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MORALITY BEFORE KNOWLEDGE

An integrated framework of community resilience to earthquakes: Implications for disaster risk reduction and recovery engineering

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ABSTRACT

Background: Indonesia is prone to earthquakes because it is located at the meeting point of tectonic plates, resulting in many coastal areas having a high risk of disaster. Earthquakes not only cause physical damage but also have a long-term impact on the psychological and social conditions of the community. Therefore, community resilience is an important factor in reducing disaster risk and supporting the post-disaster recovery process. This study aims to examine the concept of community resilience in facing earthquakes and the factors that influence it. **Methods:** This scientific paper uses a literature review method by examining accredited scientific journals, disaster textbooks, official agency reports, and relevant laws and regulations. **Findings:** The results of the study show that community resilience to earthquakes is shaped by the integration of social, economic, physical and infrastructure aspects, human resources, and the environment. Social aspects and social capital play an important role in accelerating post-disaster response and recovery, while economic capacity and infrastructure quality determine the community's ability to absorb the impact of disasters. These findings are in line with resilience theory, which emphasizes adaptive capacity and collective engagement as key factors in community resilience. **Conclusion:** Community resilience to earthquakes is built through the integration of social, economic, physical, human resource, and environmental aspects that reinforce each other. Strengthening the adaptive capacity of communities in an integrated manner is key to reducing the impact of disasters and supporting post-disaster recovery and sustainability. **Novelty/Originality of this article:** The novelty of this research lies in its comprehensive conceptual synthesis of community resilience to earthquake disasters by integrating social, economic, physical, human resource, and ecological perspectives into a single framework of discussion.

KEYWORDS: impact; earthquake; community resilience.

1. Introduction

Indonesia is an archipelago consisting of 17,508 islands located in Southeast Asia between the Pacific Ocean and the Indian Ocean. Indonesia has a total area of 5,180,053 km^2, consisting of 1,922,570 km^2 of land (37.1%), 3,257,483 km^2 of sea (62.9%), and 81,000 km of coastline (BNPB, 2017). According to Larama (2020) , Indonesia is located at the meeting point of three tectonic plates, making it prone to natural disasters such as earthquakes and tsunamis, especially in coastal areas. Earthquakes are disasters caused by collisions between tectonic plates, fault activity, volcanoes, and building collapses.

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Earthquakes are destructive disasters that can occur at any time in a short period of time (Yanuarto, 2019).

Data obtained from BNPB during 2021 shows that at least 2,976 disasters occurred in Indonesia, an increase of 19.4% from November 2020. Eighty percent of these disasters occurred in West Sumatra Province, and 31% of them were earthquakes. The Padang City Disaster Management Agency said that Padang City is flanked by two faults that can cause earthquakes, namely the Semangko fault and the Megathrust fault. Experts predict that an earthquake caused by the Megathrust fault will have a magnitude of 8.9 and will be followed by a 6-10 meter high tsunami in Padang City (Banjarnahor, 2020).

Natural disasters such as earthquakes not only have a negative impact on the environment, but also have a significant impact on physical, psychological, and social conditions. The psychological impact on humans should be eliminated immediately. The effects of disasters such as earthquakes not only affect individuals, but also affect the entire community affected by the disaster. Communities have access to resources and the ability to make decisions under stressful conditions. Planning and preparation for disasters require the immediate involvement of local governments. What communities can do to protect themselves from the aftermath of a disaster is to build resilience. Resilience can sustain community life and reduce adverse effects in the long term (Novianty, 2016).

According to Suwarjo (2008), resilience is an individual's ability to face, overcome, and respond positively to unpleasant conditions. In this case, individuals are able to use these unpleasant conditions to strengthen themselves and turn them into something that is normal to overcome. Community resilience is the ability of a community to build, maintain, or regain the desired level of community capacity in facing difficulties and challenges (VanBreda, 2001).

Reivich & Shatte (2002) state that there are seven abilities that form resilience, namely: emotional regulation, impulse control, optimism, empathy, causal analysis, self-efficacy, and reaching out. Basically, every human being possesses all of these resilience factors, but what distinguishes them is how each individual uses each factor to the maximum extent possible so that they develop the ability to persevere in the face of difficulties, prevent stress, and have the ability to bounce back even better than before.

Communities are the first to be affected when a disaster strikes. They are also the first to respond to the disasters they face. When a disaster occurs, it is the community that will play an important role in reducing the impact of the disaster itself. Therefore, the community must be prepared to face the worst-case scenario of a disaster. Disasters can cause hundreds of thousands of deaths and have long-term effects on human survival. If a disaster occurs, the government or disaster relief organizations will not immediately go to the disaster site, so it is important for the community to prepare for disasters (Plough et al., 2013).

Communities that have experienced disasters and are beginning to recover from adversity or have already become resilient still have a low level of awareness of disasters. One of the factors contributing to the high number of casualties in disasters is the lack of community preparedness for disasters. Therefore, it is important to prepare disaster preparedness measures early on for communities that are vulnerable to disasters in order to avoid or minimize the risk of disasters (Sutton & Tierney, 2017).

Community resilience is the integration of disaster management and community involvement, which has a positive relationship with public morale in the long term and the development and sustainability of a community after a disaster (Paton et al., 2014). The factors that influence communities in relation to disasters depend on the frequency and severity of the disaster and the vulnerability of the community, so it is important to understand the perceptions of the community and how a community responds to a disaster. Therefore, understanding how a community adapts to a disaster is essential for building community resilience (Twigg, 2015).

The success of a community in building disaster resilience is not only based on the efforts of the community itself, but also requires assistance from the government and non-governmental organizations. The assistance needed is mainly in the areas of economics,

policy, and sustainable organizational development management for recovery. This is crucial in building community resilience (Parvin et al., 2015). According to Dewi (2017), after a disaster occurs, social adjustments are also needed within the community to improve development in various aspects. It is this community adjustment mechanism that will play a major role in rebuilding homes, cleaning up areas affected by disasters, building public facilities through mutual cooperation, and maintaining security in the area on a rotating basis.

1.1 The concept of disaster

According to Law No. 24 (2007), a disaster is an event or series of events that threaten and disrupt the lives and livelihoods of the community, caused by natural or non-natural factors or human factors, resulting in loss of life, environmental damage, property damage, and psychological impacts (Law No. 24, 2007). According to the National Disaster Management Agency (BNPB), a disaster is an event or series of events caused by nature, including earthquakes, volcanic eruptions, floods, and hurricanes. Meanwhile, the WHO defines a disaster as any event that causes damage, ecological disruption, loss of human life, or deterioration of health or health services on a scale that requires a response from outside the affected community or region (Aho et al., 2006).

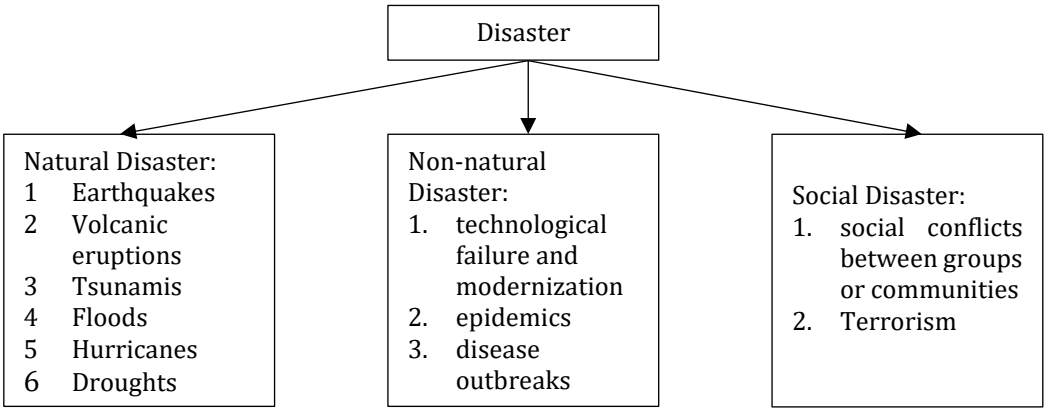

Fig. 1. Three types of disasters (Hutapea et al., 2021)

Disaster management is a process where the end of one process is the beginning of another. The disaster management cycle consists of mitigation, preparedness, response, and recovery. The disaster management cycle consists of the pre-disaster phase, which is before a disaster occurs, with activities carried out including prevention, mitigation, and preparedness; the disaster phase, which is when a disaster occurs, with emergency response activities carried out; and the post-disaster phase, which is after a disaster occurs, with rehabilitation and reconstruction activities carried out (Hutapea et al., 2021).

Mitigation is an action taken to reduce the impact or harmful effects of a disaster, including preparedness and risk reduction measures through awareness and capacity building among communities, physical development, so that the impact of disasters on human health, economic infrastructure, and community functions can be limited (Hutapea et al., 2021). Mitigation activities are generally divided into two types; (1) structural mitigation, which involves construction projects that can reduce economic and social impacts, (2) non-structural activities, which are policies and actions that increase awareness of a hazard, encouraging the implementation of development to reduce the impact of disasters, such as through outreach, regulations, and education (Hutapea et al., 2021).

Preparedness is an effort to plan for disasters and develop disaster responses before they occur, such as emergency training and warning systems that include risk assessment and disaster occurrence trends (Hutapea et al., 2021). Activities carried out during

preparedness are; activating disaster preparedness posts, preparedness training or technical simulations for each disaster management section, including SAR, health, infrastructure, social, and public works, providing an inventory of resources to support emergencies, preparing logistical support and mobilization, preparing a rapid information and communication system to support disaster management, preparing and installing an early warning system, developing a contingency plan, and mobilizing resources.

Emergency response is a phase of implementation of planning that is taken when a disaster occurs to minimize the dangers caused by the disaster. This phase focuses on providing emergency assistance, such as saving lives, administering first aid, minimizing and restoring damaged systems such as communication and transportation systems, and providing care and basic necessities for disaster victims, such as food, water, and shelter (Hutapea et al., 2021). Overall, the objectives of the disaster response phase are; ensuring the survival of victims by ensuring that they live in good health, rebuilding self-sufficiency and essential services as quickly as possible for all groups, especially for communities that require special attention, such as those who are vulnerable in terms of health or economy, repairing and replacing damaged infrastructure and restoring economic activity, in cases of civil or international conflict, the goal is to protect civilians and then work with international committees, in cases caused by population displacement due to disasters, this phase aims to find solutions as quickly as possible and ensure protection and necessary assistance for the time being. several actions taken in the emergency response phase include: warning, evacuation, population displacement, search and rescue, post-disaster assessment, logistical and supply assistance, communication and information management, security, emergency operations management, rehabilitation and reconstruction (Hutapea et al., 2021).

The recovery process is a phase to restore the community to a normal situation (before the disaster occurred). Psychological recovery of disaster victims is very much needed. In this phase, where many victims experience long-lasting traumatic stress such as sadness, loneliness, worry, and excessive anxiety (Hutapea et al., 2021). Reconstruction can be carried out as follows, infrastructure and facilities are rebuilt, community social facilities are rebuilt, the social and cultural life of the community is revived, designing appropriate buildings using good equipment that is resistant to disasters, community institutions and organizations, the business world, and the community participate and play an active role, improving socioeconomic and cultural conditions, improving public service functions, improving essential services in the community (Hutapea et al., 2021).

1.2 Earthquake management

An earthquake is a vibration that occurs on the earth's surface due to the sudden release of energy from within, creating seismic waves that are usually caused by the movement of the earth's crust (BMKG, 2019). An earthquake is an event in which the earth shakes due to collisions between tectonic plates in the form of faults, rockfalls, or volcanic activity, which can occur at any time and damage buildings, roads, bridges, and other structures (Huang, 2021). Meanwhile, according to BNPB (2017), an earthquake is an event in which the earth shakes due to collisions between tectonic plates, fault activity, volcanic activity, or landslides that can instantly damage and destroy buildings, roads, bridges, and so on.

Earthquakes occur as a result of the movement and interaction of tectonic plates within the Earth’s lithosphere. According to the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG, 2019), the Earth is composed of three main layers: the crust, the mantle, and the core. The Earth’s crust is fragmented into irregularly shaped and rigid tectonic plates that are constantly in motion. When these plates collide, slide past one another, or experience fractures along fault lines, the accumulated stress is released in the form of seismic energy, resulting in earthquakes. This tectonic activity explains the frequent occurrence of earthquakes in regions located along active plate boundaries, including Indonesia.

Earthquake mitigation efforts are essential to reduce risks and minimize the impacts of seismic hazards on communities. The National Disaster Management Agency (BNPB, 2017) emphasizes that disaster management should be conducted in a comprehensive manner through actions undertaken before, during, and after an earthquake event. In the pre-disaster stage, mitigation focuses on preparedness and risk reduction. Communities are encouraged to develop personal and family evacuation plans, conduct regular earthquake response drills such as practicing safe positions to protect the head and body, and prepare emergency equipment including fire extinguishers, safety tools, and medical supplies. In addition, the construction of earthquake-resistant houses with strong structural foundations is strongly recommended. Attention to earthquake-prone areas and compliance with government regulations on land use and spatial planning are also critical components of effective mitigation.

During an earthquake, immediate response actions are crucial to ensure personal safety. Individuals are advised to seek shelter under sturdy furniture to protect themselves from falling objects and shattered glass. After the shaking subsides, they should move quickly to open spaces while remaining alert to hazards such as broken glass, roof debris, and unstable structures. It is important to avoid standing near power poles, trees, or buildings that may collapse. Emergency stairways should be used during evacuation, and all official evacuation instructions must be followed carefully. In coastal areas, if an early tsunami warning is issued following a strong earthquake, communities must evacuate immediately to higher ground, such as hills or tall, reinforced buildings.

Post-disaster actions focus on safety, recovery, and vigilance against secondary hazards. After an earthquake, individuals should remain alert to the possibility of aftershocks, which may cause additional damage. Evacuation should be carried out once the shaking has completely stopped, particularly for those inside damaged buildings. If evacuation is not immediately possible, individuals are advised to stay under sturdy furniture for protection. Remaining in open areas away from buildings, power poles, and other potential hazards is essential until conditions are declared safe by authorities. These integrated mitigation efforts across all disaster phases are fundamental to reducing vulnerability and strengthening community resilience to earthquake hazards.

According to Sembiring (2019), disasters generate a wide range of impacts that significantly affect human health and well-being. These impacts include mass casualties resulting in injuries, disabilities, and even loss of life. Disaster situations often lead to increased rates of illness, mortality, and malnutrition, particularly among displaced populations living in temporary shelters or refugee camps. In addition, the lack of access to clean water and poor sanitation conditions in evacuation centers further exacerbates public health risks. Health services frequently become unable to function optimally due to overwhelming demand, limited resources, and operational constraints. These conditions are often compounded by damage to health facilities and supporting infrastructure, which disrupts the delivery of essential medical services during and after disasters.

Similarly, Erchanis (2019) highlights that natural disasters also have profound social and psychological consequences. Affected individuals may experience temporary or permanent loss of shelter and livelihoods, which undermines economic stability and household security. Disasters can cause separation from family members and lead to inadequate fulfillment of basic needs such as food, shelter, and healthcare. Educational activities are often disrupted, particularly for children, while the risk of disease increases due to overcrowding and poor living conditions. Beyond physical and economic impacts, disasters can impair family functions and social roles, resulting in diminished self-esteem and reduced capacity to perform social responsibilities within the household. Prolonged uncertainty in post-disaster situations may also cause fatigue and psychological distress, including unrealistic or distorted patterns of thinking, which further hinder individual and community recovery.

1.3 The concept of resilience

According to Hendriani (2018), resilience is a dynamic process involving various individual, social, and environmental factors, which reflects a person's strength and fortitude to recover from negative emotional experiences when facing difficult situations that are stressful or contain significant obstacles. Meanwhile, according to Reivich & Satte (2002), resilience is an individual's ability to respond in a healthy and productive manner when dealing with trauma, which is very important for controlling daily life pressures.

Resilience generally leads to positive adaptation patterns during or after facing difficulties or risks. Resilience is an idea that refers to the capacity of a dynamic system to survive or recover from disruption (Fullerton et al., 2021). Grotberg (1995) opinion is widely used in research on resilience. He states that resilience is the human capacity to face and overcome difficulties and is strengthened or transformed by difficulties in life.

However, it is often found that individuals' resilience in facing various difficulties in life is less than optimal. People prefer to give up on their circumstances or even experience various disorders in their social, mental, or physical abilities. They are unable to maintain balance in the face of intense pressure. Improving resilience is an important task because it can provide people with experience in facing challenges and difficulties in life (Hendriani, 2018).

Resilience plays a crucial role in enabling individuals to withstand and navigate the various challenges they encounter throughout their lives. Reivich & Shatte (2002) argue that resilience is grounded in several fundamental principles that shape an individual's capacity to adapt and persevere. One key principle is the belief that people are capable of change. Individuals are not merely victims of their ancestry or past experiences; rather, they possess the freedom, motivation, and agency to reshape their lives. Each person is endowed with the capacity to develop skills, pursue goals, and actively create opportunities for themselves. Another essential principle emphasizes the central role of cognition in strengthening resilience. An individual's thoughts directly influence emotional responses, and these emotions, in turn, determine whether a person remains resilient or chooses to give up when facing adversity. Furthermore, accurate and realistic thinking is considered a critical component of resilience. Realistic optimism does not imply passively expecting positive outcomes to occur on their own. Instead, it involves recognizing challenges while believing that favorable outcomes can be achieved through deliberate effort, effective problem-solving, and careful planning. Together, these principles highlight that resilience is an active and dynamic process rooted in mindset, cognitive control, and purposeful action.

The concept of resilience places a strong emphasis on human strength as the foundation of emotional and psychological well-being. Resilience is regarded as a fundamental capacity that underlies all positive human characteristics, including courage, rational thinking, and insight. Without resilience, individuals would lack the ability to cope effectively with adversity, make sound decisions, or maintain psychological stability in challenging situations. As such, resilience functions as a core human strength that enables individuals to adapt, recover, and grow when confronted with stressors and life disruptions.

According to Herrman et al. (2011), the factors that support resilience can be understood as sources of resilience, which are broadly categorized into personality, biological, and environmental domains. Personality-related factors encompass a wide range of individual attributes, including self-efficacy, self-esteem, internal locus of control, optimism, intellectual capacity, and positive self-concept. These factors are further shaped by demographic characteristics such as age, gender, and ethnicity, as well as by expectations, emotional regulation, and overall coping capacity. Together, these characteristics influence how individuals perceive challenges and mobilize internal resources to respond to adversity.

Biological factors also play an important role in resilience, particularly those related to early environmental conditions. Early life experiences influence brain development, neurobiological structures, and physiological stress responses, all of which shape an individual's long-term capacity for emotional regulation and adaptation. In addition to

internal and biological factors, environmental influences constitute a critical source of resilience. Immediate environmental factors include social support systems such as secure relationships with family members, peers, and caregivers, especially the presence of stable and supportive parental attachments. At a broader level, environmental resilience is shaped by community systems, including schools, social institutions, community services, and opportunities for engagement in positive and meaningful activities. Cultural values, spirituality, religious beliefs, and experiences related to safety or exposure to violence further interact with these systems, collectively influencing individual and community levels of resilience. Masten and Coatsworth emphasize that individual resilience is supported by a combination of interrelated factors operating at the individual, family, and community levels. At the individual level, resilience is strongly influenced by cognitive abilities, self-concept, self-esteem, and social competence. Cognitive skills play a crucial role in shaping how individuals interpret and respond to adverse events. Through cognitive processing, individuals are able to perceive disasters not solely as the result of personal negligence but also as events beyond human control, which helps reduce self-blame and excessive regret. This cognitive reframing enables individuals to find meaning in adversity, maintain optimism, and mobilize motivation to recover and restore their functioning. A minimum level of cognitive capacity, generally within an average range of intelligence, is required to support problem-solving, learning from experience, and adaptive coping during the recovery process. Moreover, the development of resilience is closely linked to communication abilities, including the capacity to understand and express thoughts through language, reading skills, and non-verbal communication. Resilience is further enhanced by the individual's ability to distance themselves from traumatic experiences through imagination, hope, and future-oriented thinking, which serve as psychological resources for recovery.

Family factors also play a central role in fostering resilience. Parental support, reflected in nurturing, caring, and responsive parenting practices, is essential in helping individuals cope with stress and trauma. Strong emotional and spiritual bonds among family members provide a secure foundation that facilitates recovery and emotional stability following adverse experiences. Family relationships significantly influence the level of support available to individuals who have experienced misfortune, enabling them to process events more objectively and regain psychological balance. In this context, family structure is an important determinant of resilience development. A complete family structure, typically consisting of parents and children, is often associated with greater emotional security and support, which can facilitate resilience. Conversely, an incomplete or unstable family structure may pose challenges to the development of adaptive coping capacities, potentially hindering resilience.

Beyond the family, community and social environment factors contribute substantially to individual resilience. Support from the surrounding community, including recognition, social attention, and opportunities for active participation in community organizations, enhances an individual's sense of belonging and social value. Through interpersonal communication and social engagement, individuals perceive that their existence is acknowledged and that supportive relationships are available to help them adapt to changing conditions. These social connections function as protective resources that assist individuals in overcoming negative consequences of adversity, strengthening their capacity to cope, adapt, and recover in the face of challenging life events.

Based on the above explanation, it can be concluded that the factors that influence resilience are factors from within the individual (internal) and factors from outside the individual (external). Internal factors include personality characteristics, cognitive abilities, self-concept, self-esteem, social competence, and demographic factors (age, gender, and ethnicity). External factors include environmental factors, both narrow and broad. Narrow environments include parents and peers, while broad environments include school, community, culture, religion, government, and so on.

2. Methods

This study employed a qualitative descriptive research design with a conceptual-analytical approach to examine community resilience to earthquakes. The qualitative approach was chosen to capture the complexity and multidimensional nature of resilience, which is understood as a dynamic process shaped by interactions among social, economic, physical, human, ecological, and governance factors. Rather than measuring resilience quantitatively, this study focused on interpreting patterns, relationships, and roles of key dimensions that contribute to community resilience across different phases of disaster management.

The research relied on secondary data sources, including peer-reviewed journal articles, policy documents, institutional reports, and international frameworks related to disaster risk reduction and community resilience. Key references were drawn from established scholars and organizations which provide theoretical and empirical foundations for understanding resilience in disaster-prone contexts. These sources were selected based on their relevance, credibility, and contribution to resilience theory and earthquake disaster studies, particularly in developing and seismic-prone regions.

Data collection was conducted through a systematic literature review process. Relevant publications were identified using academic databases such as Google Scholar, Scopus-indexed journals, and institutional repositories. Keywords including "community resilience," "earthquake resilience," "social capital," "disaster preparedness," and "disaster recovery" were used to retrieve literature published primarily within the last two decades to ensure conceptual relevance. The selected literature was then reviewed thoroughly to extract key concepts, dimensions, and indicators of community resilience to earthquakes.

Data analysis was carried out using thematic content analysis. The collected data were categorized into major resilience dimensions, namely social, economic, physical and infrastructure, human resources, ecological, and governance or institutional synergy. Each dimension was analyzed in relation to its role across different disaster management phases, including pre-disaster preparedness, emergency response during disasters, and post-disaster recovery. This analytical framework enabled the study to systematically interpret how each dimension contributes to reducing vulnerability, enhancing adaptive capacity, and supporting sustainable recovery.

To strengthen analytical rigor, the study applied a comparative synthesis approach by cross-referencing findings from multiple sources. This process helped identify consistent patterns and relationships among resilience dimensions, as well as contextual differences in their application. Tables were developed as analytical tools to synthesize complex information and illustrate the interaction between resilience dimensions and disaster phases, thereby improving clarity and interpretability of the findings.

Overall, this methodological approach allowed for an in-depth understanding of community resilience as an integrated and multidimensional concept. The qualitative synthesis provides a comprehensive framework that can be used as a reference for policymakers, practitioners, and researchers in developing strategies to enhance community resilience to earthquakes, particularly in disaster-prone regions such as Indonesia.

3. Results and Discussion

3.1 Overview of community resilience to earthquakes

Community resilience in the face of earthquakes is the collective ability of a community to anticipate, prepare for, respond to, and recover from the effects of disasters effectively. This concept is in line with the opinion (Paton et al., 2014) which states that community resilience is a social capacity that enables communities to reduce vulnerability and increase adaptability to disaster threats. According to Masten (2014), resilience is not a static

condition, but a dynamic process that develops through interactions between individuals, communities, and the environment. In the context of sudden and destructive earthquakes, this process includes pre-disaster preparedness, the ability to survive during a disaster, and post-disaster recovery capacity. This is reinforced by UNDRR (2015), which emphasizes that community resilience reflects the ability of social systems to absorb shocks without losing their basic functions. In the context of disasters in Indonesia, community resilience is very important given the geological conditions of the region, which is located in an active seismic zone. (Twigg, 2015) states that communities living in disaster-prone areas must have internal capacities in the form of knowledge, skills, and risk awareness, so that they are not entirely dependent on external assistance. Therefore, community resilience is the main foundation for sustainable development in earthquake-prone areas.

Table 1. Dimensions of community resilience to earthquakes

Dimension	Key Components	Role in Earthquake Resilience	Key References
Social	Social capital, networks, trust, community organizations	Accelerates response and recovery through cooperation and mutual assistance	Putnam (2000); Aldrich (2012); Paton et al. (2014)
Economic	Income stability, savings, access to credit	Enhances capacity to absorb losses and recover livelihoods	Cutter et al. (2008); Rose & Hudgins (2017)
Physical & Infrastructure	Earthquake-resistant buildings, evacuation routes, lifeline systems	Reduces casualties and physical damage	Bosher et al. (2007); Wisner et al. (2012)
Human Resources	Education, training, disaster experience, psychological resilience	Improves preparedness and adaptive response	UNESCO (2017); Reivich & Shatte (2002)
Ecological	Land use, natural resources, environmental management	Reduces vulnerability and supports sustainable recovery	Folke et al. (2010)
Governance & Synergy	Policy, institutional capacity, community participation	Ensures integrated and sustainable resilience building	Twigg (2015); Paton et al. (2014)

3.2 The role of social aspects in building community resilience

Social aspects play an important role in shaping community resilience to earthquakes. Putnam (2000) explains that social capital in the form of networks, norms, and social trust can improve community coordination and cooperation in facing crises. In disaster situations, this social capital acts as an initial defense mechanism before formal assistance arrives. According to Aldrich (2012), Communities with strong social bonds tend to recover more quickly after disasters than communities with low levels of social trust. This is due to the community's ability to help each other, share resources, and provide emotional support to disaster victims. Local social organizations, such as neighborhood associations, youth organizations, and religious organizations, serve as important actors in building community resilience. Paton et al (2014) emphasize that active community participation in local organizations can improve disaster preparedness and response effectiveness. Thus, strengthening social aspects is an important strategy in reducing the impact of earthquakes.

The social aspects that can influence community resilience to disasters are social organizations within the community, norms that apply in the community, and community coordination and cooperation. For example, social organizations can form community bonds and networks that can be useful as social resources in the community, where if there are problems within the community, these problems can be overcome together. Social networks in the community are an important asset that enables communities to solve problems more easily. The social aspect in society can be seen in the existence of organizations in society, volunteer associations, religious organizations, youth

organizations, and other social groups. Actions that fall under the social aspect include mutual assistance, relationships of mutual trust between people, and mutually beneficial cooperation as social security.

3.3 Economic aspects as determinants of community resilience

Economic aspects are a major factor influencing the community's ability to absorb and recover from the impact of earthquakes. Cutter et al (2008) state that good economic capacity will increase the community's ability to adapt to disaster risks. Stable income, savings, and access to sources of financing enable communities to repair damage and resume economic activities after a disaster. According to Rose & Hudgins (2017), conomic losses due to disasters often prolong the period of social recovery if not balanced with appropriate recovery policies. Therefore, government support through social assistance, economic recovery programs, and access to microcredit are important instruments in building the economic resilience of communities affected by earthquakes.

The economic aspects of community resilience to disasters refer to the financial resources used by communities to meet their needs. These include income, savings, investments, and credit. Economic factors contribute to building community resilience by increasing the community's ability to absorb the impact of disasters and accelerate the post-disaster recovery process. This means that communities can seek alternative sources of livelihood after a disaster, which can increase their resilience to disasters. Economic factors influence resilience because if a community has a stable economy, it will generally increase the community's resilience in facing unexpected negative events, while a community with an unhealthy economy will increase its vulnerability.

3.4 Contribution of physical aspects and infrastructure

Physical aspects and infrastructure are crucial components in community resilience to earthquakes. Bosher et al (2007) state that the development of disaster-resistant infrastructure is the most effective form of structural mitigation in reducing the risk of casualties and material losses. According to Wisner et al (2012), the physical vulnerability of an area is greatly influenced by the quality of buildings, spatial planning, and settlement density. Infrastructure that does not meet safety standards will increase the level of damage and slow down the recovery process. Therefore, the application of earthquake-resistant building standards and the provision of evacuation routes are important elements in increasing community resilience.

The physical aspect of community resilience to disasters refers to the environment that is created for disaster resistance. This aspect is formed as a product of the economy, such as public buildings, dams, embankments, shelters, warning sirens, evacuation routes, and so on. The physical aspect also includes electricity, water, telephone lines, and infrastructure such as hospitals, schools, police stations, fire stations, and so on. Physical aspects are important assets for communities to increase their resilience in the event of a disaster. Roads, bridges, dams, shelters, communication systems, evacuation routes, and warning sirens are very important for communities, especially during evacuation.

3.5 The role of human resources in resilience

Human resources are at the core of community resilience. UNESCO (2017) emphasizes that disaster education plays an important role in increasing risk awareness and the community's ability to respond to disasters. The knowledge and skills possessed by the community will determine the speed and accuracy of their actions when an earthquake occurs. According to Reivich & Shatte (2002), individuals with good psychological resilience are better able to manage stress and make rational decisions in emergency situations. Previous experiences of disasters also serve as learning factors that strengthen communities' capacity to adapt to future disasters. Human resources are defined as the

productive population that has the knowledge, skills, and abilities to strive for a better life. Several things that affect human resources during a disaster are education, training, and experience. Experience in dealing with disasters provides additional benefits because it can improve the ability to cope, adapt, and recover from disasters.

3.6 Ecological and environmental aspects in supporting resilience

Ecological and environmental aspects play an important role in supporting community resilience to disasters. Folke et al (2010) state that social-ecological systems that are managed sustainably have a greater ability to absorb disturbances and adapt to extreme changes, including natural disasters. Proper land use management, preservation of open spaces, and protection of natural resources can reduce the level of damage caused by earthquakes. Conversely, environmental degradation can increase community vulnerability to post-disaster risks. The natural or ecological aspect refers to the supply of natural resources that can support and benefit human life. These natural resources include land, water, aquatic resources (fish), trees as forest products, game animals, biodiversity, and all activities related to the environment. The natural aspect is an important asset that can support human life, but human activities are often responsible for the depletion and deterioration of the quality of natural resources themselves.

3.7 Synergy between the government and the community in improving resilience

Community resilience cannot be built partially, but requires synergy between the community, the government, and other stakeholders. The government plays a role in policy formulation, infrastructure provision, and strengthening disaster management institutions. Meanwhile, the community plays a key role in implementing preparedness and initial response to disasters. Community resilience to disasters is the integration of disaster management and community involvement, which has a positive relationship with public morale in the long term and the development and sustainability of a community after a disaster (Paton et al., 2014). Factors that influence communities in the face of disasters depend on the frequency and severity of disasters and the vulnerability of the community, so it is important to understand community perceptions and how a community responds to a disaster. Therefore, understanding how a community adapts to a disaster is essential for building community resilience (Twigg, 2015). Community resilience broadly arises from the community's own capabilities and is driven by external factors such as government and private sector support in planning, preparing, absorbing, responding to, and recovering from disasters, as well as being able to adapt to new conditions.

Table 2. Community resilience dimensions across disaster management phases

Dimension	Pre-Disaster	During Disaster	Post-Disaster
Social	Preparedness training, social networks	Mutual aid, coordination	Social recovery, trust rebuilding
Economic	Savings, insurance	Emergency financing	Livelihood recovery
Physical	Building standards	Shelter, evacuation	Reconstruction
Human Resources	Education, drills	Decision-making	Capacity rebuilding
Ecological	Land-use planning	Environmental protection	Ecosystem restoration

4. Conclusions

Community resilience in the face of earthquakes is a collective capacity that is formed through interactions between social, economic, physical, human resource, and environmental aspects. Resilience is not only related to the community's ability to survive

when a disaster occurs, but also includes preparedness before a disaster and the ability to recover and adapt after a disaster.

Social aspects play an important role in strengthening community resilience, particularly through the existence of social networks, trust, and cooperation among citizens. Strong social ties enable communities to help each other and accelerate the recovery process after a disaster. In addition, economic aspects also determine the level of community resilience, where income stability and access to economic resources influence the community's ability to absorb and recover from the impact of a disaster.

Physical and infrastructure aspects are also crucial factors in reducing the risks and losses caused by earthquakes. The availability of earthquake-resistant buildings, evacuation routes, and adequate public facilities can reduce the number of casualties and damage. On the other hand, the quality of human resources, especially knowledge and skills related to disasters, plays a major role in determining the effectiveness of community response when a disaster occurs. Ecological and environmental aspects also support community resilience if they are managed sustainably and take into account environmental carrying capacity.

The recommendations derived from this study emphasize the importance of strengthening both institutional and community capacities in enhancing earthquake resilience. The government is encouraged to improve community-based disaster education and training programs to increase public awareness, preparedness, and adaptive capacity in facing earthquake risks. In addition, communities living in earthquake-prone areas should be actively involved in disaster planning processes and simulation activities, as participatory approaches can strengthen local ownership, coordination, and practical readiness during emergencies. Finally, future research is recommended to adopt an empirical approach by quantitatively measuring community resilience levels, which would allow for more precise assessment, comparison across regions, and the development of evidence-based policies to support disaster risk reduction efforts.

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