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Disaster Mitigation Strategy in Urban Slum Areas of Palu Based on ISO 31000:2018 Risk Management (Case Study of Lere and Talise Sub-Districts)

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Abstract: The slum areas of Lere and Talise Sub-districts in Palu City face infrastructure limitations, high settlement density, and very high threats from earthquakes, tsunamis, and liquefaction. The vulnerable communities living in these areas are often not involved in the formulation of mitigation policies. This study aims to analyze the level of disaster risk and formulate a mitigation strategy based on ISO 31000:2018, encompassing prevention, preparedness, response, and recovery.

The research employed a sequential explanatory mixed-methods approach using a questionnaire instrument administered to 58 resident respondents, in-depth interviews with 5 key informants (Heads of Lere and Talise Sub-districts, Regional Disaster Management Agency/BPBD, Housing and Settlement Office/Perkimtan, Public Works and Spatial Planning Office/PUPR), and field observations. The results show a very high risk level for earthquakes in Lere (19.28) and Talise (19.17), and a very high risk for tsunamis in Lere (17.72) and Talise (18.05). Liquefaction risk is high in Lere (12.55) and moderate-high in Talise (10.34), while flood risk is high in Talise (12.77) and moderate-high in Lere (10.00).

The formulated mitigation strategies include drainage normalization, retaining wall repair, routine evacuation training, the formation of a Disaster Alert Task Force (SATGANA) at the neighborhood (RT) level, strengthening early warning systems, and economic empowerment programs. The study concludes that humane, participatory mitigation strategies rooted in local values are essential to protect the fundamental rights of slum residents to live safely and with dignity.

Keywords: *Disaster Mitigation, Slum Areas, ISO 31000, Lere, Talise, Risk Management, Community Resilience.*

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I. INTRODUCTION

Slum areas are densely populated settlements that grow organically due to economic limitations, with restricted access to clean water, sanitation, and decent housing (Ministry of Public Works and Public Housing/PUPR, 2018). Based on the level of slum severity, these areas are classified into four categories: non-slum, mild slum, moderate slum, and severe slum.

Palu City is one of the regions in Indonesia with several slum locations highly vulnerable to natural disasters such as earthquakes, tsunamis, and liquefaction, as occurred in 2018 (Paulik et al., 2019). The disaster that struck Palu City on September 28, 2018, caused thousands of casualties and massive infrastructure damage, turning the city into a natural laboratory for disaster studies.

Furthermore, slum areas in Palu City, such as Lere and Talise Sub-districts, also face significant disaster risks due to population density, infrastructure limitations (Saputra & Hermansyah, 2022), and low public awareness of disaster mitigation (Muis & Anwar, 2018). This condition is exacerbated by poorly planned spatial layouts, increasing vulnerability to disaster impacts.

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The existence of slum areas in Palu City is also related to the socio-economic factors of the community, which tend to have limited access to disaster resources and information. The community's low adaptive capacity increases the potential for loss of life and property (Wekke, 2021).

Behind the simple houses and narrow alleys in Lere and Talise Sub-districts, thousands of families live with extraordinary resilience (Ahmed, 2014), despite being haunted by the risks of earthquakes, tsunamis, and liquefaction. They live on vulnerable land not by choice, but due to economic constraints and unaccommodating spatial planning.

ISO 31000:2018, as an international risk management framework, can serve as a reference for formulating structured and effective disaster mitigation strategies. This standard provides systematic risk management principles, frameworks, and processes. The ISO 31000:2018-based approach enables risk identification, analysis, evaluation, and determination of appropriate control measures.

By utilizing the ISO 31000:2018 matrix, mitigation strategies can be systematically designed, covering prevention, preparedness, and post-disaster recovery aspects (Asnudin et al., 2026). This is highly relevant for implementation in Lere and Talise Sub-districts given the high disaster threat and the need for measurable risk management.

Previous research on the application of ISO 31000:2018 has been conducted by Pratiwi et al. (2024) on a locomotive depot construction project in Maros, Sugiyanto et al. (2023) for disaster mitigation in Lombok, and Chaidir et al. (2020) for SPBE operational risk management in Bandung City. However, no research has specifically adapted the ISO 31000:2018 framework for urban slum areas with multi-hazard characteristics like those in Palu.

Research by Asnudin et al. (2024) on post-disaster housing in the Palu-Koro Fault area and technical studies on relocation (Asnudin, 2025) provide an essential foundation, but their focus is on post-disaster housing rather than existing slum areas. Therefore, this study fills this gap by examining appropriate mitigation strategies for occupied slum areas with complex socio-economic dynamics.

Based on the description above, this study aims to: (1) analyze the level of disaster risk in the slum areas of Lere and Talise Sub-districts using the ISO 31000:2018 risk matrix approach; and (2) formulate a disaster mitigation strategy based on ISO 31000:2018 that includes prevention, preparedness, response, and recovery measures to reduce disaster risk in both sub-districts.

This research is expected to contribute to the development of disaster management science, particularly in applying the ISO 31000:2018 framework to the context of disaster-prone urban slum areas.

II. MATERIALS AND METHODS

- *Type and Approach of Research*

This study employs a mixed-methods approach (combining quantitative and qualitative data) with a sequential explanatory design (Creswell & Clark, 2017). This approach was chosen to obtain a comprehensive and complementary understanding.

In the first phase, quantitative data were collected through structured questionnaires to measure the level of risk based on respondents' perceptions. In the second phase, qualitative data were collected through in-depth interviews, field observations, and documentation studies to validate and enrich the quantitative findings.

- *Location and Time of Research*

The research was conducted in the slum areas of Lere Sub-district (West Palu District) and Talise Sub-district (North Palu District), Palu City. These two sub-districts were designated as priority slum areas for handling based on the 2024 Determination of Slum Housing and Slum Settlement Locations of Palu City. The research was carried out over 3 months.

- *Population and Sample*

The research population was all heads of families (KK) living in the slum areas of Lere Sub-district (52 KK) and Talise Sub-district (32 KK). Quantitative sampling used simple random sampling with the Slovin formula (margin of error 10%), resulting in 58 resident respondents (Lere=34, Talise=24).

The qualitative sample used purposive sampling with 5 key informants: the Heads of Lere and Talise Sub-districts, a Disaster Management Functional Officer from the Palu City BPBD, a Staff/Project Management Officer (PPK) from the Palu City Perkimtan Office, and a Staff/PPK from the Palu City PUPR Office.

- *Variables and Indicators of Research*

This study uses three main variables. The slum area characteristics variable includes building density, distance between houses, availability of basic infrastructure, drainage conditions, environmental conditions and green open space (RTH), and land ownership status.

The disaster risk variable includes the frequency of earthquake threats, physical condition of buildings, building materials, knowledge and preparedness, knowledge of evacuation routes, family anticipation plans, and potential material loss.

The mitigation strategy variable includes government policies, the role of community leaders, application of risk management, and multi-stakeholder collaboration. All indicators were measured using a 1-5 Likert scale.

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➢ *Data Collection Techniques*

Data collection was carried out through four techniques. First, a 1-5 Likert scale questionnaire distributed to 58 resident respondents. Second, semi-structured in-depth interviews with 5 key informants. Third, field observations using a structured observation sheet. Fourth, documentation studies to review regulatory documents, disaster hazard maps, and program reports.

➢ *Instrument Validity and Reliability*

Instrument validity was tested through content validity and construct validity. Construct validity used item-total correlation analysis with Corrected Item-Total Correlation on 58 respondents. With df = 56 and $\alpha = 0.05$, the r-table value was 0.264. All items had values > 0.264, thus declared valid. Reliability testing using Cronbach's Alpha method yielded a value of 0.901 (> 0.7), indicating that the instrument is reliable with a very high level of dependability. The Kolmogorov-Smirnov normality test showed a significance value > 0.05, indicating normally distributed data.

➢ *Data Analysis*

Data analysis was performed in three stages. First, descriptive statistics to describe sample characteristics. Second, the ISO 31000:2018 risk matrix using the formula: **Risk = Likelihood × Consequence**. The multiplication results were mapped onto a risk matrix with categories: 1-5 (very low), 6-10 (low), 11-15 (moderate), 16-20 (high), 21-25 (very high). Third, mixed-methods data integration was carried out by deepening quantitative findings using qualitative data as a basis for formulating mitigation strategies.

III. RESULTS AND DISCUSSION

➢ *General Overview of the Research Area*

Lere Sub-district has a slum area of approximately 3.12 Ha with approximately 52 KK, while Talise Sub-district has an area of approximately 1.17 Ha with approximately 32 KK. Observation results show that both sub-districts have fairly dense building density with alleys 1-2 meters wide, predominantly permanent building quality (concrete/brick), and have functioning signs and sirens.

Differences are seen in basic infrastructure (Lere adequate, Talise partially non-functional) and environmental conditions (Lere limited RTH, Talise mildly polluted). Both lack risk maps, standard operating procedures (protap), or evidence of multi-stakeholder collaboration.

➢ *Respondent Characteristics*

Resident respondents were predominantly male (74.1%), aged 46-60 years (41.4%), working as fishermen (27.6%), laborers (22.4%), and traders (22.4%). Average income was approximately IDR 1,976,000/month (below the Palu minimum wage/UMK). Agency respondents numbered 5 people with educational backgrounds ranging from Bachelor's (S1) to Master's (S2) degrees.

➢ *Analysis of Slum Area Characteristics*

Building density in both sub-districts falls into the fairly dense to dense category (mean 3.33), with a distance between houses of 1-2 meters (mean 3.24). This condition makes access for emergency vehicles difficult, evacuation routes inadequate, and increases the risk of fire propagation.

Basic infrastructure is not yet optimal (mean 2.54-2.88). The availability of drainage, clean water, and sanitation scored 2.79 (fair, needs improvement). Drainage conditions during heavy rain scored 2.57 (light-moderate inundation). Environmental cleanliness and RTH scored 2.54 (fairly managed-mildly polluted).

Land ownership status: 34.5% fully certified, 27.6% in certification process, 25.9% state land, 8.6% disputed, 3.4% eviction conflict. Unclear land status hinders relocation, house repairs, and spatial planning.

➢ *Disaster Risk Analysis*

- *Hazard Identification*

Lere and Talise Sub-districts have a very high risk of earthquakes and a high to very high risk of tsunamis. Lere has a moderate-high risk of liquefaction and moderate flood risk. Talise has a low-moderate risk of liquefaction and a moderate-high risk of floods.

- *Physical Vulnerability*

Building conditions: 41.4% minor cracks, 32.8% moderate damage, 12.1% severe damage, 10.3% safe structure, 3.4% collapsed. Dominant material is concrete/brick (48.3%) but not earthquake-resistant due to building age and the impact of the 2018 earthquake.

- *Economic Vulnerability*

Potential material loss reaches 25-50% of total assets, indicating limited economic capacity for post-disaster recovery.

- *Community Capacity*

Preparedness knowledge mean 2.59 (knows the basics). Knowledge of evacuation routes mean 3.31 (only have heard of them). Anticipation plan mean 3.52 (have only just discussed it). Evacuation drills have never been conducted.

➢ *Risk Level Calculation*

Based on the formula Risk = Likelihood × Consequence, the following results were obtained:

Table 1. Disaster Risk Assessment in Lere and Talise Sub-Districts

Disaster Type	**Lere**	**Talise**	**Category**
Earthquake	19.28	19.17	Very High
Tsunami	17.72	18.05	Very High
Liquefaction	12.55	10.34	High (Lere) / Moderate-High (Talise)

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Disaster Type	Lere	Talise	Category
Flood/Inundation	10.00	12.77	Moderate-High (Lere) / High (Talise)

Earthquakes have the highest risk value in both sub-districts (very high). Tsunamis are also very high. Liquefaction is more risky in Lere due to active fault zones. Floods are more risky in Talise due to non-functional drainage and lower topography.

Main priorities: earthquakes in Lere and Talise, followed by tsunamis. Liquefaction is a priority in Lere, floods are a priority in Talise. All actions are integrated because earthquakes can trigger simultaneous tsunamis and liquefaction.

➢ *Analysis of Existing Mitigation Strategies*

Existing mitigation strategies are not yet optimal: government policies are incidental (mean 3.41), the role of community leaders is routine coordination (mean 2.59), risk management implementation is unsystematic (mean 3.83), multi-stakeholder collaboration has minimal communication (mean 4.02).

Based on interviews, mitigation programs are incidental, the budget is limited, evacuation route maps are damaged and have not been socialized, evacuation drills have never been conducted, and coordination with BPBD is poor.

Gap analysis shows that context establishment is not yet formal, risk identification does not involve residents, risk analysis does not use a standard matrix, risk evaluation lacks criteria, risk treatment is incidental, communication is minimal, and monitoring is not carried out.

➢ *Formulation of Mitigation Strategies Based on ISO 31000:2018*

- *Prevention Strategy.*

Drainage normalization prioritized for Talise (2027-2028), retaining wall repair prioritized for Lere (2027-2028), repair of uninhabitable buildings (2027-2030). Updating disaster hazard zone maps (2027), voluntary relocation from red zones (2027-2029) targeting 50% moved, provision of relocation land (2027-2028), land asset legalization (2027-2030) targeting 80% certified.

Table 2. Infrastructure Prevention Strategy

No	Strategy	Location	Implementer	Target Time
1	Drainage normalization	Talise	PUPR Office	2027-2028
2	Retaining wall repair	Lere	PUPR Office	2027-2028
3	Repair of uninhabitable buildings	Entire area	Perkimtan Office	2027-2030

- *Preparedness Strategy.*

Evacuation training twice/year starting 2027 targeting 80% of residents trained. Formation of SATGANA per RT (2027) with a minimum of 5 cadres. Socialization of evacuation routes (2027) targeting 100% resident awareness. Evacuation drills once/year targeting response time <10 minutes.

Installation of evacuation signs (2027), procurement of sirens (2027-2028), integration of EWS with BMKG targeting warning time <3 minutes (2027), development of a standby WhatsApp group per RT (2027).

Table 3. Preparedness Strategy

No	Strategy	Implementer	Target Time	Indicator
1	Evacuation training 2x/year	BPBD, Sub-district	Starting 2027	80% trained residents
2	Formation of SATGANA per RT	BPBD, Sub-district	2027	5 cadres/RT
3	Socialization of evacuation routes	BPBD, Sub-district	2027	100% resident awareness
4	Evacuation drill 1x/year	BPBD, Sub-district	Starting 2027	Time <10 minutes
5	EWS integration with BMKG	BPBD, BMKG	2027	Warning time <3 minutes

- *Emergency Response Strategy*

Strengthening 24-hour standby posts (2027), provision of emergency logistics for 1,000 people (2027), development of SOPs for evacuating vulnerable groups (2027), basic first aid (P3K) and SAR training for 100 cadres (2027-2028).

- *Recovery Strategy*

Database of vulnerable residents updated every 6 months (2027), trauma healing services for 500 people (2027-2028), house repair assistance for 100 units/year (2027-2028). Economic empowerment program for 500 residents (2027-2030), environmental rehabilitation recovered within 6 months (2027-2030), revision of spatial plan (RTRW) integrated with risk maps (2027-2028).

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Table 4. Emergency Response and Recovery Strategies

No	Strategy	Implementer	Target Time
1	Strengthening 24-hour standby posts	BPBD, Sub-district	2027
2	Provision of emergency logistics	BPBD, Social Office	2027
3	Basic first aid and SAR training	BPBD, Indonesian Red Cross (PMI)	2027-2028
4	Database of vulnerable residents	Sub-district, Social Office	2027
5	Economic empowerment program	Cooperatives & SMEs Office	2027-2030

➢ *Synthesis and Implications of the Research*

- *Theoretical Implications*

This research confirms the adaptability of ISO 31000:2018 for urban slum areas, develops a contextual multi-hazard risk matrix (earthquake, tsunami, liquefaction, flood), identifies key vulnerability factors (building density, distance between houses, physical condition of buildings, knowledge of evacuation routes), and strengthens the concept of participatory mitigation with local wisdom.

- *Practical Implications*

Recommendations for the Palu City Government: draft a Mayor's Regulation (Perwal) on disaster mitigation in slum areas, integrate risk maps into the RTRW, allocate a sustainable special budget.

Recommendations for BPBD: adopt the ISO 31000:2018 risk matrix, conduct routine evacuation drills once/year, build an integrated early warning system.

Recommendations for the Perkimtan and PUPR Offices: integrate slum management programs with disaster mitigation, prioritize drainage repair in Talise and retaining wall repair in Lere, facilitate land asset legalization.

Recommendations for the community: form and activate SATGANA per RT, actively participate in evacuation drills, prepare family anticipation plans and emergency supplies.

➢ *Research Limitations*

This study has limitations: (1) quantitative data is perceptual, (2) the data collection timeframe is limited, (3) focus on non-structural and policy aspects, (4) generalizability is limited to the context of Lere and Talise Sub-districts.

IV. CONCLUSIONS

Based on the research conducted in the slum areas of Lere and Talise Sub-districts, Palu City, using the ISO 31000:2018 risk management framework, the following conclusions are drawn:

➢ *Level of disaster risk in both sub-districts is classified as very high for earthquakes (Lere 19.28; Talise 19.17) and tsunamis (Lere 17.72; Talise 18.05). Liquefaction: high in Lere (12.55), moderate-high in Talise (10.34). Floods: high in Talise (12.77), moderate-high in Lere (10.00).*

Physical vulnerability: 74.2% of buildings have minor cracks to moderate damage, distance between houses is 1-2 meters, basic infrastructure is not yet optimal. Community capacity is low: preparedness knowledge mean 2.59 (knows the basics), evacuation drills have never been conducted.

➢ *Mitigation strategy based on ISO 31000:2018 was formulated in phases (2027-2030) including:*

- Prevention: drainage normalization in Talise, retaining wall repair in Lere, repair of uninhabitable buildings, voluntary relocation from red zones.
- Preparedness: routine evacuation training twice/year, formation of SATGANA per RT, installation of signs and sirens, socialization of evacuation routes, strengthening of 24-hour standby posts.
- Emergency response: strengthening standby posts, provision of logistics, SOP for evacuating vulnerable groups, first aid training.
- Recovery: data collection on vulnerable residents, trauma healing services, economic empowerment programs, environmental rehabilitation, revision of spatial plan integrated with risk maps.

All strategies are designed to be implemented in phases with the hope that the residents of Lere and Talise can live more safely, peacefully, and resiliently in the face of disasters.

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