have provincial training, which was organized by the provincial government of Tarlac.

5.2 Proposed Improvements

Pretotype of the Three Solutions

The researchers created a pretotype for each of the chosen alternative solutions per criterion to address the problems with the LGU's service. A pretotype is a simplified version of a product that is only intended to gauge the interest of

people in it (Ponomarev 2019). For the criterion Efficiency of LGU's Disaster Response, a "Standard Operating Procedure on Disaster Management" was developed, as was a "Drill and Training for Disaster Preparedness and Response" for the criterion Readiness of LGU Personnel for Disaster Operation, and "ALPAS: A Mobile application for Disaster Resilience" for Effective Disaster Plan Dissemination.

Standard Operating Procedure on Disaster Management

A Standard Operating Procedure (SOP) is a manual that outlines the step-by-step methods for municipal officials to comprehend the specific emergency response activity in the event of a disaster. In the event of a crisis, officials must affirm each job and obligation by utilizing SOP for quick emergency reaction and recovery. In an emergency, operations and responsibilities tend to fluctuate, and the SOP helps keep things organized and functioning efficiently. It can assist preserve operational continuity while emphasizing good emergency preparedness and protocol. The goal is to keep operations running during and after an incident. This is done in conjunction with emergency response responsibilities.

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E. Post Disaster Plan
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F. Procedure of SOP update and revision

Drill and Training for Disaster Preparedness and Response

Course Overview

There are five parts to the disaster preparedness and response training course as seen in Table 3. Additionally, there is a disaster simulation exercise at the end of the semester where learners apply the knowledge and abilities they have learned. Participants will have a better grasp of the disaster-related rapid needs assessments and surveillance required to assist responses to disasters and other public health emergencies once they have finished the training. The suggested program flow with their corresponding timeframe in Table 3 for the drills and training were benchmarked on the disaster preparedness and response training of the Centers for Disease Control and Prevention (n.d.).

Table 3. Program flow of drills and trainings

Program	Duration
Introduction to Disaster and its Intensities a. Types of Disasters and its Intensities b. What to do when: i. Earthquake ii. Fire iii. Floods iv. Typhoons	2 Hours
Equipment Needed by the Rescuers	40 Minutes
GO Bag Emergency Kit	20 Minutes
Disaster Simulation Exercises	3 Hours and 30 Minutes
First Aid Training	1 Hour and 30 Minutes

ALPAS: A Mobile application for Disaster Resilience

This application is inspired by the Batingaw app, but with an improved and more user-friendly interface. This application is a proactive, comprehensive, and rational mobile application for disaster management, serving as a communication tool to aid in reducing and mitigating the catastrophic consequences of natural disasters in vulnerable areas through mobile technologies. The mobile app gives government agencies, businesses, and people quick access to disaster alerts, advisories, location information, and offline disaster maps. It provides disaster-affected consumers with guidelines that can lead them to safety. The software also enables users to offer emergency agencies information more efficiently. To further visualize it, the researchers provided a sample interface for the application in Figures 4.

Figure 4. ALPAS mobile application mobile interface

6. Conclusion

As seen in Table 4, the researchers clustered each variable item by factor based on the factor analysis. By clustering variables, factor 1 is linked the Readiness of LGU Personnel for Disaster Operations. Factor 3 is referred to as Effective Disaster Plan Dissemination. Three (3) alternative solutions are then provided for each factor. Analytical Hierarchy Process (AHP) was used to identify which among the proposed solutions should be prioritized based on the results of the focused group discussion with some of the survey respondents. Finally, the three (3) solutions, one for each factor, that the researchers recommend prioritizing based on the results are as follows: establishment of standard operating procedures (SOP) on disaster management, drills and training, and ALPAS: a mobile application for disaster resilience.

Table 4. Factors component

Factor 1 Efficiency of LGU's Disaster Response	**Factor 2** Readiness of LGU Personnel for Disaster Operations	**Factor 3** Effective Disaster Plan Dissemination
EMP1 - LGU provides for each household's specific needs	**ASS1** - LGU disaster response personnel are courteous in conversation	**ASS3** - LGU personnel are knowledgeable with the disaster plan in the area.
EMP2 - The LGU is aware of its constituents' needs.	**ASS2** - LGU disaster response personnel are well supported by their unit during disaster response	**FUL1** - I feel prepared with well-disseminated information and knowledge across groups in our community regarding rescue operations during the disaster.
EMP3 - LGUs facilitate convenient disaster responses	**REL3** - The LGU personnels well-trained in handling rescue operations.	**TAN1** - The local government provides adequate evacuation facilities for natural disaster victims, including safe and well-equipped evacuation centers
FUL2 - I feel safe in the community amidst disasters knowing that LGU can respond to them effectively.	**RES2** - There is enough LGU personnel to meet the needs of residents after a disaster.	
FUL3 - I received enough relief goods for my family and me.	**TAN2** - LGU has adequate equipment and supplies to perform rescue operations during a disaster	
REL1 - LGU executes disaster management response effectively	**TAN3** - Rescuers and/or volunteers are well-equipped with safety gear.	
REL4 - LGU provides the residents with seminars regarding the community's disaster management plan.		
RES3 - The LGU personnel are well-trained in handling rescue		

operations.		

For SOP on disaster management, it can improve the efficiency of LGU's disaster response through standardization of procedures during emergencies and would increase disaster preparedness of the research locale. According to Chang et al. (2019), disaster response is substantial in ensuring that the possible risk of losses during a disaster is reduced. The study also mentioned that the absence of standard operating procedures when it comes to disaster could negatively impact the number of victims during a disaster since it may lead to improper management of the situation. In this case, it is highly recommended that the LGU of La Paz, Tarlac establish an SOP for disaster management to increase service efficiency.

Moreover, the drills and training about disaster preparedness is another solution proposed by the researchers to increase the readiness of LGU personnel for disaster operations. According to Liu et al. (2020), initiatives like training will encourage rapid response and effective coordination among staff and involved departments during an emergency situation. With this, drills and training will be beneficial for the LGU personnel to execute disaster operations effectively. It will also maximize task delegation for its departments so that they can fully accommodate the needs of residents and reduce the losses in the aftermath of a disaster.

Lastly, the mobile application, ALPAS, will increase the effectiveness of disseminating the municipal's disaster plan among its residents. Through the app, they can educate people on how to react to emergency operations through the provided guidelines initially. The LGU officials in-charge of rescue operations can also easily locate the residents who are in need amidst a disaster. Maximizing technology to increase the community's disaster resilience is another aspect of the LGU's service that needs to be considered.

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