Risk assessment of housing reconstruction project community-based construction after the earthquake

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Abstract. Earthquake events caused thousands of families to be displaced, some inside refugee camps, others living in relatives' houses, besides causing the stages of government, economy and Social Stage to experience many obstacles. Reconstruction implementation Community-based housing is the backbone for sustainable development. Through this approach, it is hoped that people can realize the importance of building a building using earthquake resistant building structures. Based Deskriftive analysis and factor analysis, there are 18 (eighteen) the risk of pre-construction project of housing reconstruction after the earthquake based society including the risk of unexpected (Un desirable). From 8 (eight) Stages of pre-construction phase of the housing reconstruction is 1 (One) Stages of risks are still acceptable namely Stages 6 (Stages of Establishment of Community Organizations). The greatest risk is in Stage 8 is R.8.16. The price of Building Materials which has the biggest risk value is: 5.389. With this risk analysis it is hoped that the parties concerned can pay more attention to the risks that have high value (categorized as an unexpected risk).

1. Introduction
Earthquake disaster event that Shook the area of West Sumatra Province and surrounding areas on September 30, 2009, at 17:16:09 pm. Based on information from the Meteorology and Geophysics Agency (BMKG), the power is estimated at around 7.6-magnitude earthquake (7.9 Richter by USGS) with the epicenter located at coordinates LS 0.84 - 99.65 BT at a depth of 71 km on the seabed and within 57 km Directions Barat Daya Pariaman, Sumatera Barat. Intermittent 22 minutes later, precisely at 17:38:52 pm happened a magnitude 6.2 earthquake aftershocks. The epicenter was located at latitude coordinates of 0.72 - 99.94 BT, at a depth of 110 km and is 22 km southwest of Pariaman, West Sumatra[1].

The Housing Sector experienced the greatest loss compared to other sectors at Rp. 15,410,000,000,000, - (Fifteen Billion Four Hundred Ten Billion Rupiah) or about 73.85% compared with other sectors, namely: Infrastructure, Social, Productive Sector and Cross-Sector.

The Phase of Housing Reconstruction is the most important stage in the post-disaster reconstruction project due to the high level of demand due to the disaster. As a result, by providing high quality of the housing can satisfy the needs and expectations of beneficiaries is a key factor (success) on the reconstruction program ([3], [29] and [4]). It turned out that in its implementation, the entire recovery program has not been able to run as planned. This is indicated by the presence of people who occupy refugee camps due to rejection in the process of reconstruction and relocation of houses by local communities.
Several studies related to post-disaster reconstruction ([5] and [6]) shows that to achieve success in post-disaster recovery, especially the reconstruction of housing, there are several factors that must be met, such as: Public Participation, Capability Stakeholder-related disasters, Source Human Resources and Financial Aspects, clear System Implementation and Sustainability Program.

Implementation of community-based housing reconstruction be the backbone of sustainable development ([7] in [5]). Through this approach, it is hoped that people can realize the importance of building a building using earthquake resistant building structures.

Implementation The pre-construction phase of post-disaster housing reconstruction The earthquake in West Sumatera based on the community was found to be at every stage of the Stage, both at Idea stage, recruitment and training of facilitators, assessment of housing damage, identification and land ownership identification, program socialization, community organization formation, community / workers as well as the stage of designing the building and use of building materials in terms of the cost, quality, time and satisfaction [3].

Reconstruction of post earthquake disaster Earthquake in West Sumatra is carried out independently between the affected communities, government, non-governmental organizations (NGOs) both from within and from abroad. Housing reconstruction after the disaster Earthquakes do with community based in West Sumatera based research [8] experienced some risks into risks that have a major impact on the development phase one of which is the problem of rising prices of building materials, the researchers propose strategies in overcoming these problems one Regarding the supply of building materials, controlling prices for building materials and making materials independently by the community.

This research needs to be done by modeling the Risk Management with Phase Pre - construction Housing Reconstruction Based Society Post-Earthquake terms of the threat (Hazard), decrepitude (Vulnerability) and capacity (capacity) in the respective stages have a more in-depth [9].

2. Literature Review
A. Understanding Disaster
Disaster is basically an event or series of events that threaten and disrupt the lives and livelihoods of the people caused by both natural and / or non-natural factors and human factors resulting in the occurrence of human casualties, environmental damage, property loss, and psychological impact [10].

B. Disaster Management
Integrated and sustainable cross-cutting processes in order to prevent and mitigate risks from disasters include mitigation, awareness, response to disasters, and recovery efforts. In general, risks can be formulated as follows (Figure 1 and Formula 1):

![Crunch Model](image)

**Figure 1. Crunch Model, [11]**

The relationship between Risk, Hazard, Vulnerability and Capacity presented in the following formula [12].

\[
(R) = (H) * (V) / (C)
\]

Where :
- \( R \) = Risk
- \( H \) = Hazard
- \( V \) = Vulnerability
- \( C \) = Capacity
Risk analysis to measure how much risk occurs due to vulnerability and capacity in facing the threat of risk. Analyzes were performed using Equation 1. [12] in the previous formula.

C. Sources of Risk (Risk Source)

In operational risk can be described as the relationship between the three parts, namely the existence of danger or threats (hazards) and vulnerability and capacity in an area (housing), while the disaster can be described risks that have occurred and cause harm to the community.

Hazard

Definition of Hazard by (FEMA, 1997 in [13]):

"Hazards are events or physical conditions have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss”.

Hazard is a physical condition that has the potential of causing damage or casualties (such as death, disability or injury, damage to property, infrastructure and agriculture, the disruption of the economy). It can be said that the danger or potential of an external actor as a trigger source of disaster, according to [13], hazards can be grouped into three types, namely natural hazards, technological hazards, and Intentional hazard. For Natural Hazard can be subdivided; Tectonic hazards; Mass-Movement Hazards; Hydrologic Hazards; Meteorological Hazards; Biological / Health-Related Hazard; Other Natural Hazards. To Technological Hazard can be grouped into; Transportation Hazards; Infrastructure Hazards; Industrial Hazards; Structural Fires and Failures. Intentional hazard to include Civil and political hazards.

Identify potential disasters or hazards [13], can be used methods such as: Brainstorming, Research of the country’s disaster and emergency history, Reviews of existing plans, Investigation of Similar hazard identification Efforts in neighboring countries, Use of maps, Interviews, site visits To public or private facilities.

Hazard as elements that affect the risk, according to the Emergency Management Australia [14] needs to be described potentially catastrophic hazard profile map based on community profiles. This map contains information such as: Geography, Property, Infrastructure, Demographics and Respondese Agencies.

The potential for disaster or hazard as a map, must contain an information format that is easy to read and understand. Such information includes, among others: Name of the hazard, General description of the hazard, frequency, magnitude and potential intensity, Location(s), Estimated spatial extent of impact, Duration, Seasonal pattern or other time-based patterns, speed of onset, And Availability of warnings for the hazard.

Vulnerability

Vulnerability [15], are:

"A set of contents and processes resulting from the physical, social, economical and environmental factors, which enhance the susceptibility of a community to the impact of hazards".

Vulnerability is a condition of the area or the built environment that is unsafe or at risk of being impacted by a hazard. These unsafe conditions can be physical environments, local economies, social relationships and understanding of local institutions. Process terbentukya which cause an unsafe condition (vulnerable) can be started from the factors of pressure or influence from outside (exposure), among others, issues of economic, demographic, political, legal, social, or other elements that are not in harmony, plus a lack of the ability of government officials Local, and the lack of applicable rules. Other factors are the root of the problem, namely the limited ability to build and limited resources, low capacity or understanding of various components of society in building the built environment.

Vulnerability is a characteristic of a person or group of surrounding circumstances which affect the capacity to anticipate, confront, defend and recovery from the impact of hazards. How large a society or building, service or area will get damaged or disturbed by the impact of a particular hazard, depends on its condition, type of construction, and proximity to a hazardous area, Vulnerability may be the potential for damage, loss, interruption or form other loss can be a loss of life, property and other assets are buildings, roads bridges or other utility.
Capacity
Capacity is the ability of communities to cope with disasters and their impact and restore the original state for all phases, through a variety of systems being developed as well as using existing resources (UN, 2007). Capacity is the overall combination of strength, completeness, and resources owned by the organization that can be used to achieve agreed goals including those related to risk reduction [16]. Scale assessment of the likelihood of the occurrence of risk events identified problems in construction projects use a scale of likelihood (frequency / probability) as in Table 1.

Table 1. Frequency Scale (Likelihood), ([17] in [18])

| No. | Frequency Rate | Scale |
|-----|----------------|-------|
| 1   | Very rarely    | 1     |
| 2   | Rarely         | 2     |
| 3   | Sometimes      | 3     |
| 4   | Often          | 4     |
| 5   | Very often     | 5     |

While the scale of assessment of the effect of an event on the occurrence of problems in construction projects using a scale consequences (consequences) as shown in Table 2.

Table 2. Scale Consequences, ([17] in [18])

| No. | Frequency Rate | Scale |
|-----|----------------|-------|
| 1   | Very small     | 1     |
| 2   | Small          | 2     |
| 3   | Medium         | 3     |
| 4   | Big            | 4     |
| 5   | Very large     | 5     |

From the scores given by the respondents on each risk identification can be determined that data mode as a representation of respondents' opinions on the risks that have been identified. Referring to the scale of acceptance of risk (risk acceptability) by [17] and [18], taking into account the scale of consequences and likelihood scale as above, then arranged a scale of risk acceptance and risk the level of interest shown in Table 3 and Table 4.

Table 3. Risk Acceptance Scale, ([17] in [18])

| Risk Acceptance       | Acceptance Scale |
|-----------------------|------------------|
| Unacceptable          | X ≥ 12           |
| Undesirable (not expected) | 5 ≤ X <12         |
| Acceptable            | 2 ≤ X <5         |
| Negligible (skippable)| X <2             |

Table 4. Risk Importance ([17])
Based on the acceptance of this risk then an evaluation of the risks identified in the questionnaire that require mitigation actions. The criteria for the risks that require mitigation actions are risks that are dominant, are all unacceptable risk and undesirable (not expected).

Every risk Rated on Probability To happen and Impact on aim if occur. Threshold organization For risk low, medium or high showed In the matrix & Determine whether risk The rated as high risk, Medium or low.

D. Risks On Post-Disaster Housing Reconstruction Project

A construction project has more risks and uncertainties than other industries such as manufacturing [19]. Because post-disaster situations are more complex than normal situations, the risks for post-disaster housing reconstruction projects are higher than construction projects in the normal environment. Specific challenges in the post-disaster reconstruction is that it involves several actors, does not have the local capacity, have limited funds, the high demand for accountability and the need for rapid reconstruction [20].

In dealing with risks, the construction industry has recognized that risk management is an important factor in achieving the project objectives [21], minimize losses and improve profitability [22]. However, risk management practices have not become common practice in projects of post-disaster housing reconstruction [23].

Reconstruction of post earthquake disaster Earthquake in West Sumatra is carried out independently between the affected communities, the government, Non-Governmental Organizations (NGOs) both from within and from outside the country. Housing reconstruction after the disaster Earthquakes do with community based in West Sumatera based research [3], experienced some risks into risks that have a major impact on the development phase, namely the problem of rising prices of building materials, the researchers propose strategies in addressing the issue one about supply Building materials, controlling the price of building materials and making materials independently by the community.

Implementation of post-disaster housing reconstruction in West Sumatra Earthquake-based society [3], there are eight (8) stages in the risk of implementation, namely:

1. The idea stage,
2. Phase Recruitment and training of facilitators,
3. Damage judging stages of Housing,
4. Verification Phase Identification and Tenure,
5. Phase Socialization Program,
6. Phase Formation Masyrarakat Organization,
7. Training Stage Community / Labor Building, and
8. As the design phase, use of Building Materials Housing affected communities

3. Research Methodology

Research housing reconstruction post-disaster community based in the coastal areas of West Sumatra that is prone to earthquakes and tsunamis do initial phase is the determination of the level of importance of each phase and the risk with the experts relevant fields (there are 7 people ekpert), the second administration of the questionnaire To the affected communities by the number of samples given as many as 330 respondents (as can be seen in table 1 previously) is divided into three areas:
Region I includes: Padang City
Region II includes: Pesisir Selatan Reg, Agam Reg, Pasaman Barat Reg, Pasaman Reg, and Pariaman City.

Region III includes: Padang Pariaman Reg
Research conducted since December 2015 until May 2016 against the expert related to the problem of housing reconstruction after the earthquake and the people affected by the earthquake.

3.1 Data collection technique
This research is research with survey method, that is research method with data from sample which will generalize research population. In this study the data we will need is as follows:

3.2 Primary data
Primary data were obtained by means of survey in the form of a list of questions given to respondents by using a questionnaire (the spread of the community affected by the earthquake disaster).

3.3 Secondary Data
Secondary data is taken from various sources for the purposes of this study, such as journals, articles proceedings, research reports and data from relevant agencies in it.

3.4 Research Instruments
This research material originated from natural disasters occurring in Indonesia and the increasing demand for settlements by our community. Recent natural earthquake disasters occur frequently in Indonesia including in the Padang - West Sumatra research area requiring analysis of the vulnerability of this disaster to the area. Therefore in accordance with the characteristics of the problem required primary data in accordance with the needs of research in order to support the achievement of this research objectives.

Primary data obtained from research instruments in the form of questionnaires distributed to respondents and supported by interviews either directly (face to face) or indirectly (through communication tools). The research instrument is in the form of a field in which there are questions related to the research of the researcher, the answer of this research must be answered by the respondent objectively, so that the answer can describe the actual situation.

Secondary data is taken from various sources for the purposes of this study, such as journals, articles proceedings, research reports and data from relevant agencies in it.

4. Research Result
Respondents are the people whose houses are affected by the earthquake. Respondents consisted of 240 respondents, the participation of respondents in this study is quite satisfactory, where the average participation rate is 72.73%. The rate of return = 72.73% > 70% is a very good rate of return [24]. The occupation of respondents is dominated as private / farmer / trader, highest male gender 53.3%, age of respondent most aged more than 55 year equal to 45%, highest education respondent maximum SMU 40% from total respondent.

Things to do first of jawan respondent is to test the validity and reliability of the questions raised (there are 90 pieces of questions), Rule-making: If \( t > t_{\text{table}} \) means valid, the opposite of \( t_{\text{arithmetic}} \leq t_{\text{table}} \) means is invalid, or can be seen from the level of significance, if the sign \(<0.05\) then the data is valid and if the sign \(\geq 0.05\), then the data is invalid [25], is only one of the questions that is R8.6. Community Participation in Design with Pearson Correlation value = -.011, Sig value. (2-tailed) = 0.871 > 0.05 which means invalid. Results Cronbach's Alpha for 90 questions Risk pre-construction phase of the reconstruction of post-disaster community-based housing Earthquakes have a value of 0.949, the value is greater than the minimum limit is 0,600 questions on the questionnaire indicated that the study made was realibel [26].

Second, factor analysis is done to reduce the questions that can not be continued because it has correlation value less than 0,500. There are 10 questions that must be reduced / released for further analysis, so there are only 80 questions (see Table 5. below)
Table 5. Reduced Risk

| Iterate  | Risk     | The value | KMO  |
|----------|----------|-----------|------|
| Iteration 1 | R.8.6    | 0.252     | 0.768 |
| Iteration 2 | R.6.7    | 0.279     | 0.777 |
| Iteration 3 | Q.6.6    | 0.301     | 0.781 |
| Iteration 4 | R.6.1    | 0.371     | 0.792 |
| Iteration 5 | R.3.4    | 0.385     | 0.798 |
| Iteration 6 | R.6.8    | 0.445     | 0.804 |
| Iteration 7 | R.7.7    | 0.461     | 0.805 |
| Iteration 8 | R.5.5    | 0.460     | 0.807 |
| Iteration 9 | R.5.6    | 0.487     | 0.813 |
| Iteration 10 | R.2.11   | 0.489     | 0.816 |
| Iteration 11 | -        | -         | 0.823 |

Table 6. Based on the results with the whole question of risk has a significance level of 0.000 which is less than α = 0.05 states that the whole question is based on one test-sample t test yielded significant results (t > t table = 1.960) [25].

Table 6. The Undesirable (not expected) Risk Level of Housing Reconstruction Post-Earthquake Disaster Based on Communities

| No | Activities                                      | Mean  | t    | Sig. (2-) |
|----|-------------------------------------------------|-------|------|-----------|
|    | Stage 1 Ideas                                   |       |      |           |
| 1  | R1.2. Local Government Capacity                 | 5.1417| 75.103| .000      |
| 2  | R1.3. Government Support                         | 5.1684| 72.019| .000      |
| 3  | R1.5. Funding Stage of Ideas                    | 5.0231| 56.459| .000      |
| 4  | R1.7. Coordination and Community                | 5.0603| 78.538| .000      |
|    | Phase 2 Recruitment and Training of Facilitator |       |      |           |
| 1  | R2.8. Facilitator's Experience                  | 5.1898| 75.749| .000      |
|    | Phase 3 Damage Assessment Housing               |       |      |           |
| 1  | R3.2. Pressure of local authorities in Damage    | 5.0831| 70.302| .000      |
| 2  | R3.6. Involvement of the whole community         | 5.2020| 74.685| .000      |
| 3  | R3.8. Damage Assessment Method                  | 5.0946| 71.021| .000      |
| 4  | R3.9. Data Base Housing                         | 5.1243| 71.096| .000      |
| 5  | R3.10. Access Transportation in the assessment of| 5.1042| 68.550| .000      |
|    | Stage 4 Benefits of Land Identification and Ownership |        |      |           |
| 1  | R4.7. Validation Identify land ownership         | 5.0750| 69.633| .000      |
| 2  | R4.9. Access Transportation in Identification and| 5.1398| 68.764| .000      |
|    | Stage 5 Socialization Program                   |       |      |           |
| 1  | R5.9. Socialization Schedule                    | 5.0195| 68.497| .000      |
|    | Phase 6 Establishment of Community Organizations |       |      |           |
|    | Stage 7 Community / Workers Training            |       |      |           |
| 1  | R7.9. Number of Laborers                        | 5.0497| 69.805| .000      |
|    | Stage 8 Design Housing and Building Materials   |       |      |           |
| 1  | R8.3. Knowledge of the Facilitator              | 5.1734| 68.254| .000      |
| 2  | R8.8. Number of documents                       | 5.0623| 71.779| .000      |
| 3  | R8.15. Lack of Utilization of the rest of the building | 5.0680| 74.132| .000      |
| 4  | R8.16. Prices of building materials             | 5.3894| 78.385| .000      |

Based Descriptive analysis and factor analysis of 80 items remaining questions, there are 18 (eighteen) the risk of pre-construction project of housing reconstruction after the earthquake based society including the risk of unexpected (Undesirable). From 8 (eight) Stages Stage pre-Construction of the reconstruction of housing there is 1 (one) Stages of risk is still acceptable that is Phase 6 (Stages of Establishment of Community Organizations).

The stages in addition to the above mentioned stages have unexpected risk, such as:
Phase 1 (idea) there are 4 (four) the risk of unintended ie: Local Government Capacity , Government Support Funding idea stage and Coordination and Communication Society.

Phase 2 (Recruitment and Plates the facilitator) 1 (one) the risk of unintended namely: Experience Facilitator.

Phase 3 (Evaluation of Damage Housing) there are five (5) co unexpected uncomfortable namely: pressure from local officials in Damage, involvement of the entire community, Damage Assessment Method, Data Base Housing and transportation access in residential damage assessment.

Stage 4 (Benefits Identification and Tenure) there are two (2) risk unexpected, namely: Validate Identification of ownership of land and transportation access in identification and land ownership.

Stage 5 (Socialization Program) 1 (one) the risk of unexpected, namely: Schedule socialization.

Stage 7 (Training Community / Labor) 1 (one) the risk of unintended namely: Total Labor.

Stage 8 (Housing Design and Building Materials) there are four (4) risks that are not expected, namely: Knowledge Facilitator, number of documents, Lack of utilization of material leftover rubble and building material prices.

The biggest risk is in Stage 8 is R.8.16 ie Building Material Price which has the biggest risk value is: 5,389. Where automatically after the earthquake disaster all prices rise significantly including the price of building materials. As research [8], there were a significant risk is the increase in the price of the building, which the researchers suggest that the government simplify the bureaucratic process and make regulations for the control of prices of building materials is a challenge for the government to speed up the reconstruction process.

At the stage of the idea there are four unacceptable risks, four risks at this stage come from the government such as government capacity, government support, funding and the failure of government to communicate well with the community, this can be reduced by increasing the capacity at each risk unexpected such as: establish good cooperation with NGOs, NGOs, universities and other stakeholders, cooperating with outsiders for funding following the disaster by making regulations / rules are straightforward and improve communication and coordination with other stakeholders [27].

Facilitator recruitment and training stage there is an unexpected risk: Experience of Facilitator, generally many inexperienced, fresh graduate. The government provides intensive training of facilitators and collaborates with higher education institutions to incorporate this disaster management in their respective college curriculum.

Housing Damage Assessment Phase five unexpected risks, namely: Pressure local authorities in the assessment of damage, the entire community involvement in assessment, Damage Assessment Method, Data Base Housing and transportation access in residential damage assessment. Overcoming these problems the government made the rules to minimize pressure from the local apparatus by involving community leaders, ninik mamak and smart cadiak. In addressing the valuation method, too many people involved in the assessment, the less data base once again, the role of government to build housing systems integrated data base such as the use of GIS, manufacture Building Code for each region. Overcoming the problem of transportation, the government prioritizes transportation improvements quickly and precisely as in Japan access to transport is the main thing that is done there [28].

Phase Benefits of Land Ownership Identification And there are two risks are not expected, namely: Validate Identification of ownership of land and transportation access in identification and land ownership. As in the previous stage, the role of the government utilizes the GIS system for the development of land and building ownership in their respective regions and to improve the transportation system immediately.

Socialization Program stage there is a risk that did not expect: a very short socialization schedule, here the government to use computerized telecommunications systems and better so as to shorten the time / schedule socialization.

The Community / Worker Training Stage has an unexpected risk: Labor, the shortage of workers can be tackled by the government by intensively training communities on the construction of earthquake-safe housing, bringing in laborers from other regions.
Stage Design Housing and Building Materials, there are four risks are not expected, namely: Knowledge Facilitator, number of documents., Lack of utilization of residual materials rubble and the price of building materials, can be reduced that risk by increasing the capacity of existing in the area such as coupling the colleges, Streamlining documents that must be checked and approved, providing training and knowledge of the utilization of building materials to the community in more depth and price of building materials as discussed earlier. [30]

5. Conclusion
With this risk analysis it is hoped that the parties concerned can pay more attention to the risks that have high value (categorized as an unexpected risk).

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