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Public Knowledge of Simple Earthquake-Resistant Houses after the 2022 Pasaman Earthquake

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ABSTRACT

The 2022 Pasaman earthquake caused significant infrastructure damage, including widespread housing losses. To mitigate future risks, constructing earthquake-resistant homes is crucial. While previous studies by Hariyanto in 2020 examined public awareness of such structures, they did not analyze behavioral changes after major disasters. This study addresses that gap by assessing how the earthquake influenced attitudes and construction practices in Nagari Kajai and Nagari Malampah. Using a quantitative approach, data were collected via a structured questionnaire, adapted from the 2021 BSPS Home Building Construction Guidebook. The survey covered five aspects: building materials, main structure, structural connections, construction quality, and post-earthquake behavioral changes. Accidental sampling was used, with 60 respondents from the two affected areas. Findings show that 60% of respondents have fair knowledge of earthquake-resistant housing, while 20% demonstrate good knowledge and 20% have poor knowledge. Pearson Correlation analysis indicates a weak but significant relationship between knowledge levels and gender ($p = 0.002$) and age ($p = 0.034$), while education and occupation showed no significant correlation ($p = 0.168$ and $p = 0.141$). Post-earthquake, a shift toward semi-permanent housing structures was observed, highlighting the need for standardized, affordable building regulations. Policymakers should collaborate with local builders to ensure effective knowledge transfer on earthquake-resistant construction. Future reconstruction efforts should integrate post-earthquake evaluations to assess long-term housing resilience.

Keywords: *Public Knowledge; Earthquake; Resistant House; Behavior Change.*

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INTRODUCTION

Indonesia's geographical position along the Pacific Ring of Fire makes it highly susceptible to frequent and destructive earthquakes[1] [2]. One of the key challenges in earthquake mitigation is the lack of public knowledge regarding earthquake-resistant housing, which contributes to structural failures during seismic events[3]. The 2022 Pasaman earthquake caused widespread destruction, particularly in Nagari Kajai and Nagari Malampah, where many houses were severely damaged due to non-compliance with earthquake-resistant construction principles. Understanding how public awareness and housing construction practices evolved after this disaster is crucial for improving future resilience[4].

Damage to house buildings during the 2009 West Sumatra earthquake was caused by poor quality construction materials. This is characterized by the low quality of the concrete used, the size and spacing of the stirrups being inadequate, and the stirrups not being tied properly[5].

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Apart from that, the lack of public awareness that they are in an area/city prone to earthquake disasters and the lack of public knowledge of the elements of earthquake-resistant buildings are also causes losses[6]. Then another cause is the lack of experts who have knowledge and techniques for earthquake-resistant planning and construction[7] . Research on public knowledge of earthquake-resistant houses also shows that the majority of homeowners who have rebuilt houses damaged by the earthquake do not know the concept of an earthquake-resistant house[6]. While guidelines and designs for earthquake-resistant houses are widely available, they have not been used as basic guidelines for people to build.

The Pasaman earthquake that occurred on February 25 2022 also caused damage to houses. This earthquake with an epicenter at coordinates 0.15 °N - 99.98°E is located in Northeast Pasaman, West Sumatra, Indonesia at a depth of 10 km, which was triggered by active fault activity of the Semangko Fault, precisely in the unmapped Talamau segment[8]. As a result, 6,627 housing units were damaged, with details of 1,075 housing units heavily damaged, 3,447 housing units moderately damaged, 2,105 housing units slightly damaged[9]. Apart from residential houses, 208 units of educational facilities, 25 units of health facilities, 53 units of places of worship, 41 units of government offices, 26 units of infrastructure, 3 units of bridge facilities and 80 hectares of agricultural land were also affected. Apart from material losses, this earthquake also caused 24 people to die, 52 people were seriously injured and 405 people were slightly injured. After the 2022 Pasaman earthquake, we realized how devastating the impact was, with many people's houses collapsing, causing many fatalities.

Previous studies by Hariyanto in 2020 have examined public awareness of earthquake-resistant houses, but they primarily focused on general knowledge without analyzing behavioral changes following a major disaster[10]. Other research by Zulfiar et al. in 2015 and Prihantony et al. in 2020 has addressed the technical aspects of earthquake-resistant construction but has not explored how public knowledge translates into actual housing decisions[5], [11]. This study seeks to bridge this gap by investigating both knowledge levels and behavioral changes in housing construction before and after the 2022 Pasaman earthquake. By focusing on affected communities, this research provides new insights into how disasters influence public decision-making in earthquake-prone areas.

This study aims to evaluate the level of public knowledge about earthquake-resistant housing, considering demographic factors such as gender, age, education, and occupation, analyze the impact of the 2022 Pasaman earthquake on changes in public behavior related to housing construction and identify key barriers to adopting earthquake-resistant construction practices and provide policy recommendations to improve disaster mitigation strategies.

METHOD

This study employs an accidental sampling technique, where respondents were selected based on their availability and willingness to participate. Accidental sampling was chosen because it allows for quick data collection in post-disaster settings, where structured sampling may not be feasible due to the urgent and unpredictable nature of reconstruction efforts. The research was conducted in two earthquake-affected areas, Nagari Kajai and Nagari Malampah, from July 16–21, 2024. The study targeted residents who experienced structural damage to their houses, ensuring that the sample included individuals directly affected by the earthquake.

To ensure the validity and reliability of the research instrument, the questionnaire was adapted from the 2021 BSPS Home Building Construction Guidebook[12] and reviewed by experts in structural engineering and disaster mitigation. A pilot test was conducted with 10 respondents

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to assess content validity and refine unclear questions. Internal consistency was measured using Cronbach's Alpha, with a coefficient of 0.82, indicating high reliability. The questionnaire included 46 structured questions**,** covering key aspects such as building materials, structural integrity, and behavioral changes post-earthquake.

Data were analyzed using SPSS software**,** applying *Pearson Correlation Test* to measure the relationship between demographic variables (gender, age, education, occupation) and public knowledge of earthquake-resistant houses. The Pearson Correlation Test was selected because it quantifies the strength and direction of relationships between numerical and categorical variables, making it suitable for evaluating how different demographic factors influence knowledge levels. A significance level of $p\text{-}value < 0.05$ was used to determine statistically meaningful correlations. Descriptive statistics were also employed to summarize respondents' knowledge distribution and behavioral changes post-earthquake.

Respondent Characteristics

The characteristics of respondents of the research were reviewed from all independent variables which can be seen in Figures:

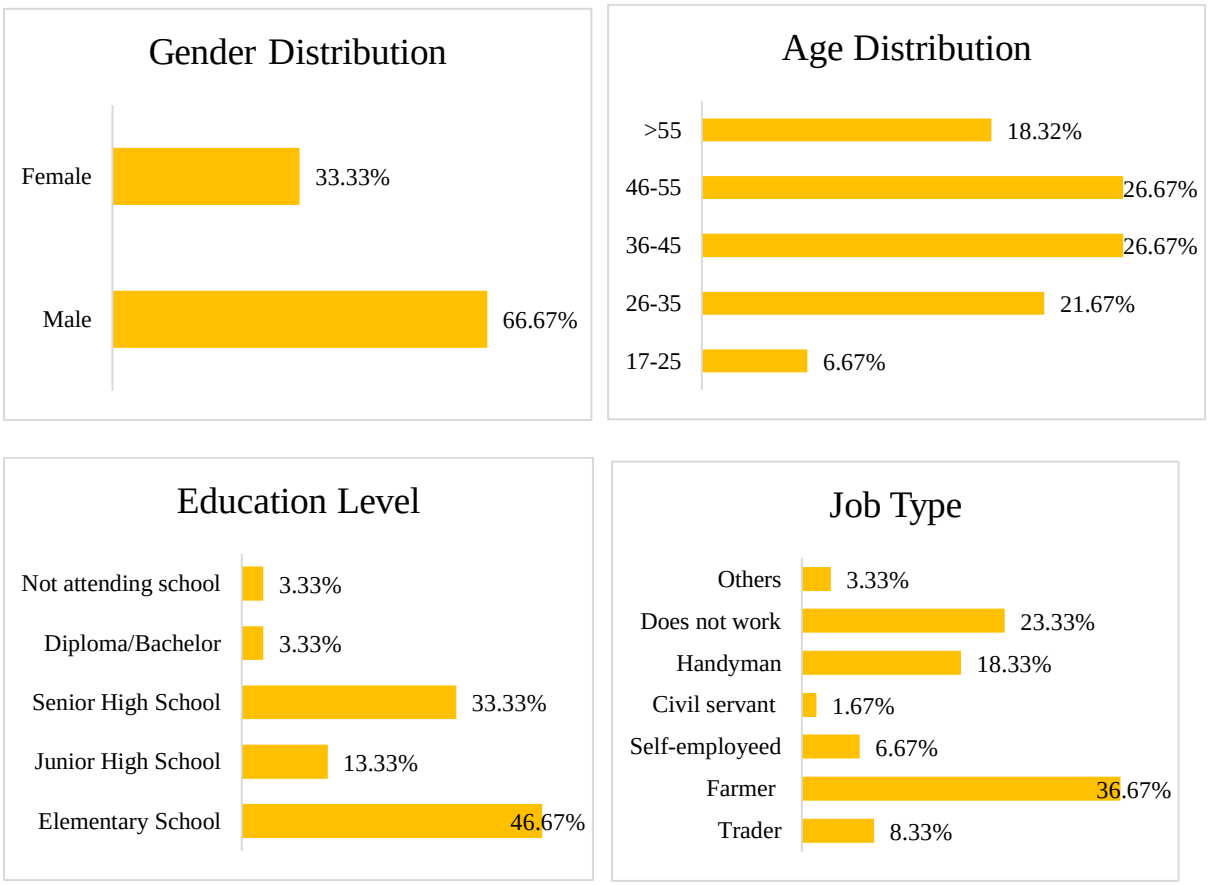

Figure 1. Characteristics of Respondents

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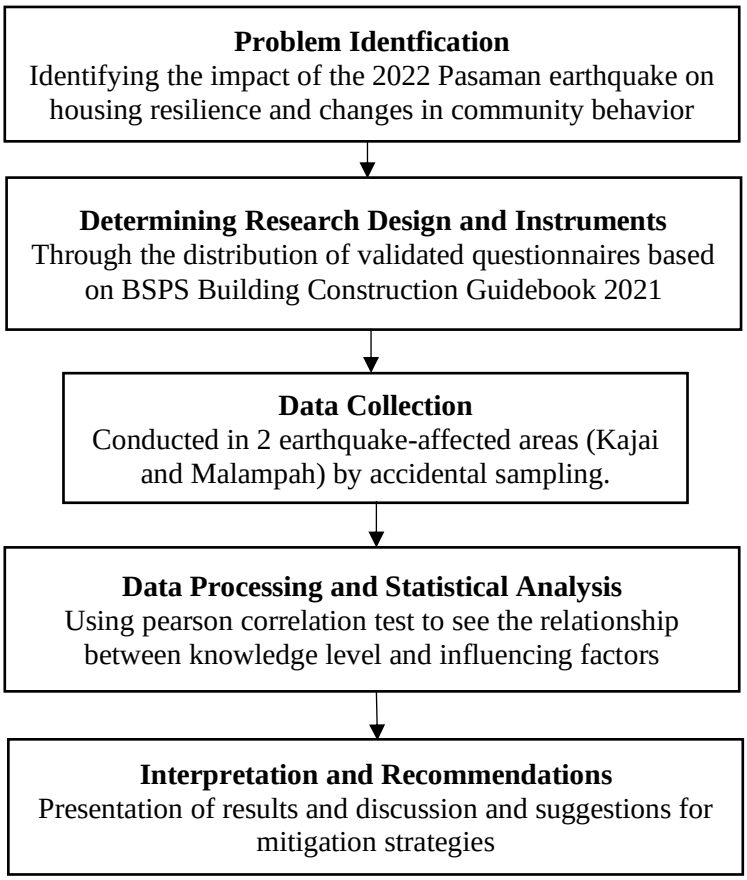

Figure 2. Research Flowchart

RESULTS AND DISCUSSION

Level of Knowledge

Measuring the level of public knowledge of simple earthquake-resistant house after the 2022 pasaman earthquake can be seen in Figure 3.

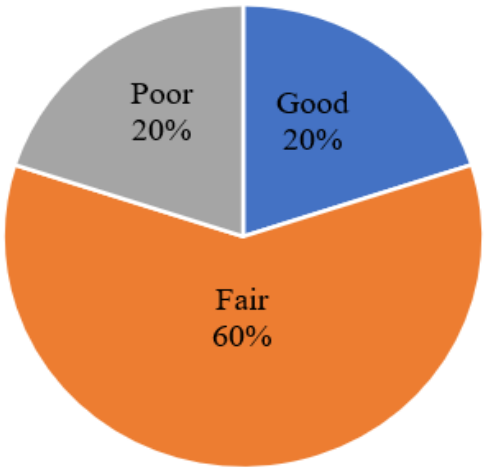

Figure 3. Level of Knowledge

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These results show that the level of public knowledge regarding the construction of simple earthquake-resistant houses after the Pasaman earthquake in 2022 is overall in the "Fair" category. This result is in line with data obtained during respondent interviews that before the earthquake occurred in 2022, the threat of an earthquake had never occurred to the community, due to the minimal history of earthquakes in the area. Apart from that, based on the questionnaire scores, in line with Lewis's research in 2003, people still build houses by following hereditary habits [13] such as not using perimeter blocks, mortar mixtures that do not have exact measurements, using 5/10 wooden trusses instead of 8/12 according to specifications, using foundations. from round stones which are believed to be better than stones that have many corners.

Gender vs Level of Knowledge

The results of the Pearson correlation test show a significance value of 0.002, indicating that there is a relationship between the gender of the respondent and the level of community knowledge in building simple earthquake-resistant houses (Sig < 0.05). The correlation coefficient shows a figure of 0.391 which indicates the strength of the relationship between variables is weak. Men's knowledge is higher than women's based on the answers to the questionnaire in the introduction, because men's participation in socialization about earthquake-resistant houses is also greater, namely 31.67% (19 people) compared to the participation of female respondents which is only 5% (3 people).

There were female respondents who were in the good knowledge level category of 2% (1 person) because the respondent took part in the socialization regarding earthquake-resistant houses which was carried out at the local Nagari Mayor's Office. Meanwhile, the relationship between gender and a low level of knowledge shows that the strength of the relationship is very weak because the knowledge level of male respondents is found in the fair category.

This is known from the answers to the questionnaire which show that there are still many men who do not know well about the aspects of building earthquake-resistant houses, so the habits that are often used in building houses are considered to meet earthquake-resistant requirements. For example, in question item Q27 regarding the size of wood for roof frame trusses, the BSPS 2021 guidebook uses size 8/12, but many respondents are used to using 5/10 wood. Mistakes in these matters are what cause the weak relationship between gender and level of knowledge.

The observed relationship between gender and knowledge levels ($p = 0.002$) aligns with social learning theory by Bandura in 1977, which emphasizes that knowledge acquisition is influenced by direct participation and observational learning[14]. Men's higher involvement in construction activities likely explains their greater familiarity with earthquake-resistant housing principles. Additionally, the weak correlation between occupation and knowledge level ($p = 0.141$) supports the argument from the Bandung Institute of Technology Professor's scientific oration, where technical expertise alone does not guarantee compliance with disaster-resistant construction practices, as socio-economic factors also play an important role[15].

Age vs Level of Knowledge

The results of data processing show a significance value of 0.034 (Sig < 0.05), which shows that there is a relationship between the age of the respondent and the level of knowledge regarding the construction of simple earthquake-resistant houses. The Pearson correlation coefficient shows 0.274, which indicates that the strength of the correlation or weak relationship between the age variable and the level of knowledge. This relationship between age and level of knowledge shows that the older the respondent, the better their level of knowledge in building earthquake-resistant houses. This happens because in the age range of

36-45 and above, respondents already own building property (houses) and have direct experience in building houses.

Level of Education vs Level of Knowledge

The significance value of 0.168 indicates that there is no relationship between the level of education and the level of community knowledge in building simple earthquake-resistant houses (Sig > 0.05). This can also be seen from the correlation coefficient with the figure -0.180 which is interpreted to mean that there is a negative relationship between variables with the strength of the relationship being very weak. The correlation coefficient which shows the existence of a weak negative (inverse) relationship shows that the lower the respondent's education level, the higher the level of knowledge at a weak level.

The findings of this study align with Hariyanto in 2020**,** who also reported that the majority of the public had only a moderate understanding of earthquake-resistant housing[10]. However, this study observed no significant correlation between education and earthquake-resistant housing awareness (p = 0.168). This discrepancy suggests that formal education alone may not be an adequate predictor of earthquake preparedness, reinforcing the argument by Prihantony et al. in 2020 that hands-on training and socialization programs are more effective in improving knowledge[11].

The level of knowledge a person has is influenced by various factors, one of which is the level of education. According to Notoatmodjo, the higher the level of education, the better the level of knowledge[16]. However, in this study the opposite happened, where increasing the level of education did not indicate an increase in the level of knowledge. This is because the sampling was carried out by chance (accidental sampling) taking into account the criteria for respondents, namely being willing to be a respondent and experiencing post-earthquake house damage, including heavy damage, moderate damage and light damage. The dominance of people with elementary education levels causes the level of knowledge at elementary school level to be better than other levels of education. Review of the research data shows that there are more male respondents than female, where the level of knowledge of male respondents regarding building earthquake-resistant houses is better than female respondents.

Job vs Level of Knowledge

The results of the Pearson correlation analysis show a significance value of 0.141 (Sig > 0.05) so that the respondent's work has no effect on knowledge in building simple earthquake-resistant houses. The correlation coefficient value shows -0.192 which indicates a negative relationship and the strength of the relationship is very weak between work and level of knowledge.

The absence of a relationship between the respondent's occupation and the level of knowledge is due to the fact that respondents who work as craftsmen were also found with the highest percentage of 17% (10 people) in the "Fair" knowledge category, while the type of work that dominated the "Good" knowledge category was farmers at 13% (8 people). This is because the majority of people in both Nagari Kajai and Nagari Malampah work as farmers.

The craftsman's knowledge which is in the fair category and not better than that of farmers in this study does not indicate that the craftsman does not have the ability to build a house. In other words, the craftsman is able to build a house, but if evaluated using the 2021 BSPS earthquake-resistant house construction reference, the craftsman's performance in building an earthquake-resistant house still does not meet the criteria for being in the good knowledge category, as described by Shahjalal in his research on the challenges of earthquake-resistant house construction[17].

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Change in People's Behavior in Building House Before and After the Pasaman's Earthquake 2022

In line with measuring the level of community knowledge regarding the construction of simple earthquake-resistant houses, an analysis of changes in behavior in building houses before and after the Pasaman earthquake was also carried out to find out whether the community in Nagari Kajai and Nagari Malampah took steps to change both in building earthquake-resistant houses and to see how the conditions were. House built after the 2022 Pasaman earthquake. It was found that there was an increase of 15% related to the public's assumption that the house they were occupying had met the specifications for earthquake-resistant houses after the 2022 earthquake. This percentage increase was influenced by the increase in information received by the community after the earthquake regarding the construction of earthquake-resistant houses, both from outreach efforts at the local nagari mayor's office, or even through billboards found in several locations. Public awareness of the importance of having earthquake-resistant buildings increased by 15% after the Pasaman Earthquake occurred in 2022. This is because the earthquake caused trauma and loss in the community and even resulted in activities in the area being paralyzed.

Sources of funds for post-earthquake house construction are known to come from private funds and local government assistance. It is known that the amount of assistance for each level of damage is; Rp. 50,000,000 (fifty million rupiah) for heavy damage, Rp. 20,000,000 (twenty million rupiah) for moderate damage and for light damage, the amount of assistance is adjusted to the condition of the house. The mechanism for distributing aid to heavily, moderately and lightly damaged houses consists of 3 ways; (1) the community is given assistance in the form of finished houses worth Rp. 50 million (house heavily damaged); (2) using a compensation system, namely people build houses independently and use private money first, then these funds will be reimbursed by the government; and (3) distribution of building materials facilitated by the government through Field Facilitator Staff.

(a) **(b)**

Figure 4. Earthquake Relief House (a) Nagari Malampah; (b) Nagari Kajai

There was an increase in the percentage of the upper, middle and lower structural elements of the house after the 2022 Pasaman earthquake. This increase occurred in the presence of ceilings, upper tie beams, columns/pillars and lower tie beams. As in Figure 5 the structural elements before the earthquake which did not use columns, lower beams and upper beams, now

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after the earthquake the structural elements of the house have met the characteristics of an earthquake-resistant house[18]. It is known that there are still people who feel unsafe and are doubtful about the durability of the house they are currently occupying against the possibility of damage due to the next earthquake. Based on interviews, people think that this cannot be confirmed because it depends on the strength of the earthquake that will occur.

(a) **(b)**

Figure 5. Differences in Element Structur (a) Before Earthquake; (b) After Earthquake

The results of an interview with one of the people who received housing assistance from the government stated that the house they found was far from safe, because of the many cracks found when the house was occupied. Observations in the field also showed that the finished house in question was made of light steel and did experience cracks at various points. Residents also consider that houses that are earthquake resistant are semi-permanent houses and wooden houses (Figure 5) because they look at Jorong Lubuk Sarik, Nagari Kajai, which is dominated by wooden houses and only a few houses were damaged. This causes people who receive assistance for the heavily damaged house category worth IDR. 50 million with a reimbursement system preferring to build a semi-permanent house.

Figure 6. Appearance of A Wooden House (Semi-Permanent) in Nagari Kajai, West Pasaman

The results of this study have direct implications for earthquake mitigation policies. Given that public knowledge is largely in the ‘fair’ category (60%) but lacks depth, targeted awareness campaigns and hands-on construction workshops should be implemented at the community level. This aligns with the Indonesian government’s Safe House Initiative, which emphasizes public participation in earthquake-resistant construction.

Furthermore, the findings indicate that many respondents prefer semi-permanent houses post-earthquake[19]. This suggests that future housing policies should integrate hybrid construction models that combine traditional techniques with modern earthquake-resistant features[20]. Providing financial incentives for homeowners who adopt certified earthquake-resistant designs could further encourage compliance. This revision ensures that the study's findings have real-world relevance and contribute to policy improvements.

CONCLUSION

This study examined public knowledge of earthquake-resistant housing and behavioral changes in house construction before and after the 2022 Pasaman earthquake. The results indicate that 60% of respondents had fair knowledge, 20% had good knowledge, and 20% had poor knowledge of earthquake-resistant construction. A key finding is that gender and age significantly influenced knowledge levels ($p = 0.002$ and $p = 0.034$, respectively), whereas education level and occupation had no statistically significant effect ($p = 0.168$ and $p = 0.141$).

Furthermore, post-earthquake housing decisions shifted toward semi-permanent structures, reflecting a preference for affordability over compliance with earthquake-resistant standards. These findings highlight the need for more targeted educational interventions and community-based training programs to improve public knowledge and encourage adherence to disastero-resilient housing practices

The change in people's behavior in building houses before and after the earthquake was an increase in awareness of the importance of earthquake-resistant houses which can be seen from the existence of the structural elements of the house. Changes in behavior can also be seen in people's decisions to choose semi-permanent housing types which are considered safer in the event of an earthquake.

Research Limitations

This study has several limitations. First, the use of accidental sampling may limit the generalizability of the findings, as respondents were selected based on availability rather than a randomized approach. Second, the study relied on self-reported knowledge levels, which may be influenced by social desirability bias. Third, while the Pearson Correlation Test identified relationships between demographic factors and knowledge, this method does not establish causality, meaning additional qualitative insights are needed to explain the underlying reasons for these correlations.

Future research would be best conducted through a mixed methods approach, combining quantitative surveys with qualitative interviews to better understand public perceptions and behavioral drivers. Follow-up studies are also recommended to evaluate whether post-earthquake housing construction decisions evolve over time and whether knowledge levels improve with continued outreach efforts. Further testing should also be conducted on the effectiveness of in-person earthquake-resistant construction training programs in improving knowledge retention and practical application.

These findings have significant implications for disaster mitigation policies and community resilience initiatives. The weak correlation between education level and earthquake-resistant housing knowledge suggests that traditional school-based education alone is insufficient to improve preparedness. Instead, local governments should implement community-based training sessions and practical demonstrations on earthquake-resistant construction techniques.

Additionally, the finding that many residents prefer semi-permanent housing post-earthquake

indicates a need for hybrid housing solutions that balance affordability with structural safety. Policymakers should consider providing subsidies or financial incentives to encourage homeowners to adopt earthquake-resistant designs while ensuring that reconstruction programs align with local preferences and socio-economic conditions. By incorporating these policy recommendations, the government and stakeholders can enhance earthquake resilience and reduce the long-term vulnerability of affected communities.

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