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RESEARCH ARTICLE OPEN ACCESS

Perception of Community Members on the Hazards of Residential Houses: Preparedness Assessment for Future Typhoons and Earthquakes in Model Community,Porac,Pampanga

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Abstract:

How individuals view the safety of their housing affects the design, structure, and maintenance of the dwelling. This study focused on community members' perception of the hazards of residential houses in the event of strong typhoons and earthquakes. Also, to evaluate houses' structural configuration using the Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines. A total of 334 respondents from Model Community, Porac, Pampanga, were asked to participate and selected using convenience sampling. The study utilized quantitative research design and descriptive statistics to analyze the survey data collected from the respondents. The study revealed that people living in the community are aware of the potential risks posed by both typhoons and earthquakes and are knowledgeable of the resistance of their houses to these natural disasters. Furthermore, the results show that the level of the structural configuration of residential houses is high. The findings indicate how the community can intervene with program factors to enhance local understanding of housing safety. The study also proposed flood hazard map and earthquake zones seismic hazard map to help the community identify areas at risk of future disasters and enable the community to plan and mitigate potential hazards.

***Keywords**:* safety, perception, typhoons, earthquake, hazards, structural configuration.

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I. INTRODUCTION

A house is a structure where people, mainly one family, live. It serves as a shelter to protect the inhabitants from the other harms and dangers of the surroundings, such as typhoons, earthquakes, and other natural calamities. Their experience of past disasters largely shapes the perception of community members on the hazards of residential houses. In the Philippines, a country prone to typhoons and earthquakes, many people are aware of the dangers of extreme weather and seismic events.

However, many community members are not adequately prepared for future disasters despite their knowledge. Most households have basic safety measures, such as securing furniture and other loose items, but more is needed to protect them from the full force of a typhoon or earthquake. Many communities lack basic infrastructure, such as reinforced buildings, that could help mitigate the damage from such disasters. In addition, some communities need more basic information on how to prepare for an emergency.

The Philippines, a group of over 7,000 islands in the Pacific Ring of Fire, is one of the most vulnerable nations in the world to natural disasters and is also severely impacted by climate change. Due to its exposure to seasonal dangers such as monsoon rainfall, typhoons, and unpredicted disasters such as earthquakes, the Philippines' population must immediately be able to construct and maintain disaster-resistant housing (Baraoidan et al., 2018).

Pampanga is a province in Region III (Central Luzon). The province comprises approximately 2,180.68 km2, 19 municipalities, three cities, and 538 barangays, with a population of 2,014,019 and 416,273 households. The majority of the Philippines is located within the Philippine Mobile Belt (PMB), a region of deformation and seismic activity induced by the movement of the Philippine Sea Plate to the northwest. At approximately 5:11 PM (PST) on April 22, 2019, a tectonic earthquake of magnitude 6.1 struck the region. According to the Philippine Institute of Seismology and Volcanology (PHIVOLCS), the earthquake's focal depth is 10 kilometers, and the epicenter is located at 15.02°N, 120.34°E, and 18 kilometers N 58°E, of Castillejos, Zambales. The National Disaster Risk Reduction and Management Council (NDRRMC) released a report detailing 18 deaths, 256 injuries, and 3 missing persons. In addition, the earthquake afflicted 18,086 people in 41 barangays in Region III (Central Luzon), a seven-province administrative region. Six evacuation centers served 2,962 people, while 4,756 were served outside the centers (Garciano et al., 2019).

The wreck of natural disasters, such as typhoons and earthquakes, on residential houses is an increasingly important concern for community members. As such, understanding community members' perceptions of the future hazards of these disasters is necessary to develop effective mitigation strategies. This research explored how community members perceived the future hazards of typhoons and earthquakes on residential houses. Additionally, this research surveyed community members' strategies to protect their homes from these hazards. The findings from this research provided valuable insights into effectively reducing the effects of natural catastrophes on residential houses.

A. *Research Objectives*

The general objective of the study is to assess the preparedness of community members in Model Community, Porac, Pampanga, for the future hazards of typhoons and earthquakes to residential houses.

Specifically, this study aims to:

- To assess the community members' knowledge of the construction of their houses and the damage from past typhoons and earthquakes.
- To evaluate the community members' understanding and awareness on the response of the structure of their houses in the event of strong typhoons and earthquakes.
- To measure the level of structural configuration of residential houses using "Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines".
- To develop a framework of recommendations that can be implemented to improve the community members' preparedness for future typhoons and earthquakes.

B. *Significance of the Study*

The study particularly aims to provide informative research about the perception of community members on the hazards of residential building construction. The research and findings will benefit the following: the University, community, future homeowners, future researchers.

- The Community. This study will help them understand the potential dangers of residential houses and the necessary steps to take to be prepared in the event of a disaster. This knowledge can help them make informed decisions about their safety and that of their families.
- The University. This study will provide research opportunities to students and faculty members, allowing them to gain knowledge and understanding on the hazards associated with

residential houses and the preparedness assessment needed for future typhoons and earthquakes. This study can also help the university provide resources and support to the community in the event of a disaster.

- The Future Homeowners. This study will help them to assess the potential hazards in a particular house and make necessary changes to ensure that the house is safe and secure. This can help them protect their investment and save money in the long run.
- The local authorities. This study will help them develop appropriate policies and regulations for residential houses in order to ensure the safety of the occupants. This can help them take the necessary steps to prevent disasters from occurring or minimize the damage caused when they do.
- The future researchers will have access regarding this research. This study will benefit them by considering this as a basis in improving the study.

C. *Scope and Limitations*

The main focus of this study is to measure the level of perception of community members on the future hazards of typhoons and earthquakes to residential houses. Also, to assess the level of understanding among community members regarding the integrity of their houses. The respondents in this study came from Model Community, Porac, Pampanga. The research population for this study consisted of adult residents in the community, aged 18 years and above, because they were more likely to be knowledgeable about the risks of typhoons and earthquakes and might have had more experience in preparing and responding to such disasters. The researchers focused their assessment only on 1-2 storey residential houses made with concrete masonry because these types of buildings were mostly found in residential areas in the community. This study was delimited to the perception of community members in a certain region only and did not extend to other communities. Additionally, this study specifically focused on the preparedness assessment for future typhoons and earthquakes and did not include other natural disasters.

D. *Review of Related Literature*

This section includes the relevant literature and studies that the researchers used to support their claims and serve as evidence to strengthen their study.

Residential Houses

When more than half of a building's floor area is devoted to accommodation, the building is considered residential. In other words, a residential building provides resting space in addition to or as a substitute for dining, cooking, or both. (The Constructor, 2019).

The construction of one's own home can be rewarding for some and frustrating for others, but it is always difficult. This is especially true when constructing a home in a local building where you may be unfamiliar with the local building standards (Astley, 2020).

Effects of Natural Disaster

A natural disaster is a devastating occurrence that threatens people's lives and property and is brought on by rain, wind, fire, or even the earth. People can take steps to minimize the impact of natural disasters on themselves and their property, even though it is frequently impossible to prevent them. It is essential that we comprehend how to safeguard our homes from the various dangers posed by nature. This can prevent unnecessary property damage and even save the lives of loved ones (Kerns, 2013).

Some estimations place 60% of the Philippines' geographical area and 74% of its population at risk from various natural hazards, including floods, cyclones, droughts, earthquakes, tsunamis, and landslides. Since 1990, 565 natural calamities have struck the United States, killed 70,000 people and caused $23 billion in damage. Besides earthquakes and volcanic eruptions, climate change is anticipated to exacerbate the Philippines' other natural hazards (The World Bank Group, 2021).

Typhoons and Earthquakes as Natural Disasters

As a result of its location at the intersection of two tectonic plates, the Philippines faces considerable seismic hazards. The country is also in the path of seasonal typhoons, and as a result of climate change, its extreme weather events are becoming more varied and less predictable. In addition to the human cost, disasters have a significant economic impact: overall losses from natural disasters are expected to cost the Philippines approximately $6.5 billion every year (Global Facility for Disaster Reduction and Recovery, 2022).

In addition to the widespread destruction wrought by Typhoon Haiyan and the Bohol earthquake, many typhoons and the conflict in the Zamboanga region in 2013 took a heavy toll on lives and property (Habitat for Humanity, 2017).

In the final three months of 2019, two severe typhoons and a series of magnitude 6+ earthquakes struck the Philippines, affecting an estimated 4.5 million Filipinos and causing damage to more than 1 million residences. Climate and seismic disasters disproportionately affect low-income households and those living in inadequate housing (Stanford, 2020).

Earthquakes and typhoons are inevitable, but they need not be catastrophic. We can prepare for these occurrences by constructing sturdy and safe structures. If we do so, we can prevent the house from collapsing. Earthquakes and typhoons do not kill people; poorly constructed buildings do (Build Change, 2017).

Typhoon in the Philippines

A Tropical Cyclone (or "Bagyo" in the Philippines) is an all-encompassing term for a weather system with intense circulation over tropical seas and oceans. Strong blows, extreme precipitation, and large ocean surges accompany it. Each year, on average, 100 tropical cyclones arise around the globe, with two-thirds of them becoming typhoons or hurricanes. Local atmospheric disturbances generate typhoons in the tropics, where ocean surface temperatures and relative humidity are elevated. Typhoons are prevalent in the western Pacific Ocean. Typhoons frequently cause extensive destruction to the coastlines and islands in their course. Typically, they originate near the equator and move westward, gathering strength as they travel (Build Change, 2017).

Yolanda, also known as Haiyan internationally, was the most destructive typhoon ever to strike the Philippines. Yolanda entered the Philippine Area of Responsibility (PAR) on November 8, 2013, and made landfall in six different areas of the Philippines on November 9, 2013: Guiuan, Eastern Samar; Tolosa, Leyte; Daanbantayan, Cebu; Bantayan Island, Cebu; Conception, Iloilo; and Busuanga, Palawan. Yolanda harmed approximately 16 million people, destroying 600,000 houses entirely and another 600,000 partially, murdering 6,300 people and displacing more than 4 million. Yolanda's projected economic damage ranged between 40 and 420 billion Philippine pesos regarding infrastructure, social damages, and production losses (Anticamara& Go, 2016).

The changing character of extreme weather events and the emergence of the "New Normal" indicates that events like Super Typhoon Haiyan, which caused extensive damage, are likely to occur more frequently, which could lead to even greater destruction. High levels of poverty (25 percent of the population resides below the national poverty level) and high levels of inequality make it difficult for many individuals to prepare for, cope with, and recover from disasters (Tilly Alcayna et al., 2016).

The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA, 2021) states that a Tropical Cyclone Wind Signal (TCWS) is an alert for locations that could be subjected to winds ranging from a moderate breeze to a typhoon within 36 hours of the notification's issuance. This warning system comprises five (5) progressively more severe levels, ranging from 1 to 5. The signal number expresses the wind's expected strength, along with a diminishing alert window.

In 2015, the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) implemented a new classification structure for tropical cyclones with a super typhoon label for conditions with continuous winds of a minimum of 185 kilometers per hour. This update occurred after the large-scale destruction of Super Typhoon Yolanda (Haiyan) in 2013, which necessitated the incorporation of the super typhoon group and the Signal No. 5 warning (Arceo, 2022).

Possible Effects of Signal No. 5 (Super Typhoon): Structures constructed of low-grade materials, utilizing makeshift components, or which have aged and deteriorated greatly are prone to destruction. Even houses that were built well can have big problems with their roofs or walls. There will be a lot of damage to industrial buildings, but only a few will have only partial roof and wall damage. Most windows in high-rise office buildings will be blown out, and swaying could cause moderate damage to the buildings (PAGASA, 2022).

Earthquake in the Philippines

The Philippine Fault results from the oblique collision of the Philippine Sea Plate and the Sunda Block/Eurasian Plate. This fault involves left lateral displacement along a 1200-kilometer stretch of the Philippine archipelago, spanning from the northwest edge of Luzon to the southeast end of Mindanao (Yu et al., 2013).

It is unpredictable when an earthquake might occur; however, being preventative now can reduce its impact. This involves devising a plan, whether for a city or a household, that considers the various steps needed to ensure the building(s) can handle it as best as possible. For instance, reparations may be necessary on older buildings, and new buildings, roadways, and bridges must be designed with this in mind. In addition, people should stock supplies and devise an earthquake plan, so they know what to do prior, during, and after the event. (California Academy of Sciences, 2019).

The Philippines has historically been susceptible to earthquakes and other severe natural disasters. These disasters have been indicated by the five active faults located in the region--the Western Philippine Fault, Eastern Philippine Fault, South of Mindanao Fault, Central Philippine Fault, and Marikina/Valley Fault--which are monitored daily by the Philippine Institute of Volcanology and Seismology (PHIVOLCS). On average, 100-150 earthquakes are felt annually, with an average of 20 earthquakes reported daily. One of the most devastating earthquakes in Philippine history occurred in 1976, when a 7.9 magnitude Moro Gulf Earthquake occurred, resulting in 17,007 fatalities and 40 aftershocks. In the 1990s, the 7.8-magnitude Luzon earthquake was responsible for causing 4,390 casualties, 1,283 deaths, 2,780 injuries, and 329 missing persons. In recent times, the most destructive earthquake on the Modified Mercalli Intensity Scale was the 6.9 Davao del Sur Earthquake in 2019, with a VII intensity level. In light of these astronomic disasters, reviewing and revising the country's disaster preparedness plan is essential to better protect the population (Ong et al., 2021).

Community-Based Resilience

The term "community" is frequently used in literature, yet no definitive meaning exists. Although community implies unity, internal divisions, and conflicts often characterize communities. It is critical to assess resilience at the community level, however, as a community has an inherent understanding of the factors impacting their ability to resist and recover from disturbances, for instance, social norms, social capital, and social networks. Furthermore, studies have proven that preparedness plans crafted by individuals within the community are more effective than those created by external consultants. Additionally, the people who live within the same community often mobilize first in the event of a disaster, signifying the importance of disaster preparedness within the community. (Tilly Alcayna et al., 2016).

As one of the nation's most vulnerable to natural calamities like floods, earthquakes, and typhoons, it is at the forefront of disaster resilience initiatives. With a significant portion of its population living in slum areas in improvised structures, the need for disaster-resistant housing is urgent. Regardless of the presence or absence of natural disasters, one of the nation's preeminent architects emphasized that climate adaptability and resilience in construction cannot be postponed any longer (Santos, 2013).

Disaster-resilient housing is a critical necessity in the country. Housing rehabilitation is frequently the most expensive recovery expense for affected people and governments in the aftermath of disasters. Financial constraints prevent nearly all householders from pursuing home improvement projects. Most have relied on the reserves and money of family members and relatives to pay for home repairs and improvements—one in every five persons financed home improvements through microfinance, cooperatives, or non-governmental organizations. All householders should have consulted an engineer or architect for design guidance or project monitoring regarding repairs and reconstruction. The majority of dwellings are not likely to withstand a natural calamity such as a severe typhoon — an event that the majority of respondents had personally encountered (Baraoidan et al., 2018).

House Construction and Challenges

The building components of residential houses are composed of different construction materials, which vary in quality and can become less reliable over time due to aging, wear and tear, and the loss of performance characteristics. Different building components will experience these changes at different rates, with roof coverings generally becoming less durable and having shorter lifetimes than the underlying truss structure (Nowogońska&Cibis, 2017).

Members of the community with the least wealth often rely on government grants or assistance programs to fulfill their housing needs. Meanwhile, those classified as the 'working poor' tend to obtain goods and services to build, repair, or improve their homes by cobbling together multiple income streams, resorting to borrowing money from family members and friends to afford the necessary work and materials. Historically, most homeowners have been able to finance repairs and upgrades through their savings or the financial assistance of their relatives (Habitat for Humanity, 2018).

For those who reside in areas prone to earthquakes and typhoons, the issue of which housing type is the safest is challenging. In general, dwellings made from lightweight and flexible materials like wood or bamboo are safer during earthquakes but more vulnerable to damage during typhoons. In contrast, concrete and masonry residences are more resistant to typhoon winds but may be susceptible to earthquakes if not constructed properly. There are both good and poor construction techniques for both categories of homes. Regardless of the materials chosen, it is essential to construct a home accurately and with high-quality materials (Build Change, 2017).

Families with limited resources frequently cannot afford to hire construction experts like architects and engineers. Applying for a building permit is also difficult because it takes take time, costs extra money, and requires a lot of paperwork, including engineering and property documents. The permitting process depends heavily on land registry, but many low-income families lack ownership and legal rights to their land. The majority of builders in the area lack comprehensive expertise in safe construction. As a result, building is frequently done in a way that puts the inhabitants of the structures at risk during severe earthquakes and typhoons. Additionally, there are no regulations or controls on the industry for concrete hollow blocks (CHB), the most popular wall material used in home construction. As a result, there is a lot of low-quality CHB available on the market, which may appeal to consumers given that it is less expensive (Ombao, 2020).

Minimum Standards of Masonry Construction from Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines

Foundation

For hard soils, excavate 40 cm deep by 60 cm broad, and for soft soils, excavate 50 cm deep by 70 cm wide. Placement of column footings at all corners, wall intersections, and door apertures. Column footings are at the same depth as the foundation's base.

Foundation made of:

Option 1 - Stone Masonry: To avoid aligned vertical joints, the stones for the structure are set horizontally, with each layer overlapping the one below it. Additionally, all spaces are filled with stone and mortar, leaving no voids.

Option 2 - The reinforced concrete strip footing should have a minimum height of 20 cm and width of 60 cm with two longitudinal 12 mm bars and 10 mm vertical starter bars within. Soil cover should then be distributed evenly to a depth of 7.5 cm. The stem wall should be created using 15 cm (6") reinforced concrete blocks.

It is necessary to install Plinth Beams on top of the foundation beneath all walls.

The top of the Plinth Beam should be aligned with the floor slab's upper edge at the height of 80 cm in areas with at-risk flooding and 30 cm in other areas.

For Plinth Beam planning, the beams should measure 18 cm x 18 cm at the base of the walls, while 18 cm x 18 cm columns should be placed at the walls' corners, intersections, and door openings. Additionally, an 18 cm x 20 cm Ring Beam should be installed at the top of all walls, and masonry construction should be used in confined areas. The walls are constructed before the columns, and the ring beam is cast directly on top of the finished wall.

The columns and beams are reinforced with 12 mm ribbed longitudinal steel rods and 6 mm stirrups with 5 cm hooks that are rotated 135 degrees. The reinforcement is newly manufactured and devoid of rust. The stirrups are separated by 10 centimeters within 50 centimeters of beam-column connections and by 20 centimeters elsewhere. Forty (40) centimeters for 10 mm steel and 48 cm for 12 mm steel are required for lap splices.

The concrete mixture comprises one part cement, two parts grit, and three parts gravel. The cement must be Type 1 or Type 1P; the sand must be pure river sand or crusher fines; and the gravel must be crushed and angular with a maximum diameter of 2cm. The slump of the mixture should be between 8 and 10 centimeters and thoroughly compacted to ensure no cavities, exposed steel, or honeycombing.

Masonry Wall Blocks: Choosing 15 cm (6 inches) wide pieces that will not shatter when dropped is essential. Mortar consists of one part sand and five parts cement, and mortar connections should range in thickness from 0.6 cm to 1.6 cm. A line and story pole are utilized to ensure the wall is constructed correctly. In addition, the first half of the columns are cast once the wall reaches 1.5 meters in height.

Reinforcement and grouting: Vertical reinforcement of 10mm is used every 40cm, and horizontal rebar dowels are used every three courses of wall-column connections. Alternately, the connection between the wall and column may employ toothing. The overlap of splices must be 40 centimeters, and the termination of wall reinforcing bars must include a 12-centimeter standard hook into the ring beam or column. All block cells must be grouted in one-meter lifts, and window apertures must utilize a single horizontal bar below the sill level in the wall panels.

Effects of Disasters to Community Houses

Disasters alone left over 400,000 individuals without a home in the world in 2018. People who lived in communities with few resources were disproportionately impacted. In response to such catastrophes, various entities such as governments, multilateral organizations, and non-governmental organizations (NGOs) often take action with the aim of utilizing the reconstruction process to enhance the physical, social, environmental, and economic conditions of affected communities, while also reducing the likelihood of future disasters. The capacity of communities to "lower the amount of danger or the effects of a disaster" must be increased in order to achieve these aims. It may also be necessary to construct homes that are safer. Improving the understanding of safe housing qualities, such as material selection and design, particularly in relation to hazards and risks, is essential for enhancing a community's ability to mitigate disaster risk. This is especially important in resource-limited communities where housing is often the infrastructure most impacted by disasters (Venable et al., 2020).

Following the 2004 Indian Ocean tsunami, there has been a focus on "building back better" in post-disaster housing rebuilding discussions. This approach prioritizes creating more resilient structures than before a disaster and promoting disaster risk reduction (DRR). Enhancing the local capacity is a crucial Disaster Risk Reduction (DRR) goal. It refers to utilizing all the available resources and qualities within a community to reduce the impact of a disaster or minimize the risk. Housing programs implemented after a disaster can contribute to capacity building by offering new homes resistant to hazards, involving local builders in the reconstruction process, and promoting awareness among families about safe construction practices. Ensuring the latter is essential to sustain a community's ability to establish and preserve secure residences in the long run (Koschmann et al., 2021).

Disaster Preparedness

The Disaster Risk Reduction (DRR) policies, strategies, and plans implemented by the Philippines provide a solid foundation for enhancing resilience. The applicable law in the Philippines is the Disaster Risk Reduction and Management Act (DRRM Law) of 2010. The DRRM Act requires the creation of local councils at different levels to perform comparable duties to those of the NDRRMC. Local councils frequently encounter obstacles such as insufficient personnel and inadequate professional development, resulting in a notable deficiency in supervision since the NDRRMC cannot oversee all local councils. The effectiveness of local councils depends on several factors, including the support of local political leaders for disaster management, recognition of the significance of disaster management at the local level, financial resources, training, and aid from the central government. Areas that have not previously encountered natural calamities are more vulnerable to severe and erratic weather phenomena. Consequently, in these regions, disaster management is not perceived as a proactive endeavor (Tilly Alcayna et al., 2016).

Over the past decade, disaster preparedness communication campaigns and other interventions have promoted individual and family-level readiness, with messages highlighting the value of emergency preparedness kits. These communications have helped increase public knowledge of disaster preparedness but have not resulted in a meaningful change in behavior. In addition, as the frequency and expense of disasters rise, communities, not just individual households, face the challenge of deciding where to rebuild, how to recover, and how to handle preparedness for the next disaster (Uscher-Pines et al., 2013).

The effectiveness of communicating disaster risk to the public, the number of programs aimed at improving community awareness of hazards and disaster risk, and the challenges in measuring and quantifying the various factors that can impact local disaster risk are all subjects of uncertainty. Limited research has been conducted to measure the collective socioecological resilience of the Philippines on both local and national scales. This information could aid decision makers in pinpointing areas that are at greater risk. Several non-governmental organizations, including the Philippine Red Cross, carry out vulnerability assessments based on the community to enhance their knowledge. It seems necessary to increase efforts in educating individuals about hazards and improving their understanding and awareness of the associated risks and dangers (Tilly Alcayna et al., 2016).

Hazard mitigation plans (HMPs) play a vital role in mitigating the impact of natural and man-made hazards and disasters, thereby reducing societal losses. Hazardous events are inevitable, but implementing hazard mitigation planning can enhance local community resilience and reduce societal losses when executed with care (Frazier et al., 2013).

Earthquakes are some of the most terrifying things that can happen to a person. From the 1960s to the present, the Philippines has been hit by the biggest and deadliest earthquakes, which ranged in size from 6.1 to 7.9 and killed between 6 and 8,000 people. The Moro Gulf Earthquake of 1976, which happened in southern Mindanao and had a magnitude of 7.9 and killed up to 8,000 people, is by far the strongest and deadliest earthquake in the Philippines. A lot of the dead, hurt, and missing people are likely to have been swept into the water and eaten by sharks because the powerful earthquake caused a tsunami. Both the earthquake and the tsunami that followed it happened at night when no one was awake to notice.

In 1990, Northern and Central Luzon was hit by the second-strongest earthquake that killed people since the 1960s. It was 7.8 on the Richter scale. Cities like Baguio, Dagupan, and Cabanatuan were hit the hardest. More than 2,000 people died because of the collapse of multi-story buildings in these cities.

The 1968 quake in Casiguran, Aurora, with a magnitude of 7.3, was the third strongest. The strong quake was felt in Manila, which is a few provinces away. There, a six-story building called the Ruby Tower collapsed, killing at least 271 people, and hurting at least 271 more.

The 2013 earthquake in the Central Visayas provinces of Bohol, Cebu, and Siquijor killed and hurt a lot of people and destroyed or damaged many buildings, including centuries-old churches that were very important to the people who lived there. It was a 7.2 on the Richter scale (PhilAtlas, 2021).

In consideration of the elevated danger posed to the Philippines, officials have pledged to strengthen the nation's ability to cope with natural hazards, prioritizing Disaster Risk Management (DRM) via approaches including increasing the ability to plan for and invest in disaster risk mitigation and establishing regulations to improve the resilience of structures. This conforms to the strategy outlined in the 2010 Philippine Disaster Risk Reduction and Management (DRRM) Act. (Global Facility for Disaster Reduction and Recovery, 2016).

Damage to Foundation, Walls, Roof Covering and Structure Supporting the Roof

It was determined that roof panels and the structures that support the roof were the house components most frequently damaged in assessments of prior typhoon damage; the failure of these components can lead to either roof collapse or flying roof panels, posing a threat to the safety and the potential for injury. As a result, close attention was dedicated to these four housing components due to the risk of harm or fatality arising from their malfunction. Additionally, wall collapse and overturning owing to a faulty foundation can endanger people's safety. It is walls and columns that sustain the most damage during earthquakes, which can result in structural collapse. Foundation failure can also result in collapse. If occupants are inside the house at the time of failure, wall collapse or foundation failure during a typhoon or earthquake pose major safety risks and may result in injury or death (Venable et al., 2020).

II. METHOLOGY

This study used a quantitative approach in gathering quantifiable data for statistical analysis of the population sample.

E. *Population of the Study*

The respondents in the study came from the community members of Model Community, Porac, Pampanga. As per the census completed by the barangay, the total number of households in this community was 2,516 with a total population of 12,343.

F. *Sample Size*

The researchers determined the sample size of the study using Raosoft, with a standard error of 5% or 0.05. The main function of the Raosoft sample calculator program was to compute or produce the sample size for studies or surveys. The total computed sample of this research is “334” consisting of “2,516” from the total number of households in Model Community, Porac, Pampanga.

G. *Sampling Technique*

The researchers used convenience sampling as the sampling method for this study. Convenience sampling is a research methodology where the researcher collects data from conveniently available respondents. Participants were selected based on their accessibility and willingness to participate rather than being chosen through a random selection. This sampling method had been used to easily obtain data and was often used when it was not possible or practical to create a random sample.

H. *Research Instrument*

The researchers used a validated research questionnaire as an instrument for the respondents of Model Community, Porac, Pampanga. The questionnaire was validated by a structural engineer, safety officer, and statistician. Most of the questions in this study used closed-ended questions in the research instrument to assess the perception of community members on the hazards of residential houses and their preparedness for future typhoons and earthquakes. The researchers prepared guided questions to collect the appropriate data needed. These were based on the literature studies gathered by the researchers and "Residential Design and Construction Guidelines: Based on the 2010 National Structural Code of the Philippines".

I. Data Analysis

Descriptive statistics and quantitative methods were used to assess community members' perceptions of the hazards of residential houses. The data was collected through a survey questionnaire and was analyzed using the Statistical Package for the Social Sciences (SPSS) software.

The factors considered on measuring the community members' perception on the hazards of residential houses on the event of strong typhoons and earthquakes were presented using weighted mean, and quantified using a four-point Liker scale interpreted as follows:

Table 1: Perception Questionnaire scale

Understanding and Awareness/Perception on the Structure of the House to Strong Typhoons and Earthquakes			
Score Rating	Verbal Interpretation	Description	Weighted Mean
4	Strongly Agree (SA)	Very High	3.28-4.00
3	Agree (A)	High	2.52-3.27
2	Strongly Disagree (SDA)	Low	1.76-2.51
1	Disagree (DA)	Very Low	1.00-1.75

Table 2: Perceive Level of Damage Scale (Venable et al., 2020)

Damage states presented to survey respondents				
Damage Level	Definition and Damage Consequences	Score for Analysis	Weighted Mean	Classification
No Damage	no visible cracks or tilting, requiring no repairs or only minor repairs	1	1.00-1.75	Positive
Minor Damage	mostly aesthetic damage, requiring "architectural repairs"; displacement of household unlikely	2	1.76-2.51	
Major Damage	damage to structural components, requiring considerable repairs and likely to temporarily displace residents	3	2.52-3.27	Negative
Completely Destroyed	components are rendered unusable and require total reconstruction; temporary displacement of household	4	3.28-4.00	

The data were analyzed using statistical scheme quantitative methods. This method focused on data and numbers. Answers from the respondents were tabulated by computing the weighted mean. The interpreted data was coded as positive and negative as shown in the table.

III. RESULTS AND DISCUSSION

This chapter presents the findings and data analysis obtained from the survey conducted by the researchers, which are presented in tables. The Statistical Package for Social Sciences (SPSS) was utilized to calculate frequencies and percentages, and descriptive statistics were employed to provide interpretations. It is divided into four (4) sections: 1) community members' assessment of the construction of their houses; 2) house's past damage from typhoons and earthquakes; 3) community members' understanding and awareness/perception of the response of the structure of their house to strong typhoons and earthquakes; and 4) structural configuration of residential houses.

SOP 1.1: Are the community members knowledgeable in terms of the construction of their house?

Table 3: Frequencies and Percentages of Community Members' Knowledge in Terms of the Construction of Their House

Community Member's Assessment on the Construction of their House	**YES**	**NO**
1. Witness the overall construction of the house.	136 (40.7%)	198 (59.3%)
2. Know all the materials used to build the house.	143 (42.8%)	191 (57.2%)
3. Hire a licensed engineer throughout the construction of the house.	8 (2.4%)	326 (97.6%)

4.	Hire a licensed architect throughout the construction of the house.	7 (2.1%)	327 (97.9%)
5.	The house has structural and architectural plan.	10 (3.0%)	324 (97.0%)
6.	Satisfied with the construction of the house.	314 (94.0%)	20 (6.0%)
7.	The house was extended or expanded.	316 (94.6%)	18 (5.4%)
a.	The house was extended or expanded and was supervised by a civil engineer or architect.	18 (5.7%)	298 (94.3%)
b.	The thickness of CHB used in the external walls is 5 inches or 6 inches.	207 (62.0%)	127 (38%)
8.	Steel bars of standard size and spacing were used in the walls of the house.	278 (83.2%)	56 (16.8%)
9.	The foundation of the house has reinforced concrete.	21 (6.21%)	313 (93.71%)
10.	The soil condition under the house consists of rock or stiff (hard) soil.	334 (100.0%)	0 (0.0%)
11.	The house is in a good overall condition.	317 (94.9%)	17 (5.1%)
12.	The house was extended or expanded and was supervised by a civil engineer or architect.	18 (5.7%)	298 (94.3%)
13.	The thickness of CHB used in the external walls is 5 inches or 6 inches.	207 (62.0%)	127 (38%)
14.	Steel bars of standard size and spacing were used in the walls of the house.	278 (83.2%)	56 (16.8%)

Table 3 shows the frequencies and percentages of community members' knowledge of the construction of their houses.

For the first statement, out of 334 respondents, 136 (40.7%) answered that they witnessed the overall construction of their house, while the majority, 198 (59.3%), responded that they did not. Next, 143 of the respondents (42.8%) said that they were aware of every material that was used in the construction of their house, while 191 of the respondents (or 57.2%) responded that they were not. In the research of Rotimi et al. (2015), many participants were involved in constructing their homes and suggested that they could influence quality performance if they were proactive enough. The homeowner's involvement at the beginning of the construction process may result in high-quality performance and satisfaction.

Then, only 8 (2.4%) of the respondents answered that they hired a licensed engineer throughout the construction of their house, while the majority, 326 (97.6%) responded that they did not. Consequently, only 7 (2.1%) of the respondents answered that they hired a licensed architect during the construction of their house, while most of them, 327 (97.9), responded that they did not. It is a prevalent Filipino habit to be frugal and to cut expenditures whenever possible. When it comes to building a house, some people do not bother paying for the services of certified professionals such as architects and engineers and instead rely on foremen or contractors to complete the project from the ground up. These unlicensed professionals have the experience, but they don't have the license to practice - it's any client's safety net for accountability if something goes wrong (Reyes, 2021). Furthermore, the majority of the respondents, 314 (94%), answered that they were satisfied with the construction of their house, while only 18 (5.4%) responded that they were not.

Next, the majority of the respondents, 316 (94.6%), answered that their house was extended or expanded, meaning they had done modifications from the original construction of their house. In contrast, only 18 (5.4%) responded that their house stayed the same through the years and did not modify it. In addition, only 18 (5.7%) out of 316 respondents who answered that they modified their house consulted a civil engineer or architect to supervise the changes made in their house. The majority, 298 (94.3%), responded that they did not ask for the help of professionals. Carrasco et al. (2016) argue that the construction of housing extensions is necessary for residents' priorities and their desire to enhance their living conditions. Such extensions reflect the residents' abilities and willingness to improve their homes. According to their research, the construction of extensions can jeopardize the safety of housing conditions, as they exhibit poor performance in earthquakes and strong winds, particularly in typhoons. There is a possibility that informal building practices may become prevalent, wherein residents may not fully need tore of the potential risks involved due to the absence of professional technical supervision. This may lead them to rely solely on local labor.

For the thickness of Concrete Hollow Blocks (CHB) used in the house's external walls, the majority of the respondents, 207 (62%), answered that their walls' CHB is 5 or 6 inches thick. On the contrary, 127 (38%) responded that they used 4 inches thick. Then, most of the respondents answered that steel bars of standard size and spacing were used in the walls of their house, with a frequency of 278 or 83.2%. The remaining 56 (16.8%) responded contrary to the statement. For CHB-type structures in the Philippines, the National Building Code, the National Structural Code of the Philippines, and the Full-Scale Shaking Table Test for CHB Houses emphasize adherence to design standards and appropriate construction implementation. The walls of CHB homes serve as the primary support for the structure. The code mandates using at least 6" (150mm) thick CHB reinforced with vertical and horizontal steel rods with a minimum diameter of 10 millimeters spaced at 40 and 60 centimeters, respectively, in the center (DOST-PHIVOLCS, 2014).

Of the 334 respondents asked about the house's foundation, 65% stated that it was constructed with reinforced concrete, while 35% indicated otherwise. All 334 respondents similarly indicated that the soil underneath the house consisted of rocks or hard soil. According to DOST-PHIVOLCS (2014), rock or stiff soil offers greater support. Typically, soft soils amplify the swaying of solid ground and tend to spread and subside, which can cause structural damage. Stone is more resistant to trembling, slipping, and biting than reinforced concrete.

For the last statement, the majority of the respondents, 317 (94.9%), answered that their house is in good overall condition. In contrast, only 17 (5.1) responded that their house was not. This contradicts the study by Stanford (2020), where it was stated that there are currently 70 million people living in inadequate housing in the Philippines, a number that is estimated to rise to 113 million by 2030.

SOP 1.2: Are the community members knowledgeable in terms of the damage from past typhoons and earthquakes in their houses?

Table 4: Houses' Past Damage from Typhoons

Houses' Past Damage from Typhoons	YES	NO
1. The house has been damaged by past typhoons.	52 (15.6%)	282 (84.4%)
a. The house has been damaged by past typhoons but already taken action to repair the damage.	27 (51.9%)	25 (48.1%)
b. The house has been damaged by past typhoons but already taken action to repair the damage and hire professionals (such as engineers and architects) to help analyze and repair the damage.	0 (0.0%)	27 (100%)

Table 4 shows that out of 334 respondents, 52 (15.6%) answered that past typhoons damaged their house, while the majority, 282 (84.4%), did not. Correspondingly, out of the 52 respondents, 27 (51.9%) had already taken action to repair the damage, while 25 (48.1%) did not. Furthermore, none of the 27 respondents hired professionals such as engineers and architects to help analyze and repair the damage in their houses from past typhoons.

In November 2013, Super Typhoon Haiyan (Yolanda) caused extensive damage to large areas of the country, including residential houses. The typhoon destroyed over 1 million homes and displaced approximately 4.4 million people, leading to a long-lasting humanitarian crisis. On the east coast of Leyte Island, the destruction was observed in poorly designed housing. Recent typhoons and flooding have caused significant damage to homes and livelihoods, necessitating the reconstruction of homes that, in most cases, reproduce the same structural vulnerabilities that existed before these hazards occurred. Approximately 1,1 million dwellings were damaged by Super Typhoon Haiyan (Mas et al., 2015).

Table 5: Houses' Past Damage from Earthquakes

Houses' Past Damage from Earthquakes	YES	NO
1. The house has been damaged by past earthquakes.	(48.2%)	173 (51.8%)
c. The house has been damaged by past earthquakes but already taken action to repair the damage.	(37.9%)	(62.1%)
d. The house has been damaged by past earthquakes but already taken action to repair the damage and hire professionals (such as engineers and architects) to help analyze and repair the damage.	0 (0.0%)	61 (100%)

Table 5 reveals that out of 334 respondents, 161 (48.2%) answered that past earthquakes had caused damage to their homes, whereas 173 (51.8%) did not. In proportion, 61 (51.9%) of the 161 respondents had taken action to resolve the damage, while 100 (48.1%) had not. In addition, none of the 61 respondents hired experts (such as engineers and architects) to analyze and repair the earthquake-related damage to their homes.

Poor craftsmanship resulted from homeowners attempting to save money on labor costs by managing their own home construction or relying on untrained neighbors, acquaintances, and family members instead of hiring expert contractors. Although a survey revealed that people prioritize quality over cost when making home repair or construction decisions, this is not reflected in the outcomes of their repair and maintenance efforts(Baraoidan et al., 2018).

SOP 2: What is the community member's level of understanding and awareness about the structure of their house in the event of strong typhoons and earthquakes?

Table 6: Community Members' Understanding and Awareness/Perception of the Structure of Their House to Strong Typhoons

Community Members' Understanding and Awareness/Perception of the Structure of Their House to Strong Typhoons	Mean	Standard Deviation	Verbal Interpretation	Classification
1. I understand how my house's structure affects its vulnerability to strong typhoons.	3.66	0.701	Strongly Agree	Positive
2.I am aware of the possible effects of a strong typhoon on the structure of my house.	3.69	0.689	Strongly Agree	Positive
3.I am aware of the location of my house's vulnerability to strong typhoons.	3.67	0.688	Strongly Agree	Positive
4.I am aware of the importance of strengthening my house against strong typhoons.	3.68	0.686	Strongly Agree	Positive
5.I am aware of the importance of proper maintenance and regular checking of my house to make sure it is structurally sound and resistant to strong typhoons.	3.60	0.702	Strongly Agree	Positive
6.I am aware of the overall condition of my house against strong typhoons.	3.64	0.716	Strongly Agree	Positive
Overall Statements	**3.66**	**0.657**	**Strongly Agree**	**Positive**

The data obtained in table 6 reveals that community members have a strong understanding and awareness of the structure of their houses regarding strong typhoons. On average, participants responded with a mean of 3.66, classified as a strongly agreed response. It indicates that participants are aware and understand how strong typhoons may affect the structure of their houses. Furthermore, the standard deviation of 0.657 suggests that participants consistently responded positively to the given statements. The study conducted by Gumasing et al. (2022) revealed that disaster awareness, adaptation, and risk perception positively impacted the respondents' perceived preparedness for super typhoons. The study also found that disaster awareness significantly influenced adaptation and risk perception.

Table 7: Perceived Level of Damage from Typhoon to the Four Components of the House

How would your house be affected if Typhoon Signal No. 5 occurred? What would you expect the level of damage to be in:	Mean	Standard Deviation	Verbal Interpretation	Classification
Walls	1.41	0.636	No Damage	Positive
Foundation	1.32	0.583	No Damage	Positive
Roof Coverings	2.19	0.957	Minor Damage	Positive
StructureSupporting the Roof	1.99	0.914	Minor Damage	Positive

Table 7 displays the perception of the respondents to the response of their house if a strong typhoons signal No. 5 occurred. What is the level of damage they would expect to the four (4) components of their house?

A weighted mean of 1.41 and a standard deviation of 0.63 are computed for walls. The outcome indicates that the respondents gave a positive rating and believed that their house's walls would sustain no damage in the event of typhoon signal No. 5. For foundation, a weighted mean of 1.32 and a standard deviation of 0.583 are calculated. The outcome indicates that respondents rated the structure of their house positively and believed it would sustain no damage if typhoon signal no. 5 occurred. For roof covering, a weighted mean of 2.19 is computed with a standard deviation of 0.957. The outcome describes that the respondents have a positive rating and perceive the roof coverings of their house to have minor damage if typhoon signal no. 5 occurred. A weighted mean of 1.99 and a standard deviation of 0.914 are calculated for the structure that supports the roof. The outcome indicates that the respondents have a positive rating and believe the structure supporting their house would sustain minor damage if typhoon signal no. 5 occurred.

In research conducted by Venable et al. (2020) on perceptions of post-disaster housing safety in future typhoons and earthquakes, perceptions of roof damage significantly impacted overall perceptions of housing safety. Participants were questioned regarding their strategies for enhancing the safety of their homes during a typhoon. The majority of respondents emphasized roof reinforcement as a means of enhancing security. One respondent believed that adding roof fasteners would enhance the safety of their home during a typhoon. Some individuals suggested that stronger roof panels would enhance roof safety. Typhoons have been the most recent and destructive natural hazard in these communities, which explains why respondents were more likely to recall typhoon damage.

Table 8: Community Members' Understanding and Awareness/Perception of the Structure of Their House to Strong Earthquakes

Community Members' Understanding and Awareness/Perception of the Structure of Their House to Strong Earthquakes	**Mean**	**Standard Deviation**	**Verbal Interpretation**	**Classification**
I understand how my house's structure affects its vulnerability to strong earthquakes.	3.52	0.893	Strongly Agree	Positive
I am aware of the possible effects of a strong earthquake on the structure of my house.	3.58	0.848	Strongly Agree	Positive
I am aware of the location of my house's vulnerability to strong earthquakes.	3.51	0.886	Strongly Agree	Positive
I am aware of the importance of strengthening my house against strong earthquakes.	3.57	0.838	Strongly Agree	Positive
I am aware of the importance of proper maintenance and regular checking of my house to make sure it is structurally sound and resistant to strong earthquakes.	3.39	0.939	Strongly Agree	Positive
I am aware of the overall condition of my house against strong earthquakes.	3.45	0.918	Strongly Agree	Positive
Overall Statements	**3.50**	**0.799**	**Strongly Agree**	**Positive**

The data in table 8 implies that community members have adequate knowledge and awareness of the resistance of their houses to earthquakes. On average, participants responded with a mean score of 3.50, classified as a response of strong agreement. It demonstrates that participants are aware of and comprehend how intense earthquakes may affect the structural integrity of their homes. In addition, the standard deviation of 0.799 suggests that participants consistently responded positively to the statements provided. In their study, Venable et al. (2020) discovered that prior experience is one of the most important predictors of perceived housing safety, especially concerning earthquake safety. Those who had previously suffered damage to their homes from multiple natural disasters anticipated that a future earthquake would cause even more destruction.

Table 9: Perceived Level of Damage from Earthquake to the Four Components of the House

How would your house be affected if Magnitude 7.0-8.4 occurred? What would you expect the level of damage to be in:	Mean	Standard Deviation	Verbal Interpretation	Classification
Walls	2.62	0.912	Major Damage	Negative
Foundation	2.47	0.964	Minor Damage	Positive
Roof Coverings	2.14	1.070	Minor Damage	Positive
Structure Supporting the Roof	2.09	1.083	Minor Damage	Positive

This table presents respondents' perceptions regarding their house's response in the event of a strong earthquake between magnitudes 7.0 and 8.4. How much damage can they presume to their house's four (4) components?

A weighted mean of 2.62 and a standard deviation of 0.91 are computed for walls. The result indicates that the respondents have a negative rating and believe that their house's walls would sustain major damage if an earthquake of magnitude 7.0–8.4 occurred. A weighted mean of 2.47 and a standard deviation of 0.96 were obtained for the foundation. The outcome indicates that the respondents rated the foundation of their house positively and believed it would sustain minor damage if an earthquake of magnitude 7.0–8.4 occurred. For roof covering, a weighted mean of 2.14 and a standard deviation of 1.070 are calculated. The outcome indicates that the respondents rated their home's foundation positively and believed it would withstand minor damage if an earthquake of magnitude 7.0-8.4 occurred. A weighted mean of 2.09 and a standard deviation of 1.083 are calculated for the roof-supporting structure. In the event of an earthquake with a magnitude between 7.0 and 8.4, respondents believed that their home's foundation would sustain only minor damage.

Overall, only the walls in the house were perceived to suffer major damage, while the foundation, roof coverings, and structure supporting the roof are expected to experience minor damage in the event of a magnitude 7.0–8.4 earthquake.

SOP 3: What is the level of the structural configuration of residential houses using "Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines"?

Table 10: Structural Configuration of Residential Houses

Structural Configuration of Residential Houses	**Mean**	**Standard Deviation**	**Verbal Interpretation**	**Classification**
1. The house layout was uniform and symmetric, like a square, short rectangle, or circle.	3.75	0.671	Strongly Agree	Positive
2. The length of every wall in the house was not more than three times the width.	3.73	0.685	Strongly Agree	Positive
3. The walls in the house having length of more than 3.5 meters are supported by cross wall or brace/The walls in our house were not more than 3.5 meters.	3.72	0.687	Strongly Agree	Positive
4. Gable walls made of masonry were well reinforced with a well-connected ring beam on top/The house was constructed with a hipped roof with masonry in the gable wall/The house was constructed with lightweight materials such as timber and CGI sheeting in the gable.	2.78	1.269	Agree	Positive

5. The house was constructed with a plinth beam at the base of the walls.	2.47	1.357	Disagree	Negative
6. The house was constructed with a ring beam on top of the walls.	2.64	1.282	Agree	Positive
7. The house was constructed with columns at every wall intersection and corner.	2.81	1.069	Agree	Positive
8. The house was constructed with columns at the edges of door openings.	3.63	0.665	Strongly Agree	Positive
Overall Statements	**3.19**	**0.588**	**Agree**	**Positive**

Table 10 presents the results of weighted mean and standard deviation for structural configuration of residential houses.

For the statement of whether the house layout was uniform and symmetric, such as a square, short rectangle, or circle, a mean of 3.75 and a standard deviation of 0.671 were calculated. This indicates that the respondents strongly agree and have a positive rating. As mentioned in Strand's (2015) Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines, an irregular shape can result in increased wind and seismic forces, making layout one of the most crucial aspects of disaster-resistant home design. It is preferable to adhere to a simple, square, symmetrical, and redundant shape.

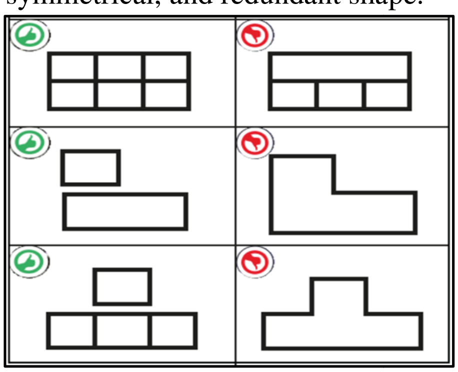

Fig. 1 House Layout Guidelines from Residential Design and Construction Based on NSCP 2010

The study computed a mean average of 3.73, with a standard deviation of 0.685, to determine whether the size of each wall in the house was no more than three times its width. This data supported a strongly agree rating, demonstrating the respondents' positive attitude towards the statement. Additionally, a mean average of 3.72 was calculated with a standard deviation of 0.687 for the statement asking whether walls exceeding 3.5 meters were supported by cross walls or the walls in the house were not more than 3.5 meters, with a similar strong agreement rating. As per Strand's (2015) residential design and construction guidelines, based on the 2010 National Structural Code of the Philippines, walls play a crucial role in withstanding seismic and typhoon forces. Masonry walls pose a significant risk if not constructed and designed appropriately due to their weight and potential for rapid collapse. For appropriate configuration, it is recommended to maintain a maximum distance of 3.5 meters between perpendicular supporting walls. The full-height walls of both interior and exterior lines must measure at least 2 meters in length or 25% of the building's length in that direction, whichever is greater. Consider only full-height wall sections that measure at least 1 meter in length.

Fig. 1The length of every wall in the house was not more than three times the width. Image from Model Community, Porac, Pampanga

Fig. 3 The length of every wall in the house was not more than three times the width. Image from Model Community, Porac, Pampanga

The respondents were in general agreement that the gable walls constructed out of masonry were adequately reinforced with a suitably connected ring beam at the top. Additionally, the house was built using hipped roof masonry in the gable wall and lightweight materials. The results of this agreement were measured using a mean average score of 2.78 and a standard deviation of 1.269, which was indicative of a positive rating. The gable walls made of masonry are prone to cracking or collapsing during a calamity as they are tall and often unsupported or unbraced. The structure must be adequately strengthened with a properly linked ring beam positioned at the top (Strand, 2015).

Fig. 4 Example of Good Construction of Gable Walls from Model Community, Porac, Pampanga

Fig. 5 Example of Good Construction of Gable Walls from Model Community, Porac, Pampanga

For the statement of whether the house was constructed with a plinth beam at the base of the walls, a total mean average of 2.47 was computed with a standard deviation of 1.357. The results describe the respondents' agreement as agree and has a positive rating. The mean average for the question of whether a ring beam was incorporated in the building of the house was calculated to be 2.64, accompanied by a standard deviation of 1.282. The results suggest that the majority of the respondents gave a positive rating, expressing their agreement with the proposed statement. The respondents generally agreed that the house was constructed with columns at every wall intersection and corner, with an overall average rating of 2.81 and a standard deviation of 1.069. This indicates a positive perception of the statement by the respondents. Results of the survey on the inclusion of columns at the edge of door openings showed that the average response was strongly agreeable, with a mean of 3.63 and a standard deviation of 0.665. The results demonstrated a strong consensus among the respondents in agreement with the incorporation of columns at the said location.

Fig. 6 Good Construction of Beams and Columns

Fig. 7 Bad Construction. No Supported Columns and Beams

According to the Handbook on Good Building Design and Construction in the Philippines by Willison (2008), for constructing reinforced concrete columns, it is essential to form the complete column prior to constructing the walls. The process should not be divided into smaller parts as walls are built. Additionally, these columns should also contain wall ties and ring beams. Reinforcing bars for the column should be four (4) vertical bars secured in hoops, kept at regular intervals equal to the width of the column, and firmly embedded in the foundation.

In general, an overall weighted mean of 3.19 was computed for the structural configuration of residential houses with a standard deviation of 0.588. The results describe the respondents' agreement as agree and has a positive rating. The National Disaster Risk Reduction and Management Council (NDRRMC) reported that the earthquake that occurred in Pampanga, Philippines, on April 22, 2019, damaged 1,549 homes. Of this number, 162 were completely damaged, while 1,387 were partially damaged. Most residences have encountered non-structural or minor structural damage and have not collapsed entirely (Garciano et al., 2019).

SOP 4: What framework of recommendations that can be implemented to improve the community members' preparedness for future typhoons and earthquakes?

In this section, the researchers developed detailed maps depicting potential flood and seismic hazards in Barangay Pio Model Community in Porac, Pampanga. These maps were designed to assist the community members in preparing for future typhoons or earthquakes in the area. These maps will strengthen the community's capacity to properly assess the potential effects of such hazardous events and build risk reduction strategies.

Flood Hazard Map

Figure 1 was created in this study using data from the Department of Science and Technology (DOST)-Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). Employing Geographic Information System (GIS) analysis, a flood hazard map of Barangay Pio Model Community, Porac, Pampanga, was developed. The results of the map indicate that the area has a low risk of floods occurring.

In areas with minimal risk for flooding, the flood levels are expected to remain at or below 0.5 meters and/or the flooding event would not last for longer than 1 day. These locations include low hills and undulating terrain which have limited to reasonable water flow.

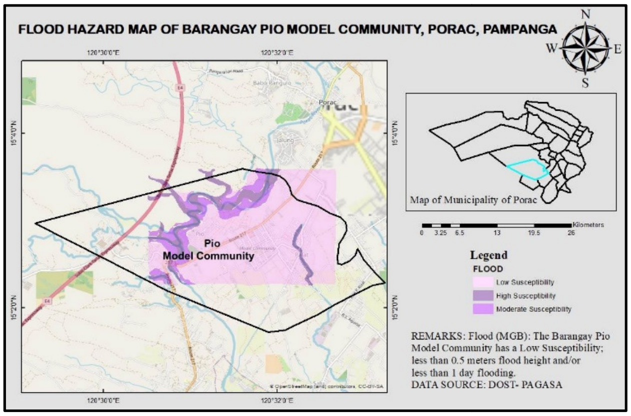

Fig. 8 Flood Hazard Map of Model Community Pio, Porac, Pampanga using ArcGIS 10.8

Seismic Hazard Map

The earthquake zones seismic hazard map of Barangay Pio Model Community, Porac, Pampanga was created using Geographic Information System (GIS) analysis. Employing the data source from United States Geological Survey (USGS).

The Earthquake Science Center of USGS gathers comprehensive information on earthquakes, faults, and crustal deformation. It also conducts research to enhance comprehension of earthquake source processes, occurrences, and effects. The center then combines this data to create probabilistic seismic hazard assessments, aftershock forecasts, and ground-shaking scenarios for expected significant earthquakes (Hickman, 2020).

The map results indicate that the area has moderate to high-risk levels of seismic hazard based on the earthquake seismic zones. According to DOST-PHIVOLCS, the area is safe from liquefaction and earthquake-induced landslides but prone to ground shaking with an Intensity VIII level. Intensity VIII from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) intensity scale is considered very destructive.

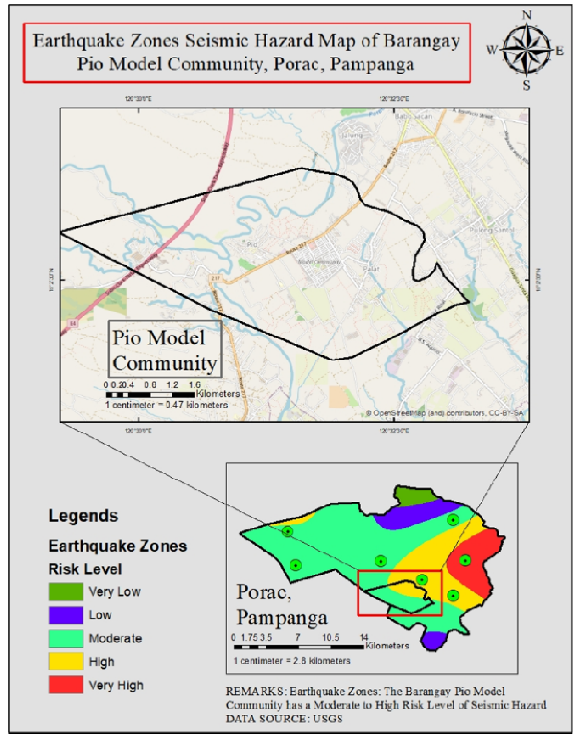

Fig. 8 Earthquake Zones Seismic Hazard Map of Model Community Pio, Porac, Pampanga using ArcGIS 10.8

IV. CONCLUSIONS

Based on the indicated findings, the following conclusions were drawn:

Community members' knowledge of the construction of their houses and the damage from past typhoons and earthquakes.

Based on the survey results, it is evident that the majority of respondents had knowledge of the construction of their houses and were satisfied with it, as well as the fact that most of them used appropriate materials and methods. However, the majority of respondents did not seek out the help of experts to repair the damage caused by past typhoons and earthquakes, suggesting that there may be a lack of awareness regarding the need for such help. This highlights the importance of providing more education and support to these communities to ensure the safety and stability of their homes.

Community members' understanding and awareness of the response of the structure of their houses in the event of strong earthquakes.

In conclusion, the survey results demonstrate that the people living in the community are aware of the potential risks posed by both typhoons and earthquakes and are knowledgeable of the resistance of their houses to these natural disasters. The participants rated their houses positively for all four components, indicating that they believe their houses will survive a typhoon with Signal No. 5 and an earthquake with a magnitude between 7.0 and 8.4 with only minor damage. This suggests that the community members have adequate knowledge and awareness of the risks posed by natural disasters and the resistance of their houses.

Level of structural configuration of residential houses using "Residential Design and Construction Guidelines Based on the 2010 National Structural Code of the Philippines".

The data from the survey reveals that the structural configuration of residential houses in the community is generally uniform and symmetric, supporting the notion of good architectural practices. The respondents had a positive rating for the structural configuration of their houses, suggesting that the houses were built with well-reinforced ring beams, plinth beams, and columns. This indicates that the level of the structural configuration of residential houses is high and constructed to ensure the safety and stability of the buildings.

Framework of recommendations that can be implemented to improve the community members' preparedness for future typhoons and earthquakes.

The findings of this study indicate that Barangay Pio Model Community in Porac, Pampanga has a low risk of flooding according to a Flood Hazard Map created using Geographic Information System (GIS) analysis. Moreover, the Earthquake Seismic Zones Map revealed a moderate to high-risk seismic hazard level with Intensity VIII as the highest on the Philippine Institute of Volcanology and Seismology (PHIVOLCS) scale. Mapping out risks and potential hazards in this area will help the community better prepare for and mitigate future disasters.

V. RECOMMENDATIONS

After completing the study, the researchers recommended the following to develop further and improve:

- Collaborate with local government agencies and community organizations to implement the preparedness plan and monitor its effectiveness over time.
- Develop an evidence-based preparedness plan for the community that includes improving the safety of residential houses, such as retrofitting structures to withstand earthquakes and typhoons.
- Educate the residents on evacuation routes and emergency procedures of the community.
- In terms of assessing perceptions, consider broadening the population for higher validation of data.
- Start by conducting a comprehensive risk assessment to identify the potential hazards and vulnerabilities of residential houses in the Model Community. This should include assessing the risk of flooding, landslides, earthquakes, and other natural disasters. A risk assessment can help prioritize the areas of greatest vulnerability and develop appropriate preparedness and mitigation strategies.
- Extensive checking of the physical structure, not just the structural configuration of residential houses.
- Consider checking residential houses with more than 1-storey and other commercial/institutional buildings.

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REFERENCES

[1] Anticamara, J. A., & Go, K. T. B. (2016). Impacts of super-typhoon Yolanda on Philippine reefs and communities. *Regional Environmental Change*, *17*(3), 703–713. https://doi.org/10.1007/s10113-016-1062-8

[2] Arceo, A. (2022, March 23). *PAGASA changes super typhoon definition, wind signals*. RAPPLER. https://www.rappler.com/nation/weather/pagasa-changes-super-typhoon-definition-tropical-cyclone-wind-signals-march-2022/

[3] Astley, D. (2020, June 1). *Pitfalls of Building a House in the Philippines*. Tropical House & Garden. https://tropicalhousegarden.com/pitfalls-building-house-philippines/

[4] Build Change. (2017). Handbook for Disaster-Resistant Houses You Can Keep Your Family Safe from Earthquakes and Typhoons Based on the 2010 National Structural Code of the Philippines Residential Design and Construction Guidelines. https://www.preventionweb.net/files/submissions/52205_160602design constructionguidefinal.pdf

[5] California Academy of Sciences. (2019, May 5). *How to Prepare for an Earthquake*. Calacademy.org. www.calacademy.org/explore-science/how-to-prepare-for an earthquake.

[6] Carrasco, S., Ochiai, C., & Okazaki, K. (2016). Impacts of resident-initiated housing modifications in resettlement sites in Cagayan de Oro, Philippines. *International Journal of Disaster Risk Reduction*, *17*, 100–113. https://doi.org/10.1016/j.ijdrr.2016.05.001

[7] Frazier, T. G., Walker, M. H., Kumari, A., & Thompson, C. M. (2013). Opportunities and constraints to hazard mitigation planning. *Applied Geography*, *40*, 52–60. https://doi.org/10.1016/j.apgeog.2013.01.008

[8] Garciano, L., Villaraza, C., Tamayo, C., Tamayo, M., Flordeliza, R., Quiaem, M., & Ramos, J. (2019). *Infrastructure damage analysis of the Pampanga, Philippines earthquake*. https://committees.jsce.or.jp/disaster/system/files/FS2020-E0002.pdf

[9] Global Facility for Disaster Reduction and Recovery. (2022, December 14). *Protecting Lives and Property from Disaster Risk in the Philippines | GFDRR*. Www.gfdrr.org. https://www.gfdrr.org/en/feature-story/protecting-lives-and-property-disaster-risk-philippines

[10] Gumasing, Ma. J. J., Prasetyo, Y. T., Ong, A. K. S., Nadlifatin, R., &Persada, S. F. (2022). Determining Factors Affecting the Perceived Preparedness of Super Typhoon: Three Broad Domains of Ergonomics Approach. *Sustainability*, *14*(19), 12202. https://doi.org/10.3390/su141912202

[11] Habitat For Humanity. (2017). *Housing Poverty in the Philippines: Shelters vs Disasters*. Habitat for Humanity GB. https://www.habitatforhumanity.org.uk/country/philippines/

[12] Habitat for Humanity. (2018). Bahay, Buhay A survey of owner-driven housing construction practices, financing modalities and aspirations for a resilient home in disaster-prone areas in Cebu Province, Philippines. https://www.habitat.org/sites/default/files/documents/Bahay%20Buhay%20-%20Short%20Report%20%2810-18%29%20%28002%29.pdf

[13] Hickman, S. H. (2020). *U.S. Geological Survey Earthquake Science Center*. Pubs.er.usgs.gov. https://pubs.er.usgs.gov/publication/fs20193067

[14] Kerns, H. (2017, October 27). *Securing Your Home for Natural Disasters*. Oklaw.org. https://oklaw.org/resource/securing-your-home-for-natural-disasters

[15] Mas, E., Bricker, J., Kure, S., Adriano, B., Yi, C., Suppasri, A., &Koshimura, S. (2015). Field survey report and satellite image interpretation of the 2013 Super Typhoon Haiyan in the Philippines. *Natural Hazards and Earth System Sciences*, *15*(4), 805–816. https://doi.org/10.5194/nhess-15-805-2015

[16] Nowogońska, B., &Cibis, J. (2017). Technical Problems of Residential Construction. *IOP Conference Series: Materials Science and Engineering*, *245*(052042), 052042. https://doi.org/10.1088/1757-899x/245/5/052042

[17] Ombao, R. (2020). *Challenges to Disaster-Resilient Housing in the Philippines | Build Change*. Build Change Blog. https://buildchange.org/challenges-to-disaster-resilient-housing-in-the-philippines/

[18] Ong, A. K. S., Prasetyo, Y. T., Lagura, F. C., Ramos, R. N., Sigua, K. M., Villas, J. A., Young, M. N., Diaz, J. F. T., Persada, S. F., & Redi, A. A. N. P. (2021). Factors affecting intention to prepare for mitigation of "the big one" earthquake in the Philippines: Integrating protection motivation theory and extended theory of planned behavior. *International Journal of Disaster Risk Reduction*, *63*(102467), 102467. https://doi.org/10.1016/j.ijdrr.2021.102467

[19] Oreta, A. W., Tanhueco, R. Ma., &Garciano, L. E. (2014). *FRAMEWORK FOR CIVIL ENGINEERING RESEARCH: ADDRESSING SAFETY AND SUSTAINABILITY THROUGH DISASTER RISK REDUCTION*. ResearchGate. https://www.researchgate.net/publication/315698667_FRAMEWORK_FOR_CIVIL_ENGINEERING_RESEARCH_ADDRESSING_SAFETY_AND_SUSTAINABILITY_THROUGH_DISASTER_RISK_REDUCTION

[20] PAGASA. (2022). *PAGASA*. Www.pagasa.dost.gov.ph. https://www.pagasa.dost.gov.ph/learning-tools/tropical-cyclone-wind-signal

[21] PhilAtlas. (2021a, September 11). *Most Severe Earthquakes in the Philippines – PhilAtlas*. Www.philatlas.com. https://www.philatlas.com/articles/most-severe-earthquakes.html#:~:text=The%20major%20earthquakes%20%E2%80%93%20the%20foremost

[22] PhilAtlas. (2021b, September 11). *Porac, Pampanga Profile – PhilAtlas*. Www.philatlas.com. https://www.philatlas.com/luzon/r03/pampanga/porac.html

[23] PHIVOLCS. (2018). *PHIVOLCS Earthquake Intensity Scale (PEIS)*. Www.phivolcs.dost.gov.ph. https://www.phivolcs.dost.gov.ph/index.php/earthquake/earthquake-intensity-scale

[24] Reyes, D. (2021, June 5). *Building a House? Invest in Hiring the Right People*. Engineer Dee's Blog. https://engineerdee.com/construction-house-hiring/

[25] Robles, S. E. (2021, July 12). *Nature's Rage: #UlyssesPH's impact on the community | Department of Education*. Republic of the Philippines Department of Education. https://www.deped.gov.ph/2021/07/12/natures-rage-ulyssesphs-impact-on-the-community/

[26] Rotimi, F., Tookey, J., & Rotimi, J. (2015). Evaluating Defect Reporting in New Residential Buildings in New Zealand. *Buildings*, *5*(1), 39–55. https://doi.org/10.3390/buildings5010039

[27] Santos, L. A. (2013, November 29). *How to build disaster-resilient homes in the Philippines*. Devex. https://www.devex.com/news/how-to-build-disaster-resilient-homes-in-the-philippines-82408

[28] Sedgwick, P. (2013). (PDF) Convenience sampling. *ResearchGate*. https://www.researchgate.net/publication/291161903_Convenience_sampling

[29] Stanford, J. (2020, August 13). *Resilient Housing in the Philippines, in the Era of COVID-19 | Build Change*. Build Change Blog. https://buildchange.org/resilient-housing-in-the-philippines-in-the-era-of-covid-19/

[30] The Constructor. (2019, May 8). *Types of Residential Buildings and Their Site Selection*. The Constructor. https://theconstructor.org/building/types-site-selection-residential-building/5995/

[31] The World Bank. (2014). Document of the world bank east asia and pacific EAP critical infrastructure risk assessment and retrofitting program safe and resilient infrastructure in the philippines applications of international experience. https://openknowledge.worldbank.org/bitstream/handle/10986/21732/ACS121820WP0Bo0B00P13104100PUBLIC00.pdf?sequence=1&isAllowed=y

[32] The World Bank Group. (2021). *World Bank Climate Change Knowledge Portal*. Climateknowledgeportal.worldbank.org. https://climateknowledgeportal.worldbank.org/country/philippines/vulnerability

[33] Tilly Alcayna, Bollettino, V., Dy, P., & Vinck, P. (2016). Resilience and Disaster Trends in the Philippines: Opportunities for National and Local Capacity Building. *PLOS Currents Disasters*. https://doi.org/10.1371/currents.dis.4a0bc960866e53bd6357ac135d740846

[34] Uscher-Pines, L., Chandra, A., & Acosta, J. (2013). Household Preparedness Is Not Enough: The Challenges and Opportunities in Assessing Community Readiness for Disasters. *Journal of Public Health Management and Practice*, *19*, S70–S76. https://www.jstor.org/stable/48516694

[35] Venable, C., Javernick-Will, A., & Liel, A. B. (2020). Perceptions of Post-Disaster Housing Safety in Future Typhoons and Earthquakes. *Sustainability*, *12*(9), 3837. https://doi.org/10.3390/su12093837

[36] Venable, C., Javernick-Will, A., Liel, A. B., & Koschmann, M. A. (2021). Revealing (mis)alignments between household perceptions and engineering assessments of post-disaster housing safety in typhoons. *International Journal of Disaster Risk Reduction*, *53*(101976), 101976. https://doi.org/10.1016/j.ijdrr.2020.101976

[37] William, K. (2022, January 25). *What is SPSS? Definition, Features, Types, and Use Cases*. SurveySparrow. https://surveysparrow.com/blog/what-is-spss/

[38] Willison, R. (2008). *HANDBOOK ON Good Building Design and Construction In the Philippines*. https://www.unisdr.org/files/10329_GoodBuildingHandbookPhilippines.pdf

[39] Yu, S.-B., Hsu, Y.-J., Bacolcol, T., Yang, C.-C., Tsai, Y.-C., & Solidum, R. (2013). Present-day crustal deformation along the Philippine Fault in Luzon, Philippines. *Journal of Asian Earth Sciences*, *65*, 64–74. https://doi.org/10.1016/j.jseaes.2010.12.007

