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Assessment of Building Damage Levels and Methods to Accelerate the Rehabilitation of Madrasah Schools in North Lombok Regency

Faried Ma'ruf*, Hariyadi, Buan Anshari
Universitas Mataram, Indonesia
Email: faried.maruf2022@gmail.com*, hariyadi@unram.ac.id, buan.anshari@unram.ac.id

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ANP;

ABSTRACT
North Lombok Regency remains vulnerable to earthquakes, and damage to madrasah buildings continues to disrupt safe learning environments. This study aimed to assess the level of building damage and formulate priority strategies for accelerating madrasah rehabilitation in the region. A mixed-methods approach was applied to 12 madrasahs comprising 65 buildings. Data were collected through visual assessments of structural, architectural, and utility components based on Circular Letter No. 47/SE/DC/2020. The findings were analyzed using Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, Internal Factor Analysis Summary (IFAS), External Factor Analysis Summary (EFAS), and the Analytic Network Process (ANP) using Super Decisions 2.10. The results showed that 42 buildings (64.62%) were slightly damaged, nine buildings (13.85%) were moderately damaged, and 14 buildings (21.54%) were severely damaged. IFAS and EFAS scores of 0.80 and 0.25, respectively, positioned the rehabilitation strategy in Quadrant I, indicating an aggressive strategic position. The ANP results ranked risk mitigation and prevention of structural failure as the leading strategy (14.87%), followed by industrialized earthquake-resistant construction using modular or prefabricated methods (13.34%). Kendall's coefficient of concordance reached 1.00, indicating perfect agreement among experts. The study concluded that rehabilitation efforts should prioritize structural safety, earthquake resistance, and accelerated construction processes while supporting administrative efficiency, budget utilization, and cost-effective contracting strategies.

INTRODUCTION

The education sector plays a crucial role in promoting human resource development and national progress. Adequate, safe, and decent educational facilities are essential requirements for supporting effective learning processes. However, these requirements cannot always be fulfilled, particularly in disaster-prone regions such as North Lombok Regency, West Nusa Tenggara, where frequent earthquakes occurred in 2018 (Mustofa, 2018; Septia & Indartono, 2019; Setyonugroho & Maki, 2024; Wulan et al., 2021; Yakin, 2020).

The earthquakes caused severe damage to infrastructure, including school buildings, resulting not only in physical destruction but also in social and psychological impacts. Due to the damage, the teaching and learning processes were disrupted, forcing educational activities to be conducted in emergency tents. This situation affected the continuity of education for

thousands of students and potentially hindered the future development of the younger generation in Lombok (Harnish, 2019; Hidayana et al., 2016; Mazhabi, 2026; Mazhabi et al., 2023; Suliyana & Waeji, 2025).

The number of madrasahs in Indonesia reached 88,072 in 2025, consisting of 4,050 public madrasahs and 84,022 private madrasahs. Based on data from the Education Management Information System (EMIS) of the Ministry of Religious Affairs, the number of madrasahs in West Nusa Tenggara reached 3,155, including Raudhatul Athfal (RA; Islamic kindergarten), Madrasah Ibtidaiyah (MI; Islamic primary school), Madrasah Tsanawiyah (MTs; Islamic junior secondary school), and Madrasah Aliyah (MA; Islamic senior secondary school). Based on these data, North Lombok Regency has a total of 135 madrasahs, comprising 19 RA, 38 MI, 52 MTs, and 26 MA institutions. Considering the substantial number of madrasahs, special attention should be given to infrastructure conditions and the sustainability of effective teaching and learning processes (Andriyani et al., 2025; Hidayatullah et al., 2025; Latif et al., 2025; Rosyadi et al., 2023; Sutrisno et al., 2023).

Although rehabilitation efforts have been carried out by the government and various institutions, several challenges remain, including limited funding, unresolved technical issues, and suboptimal coordination. Therefore, comprehensive identification of building damage is essential to determine damage levels and establish repair priorities. Furthermore, effective, innovative, and collaborative rehabilitation strategies are required. These strategies should involve the government, communities, and relevant stakeholders to ensure that the rehabilitation process is accelerated, properly targeted, and capable of producing reconstructed school buildings with improved standards and earthquake-resistant performance.

Based on the study conducted by Fradana et al. (2023), which focused on the post-earthquake housing rehabilitation and reconstruction subsector in West Nusa Tenggara in 2018, particularly in North Lombok Regency, the application of SWOT and AHP methods resulted in a global priority weight of 36.3% for community involvement in the rehabilitation and reconstruction processes, including policy formulation and field implementation. Such involvement contributed to the implementation of more optimal strategies. Susdiana et al. (2021) conducted a study to identify alternative strategies for optimizing the reconstruction of moderately and slightly damaged houses after the earthquake in West Lombok Regency using SWOT and AHP methods. The findings indicated that the best alternatives for managing the implementation of Rumah Tahan Gempa (RTG; earthquake-resistant houses) involved community participation in policy-making, problem resolution, and supplier selection.

In this study, SWOT and ANP were applied as approaches for addressing complex problems through a synthesized mechanism that considered interrelated factors. The priority scale was determined to identify the alternatives that contributed most significantly to accelerating rehabilitation. This approach enabled more informed decision-making by considering interrelationships, dependencies, and feedback among elements. SWOT analysis was used to systematically identify and evaluate internal and external factors that could assist the government in formulating regional development strategies. This analysis was based on the principle of optimizing strengths and opportunities while minimizing weaknesses and threats (Rangkuti, 2001). ANP enables the analysis of complex relationships among elements within a system, including dependency and feedback relationships (Saaty, 2001).

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This study aimed to analyze the damage levels of madrasah buildings and identify factors that could accelerate madrasah rehabilitation in North Lombok Regency. These factors were used as analytical components to formulate the most effective strategies for accelerating the rehabilitation process. This study supports the government program outlined in Presidential Instruction No. 7 of 2025 concerning the Acceleration of Educational Unit Development and Revitalization, which aims to provide quality and equitable education, particularly in West Nusa Tenggara.

METHOD

Data Collection.

The method section has been proofread, revised into appropriate past tense for a methodology description, and streamlined by removing unnecessary explanatory details while maintaining the original meaning and academic structure.

The study employed a mixed-methods approach involving quantitative and qualitative analyses. The research sample consisted of 12 madrasahs comprising 65 buildings in North Lombok Regency. Data collection began with a preliminary survey, which included a literature review, preparation of survey instruments, and research planning.

Visual observations were conducted to assess the extent of damage to building components, including structural, architectural, and utility elements. The assessment followed the Circular Letter of the Director General of Human Settlements, Ministry of Public Works and Public Housing No. 47/SE/DC/2020 on the Technical Guidelines for Standardized Design of School and Madrasah Damage Assessment. Based on these guidelines, building damage levels were classified as severely damaged, moderately damaged, or slightly damaged, which served as the basis for determining rehabilitation priorities and technical planning.

Field observations were further conducted to support the SWOT and ANP analyses. SWOT analysis was used to identify internal and external factors through IFAS and EFAS matrices and to formulate alternative strategies for accelerating rehabilitation based on priority scales. The selected strategies were then analyzed using ANP to determine the priority weights through a paired comparison network structure. The respondents consisted of experts from relevant government institutions, including the Ministry of Public Works, the Strategic Infrastructure Implementation Working Unit (Satuan Kerja Pelaksanaan Prasarana Strategis [Satker PPS] NTB), and the Ministry of Religious Affairs of West Nusa Tenggara (Kementerian Agama Nusa Tenggara Barat [Kemenag NTB]).

Data Collection.

Identification of Building Damage Levels.

The findings of the visual observation refer to Circular Letter No. 47/SE/DC/2020 Regarding Technical Guidelines for Standardized Design of School and Madrasah Damage Assessment. The building damage levels were identified based on the structural, architectural, and utility components. The structural components cover foundation, columns, beams, floor slabs, staircases, and roof frames while architectural components cover walls, partitions, ceilings, floor coverings, frames, doors, windows, and finishes. Meanwhile, the third components, utility components include electrical, plumbing, and wastewater systems. The data on Madrasah in this study is available in Table 1.

Table 1. Data of Madrasah School

No	Madrasah	Regency	District	Sub-District	Address	Education Level
1.	MIS MARAQITTA'LIMAT LOKOK AUR	North Lombok Regency	Bayan	Karang Bajo	Dusun Lokoq Aur, Desa Karang Bajo	Madrasah Ibtidaiyah (MI)
2.	MIS MIFTAHUL ULUM DEKONING SCHOOL	North Lombok Regency	Bayan	Sukadana	Jl. Rumah Adat Dusun Segenter	Madrasah Ibtidaiyah (MI)
3.	MIS IJTIHADUL ISLAMIYAH AL AMIN	North Lombok Regency	Gangga	Genggelang	Jl. Raya Selelos KM.03	Madrasah Ibtidaiyah (MI)
4.	MTSS RIADHUL JANNAH NW	North Lombok Regency	Gangga	Genggelang	Jl. Raya Selelos KM.07 Dusun Penjor	Madrasah Tsanawiyah (MTs)
5.	MTSS AL-BAQIYATUSSHALIHAT NW SANTONG	North Lombok Regency	Kayangan	Santong	Jl. Raya Santong Kayangan KM 07 Dusun Suka Damai	Madrasah Tsanawiyah (MTs)
6.	MTSS AL IKHLAS MENTIGI	North Lombok Regency	Pemenang	Malaka	Jl. Raya Malaka - Pemenang	Madrasah Tsanawiyah (MTs)
7.	MTSS AL MUJAHIDIN AL MAJIDIYAH NW JELITONG	North Lombok Regency	Gangga	Rempek	Jelitong, Desa Rempek	Madrasah Tsanawiyah (MTs)
8.	MTSS AL IKHWAN SESAIT	North Lombok Regency	Kayangan	Sesait	Sumur Pande Lauk	Madrasah Tsanawiyah (MTs)
9.	MTSS AL JARIYAH NW SANBARO	North Lombok Regency	Gangga	Bentek	Jl. Raden Berneng, Bentek Sanbaro	Madrasah Tsanawiyah (MTs)
10.	MAS AL BAQIYATUSSHOLIHAT NW SANTONG	North Lombok Regency	Kayangan	Santong	Jl. Raya Santong - Kayangan	Madrasah Aliyah (MA)
11.	MAS AL JARIYAH NW SANBARO	North Lombok Regency	Gangga	Bentek	Jl. Raden Berneng, Bentek Sanbaro	Madrasah Tsanawiyah (MTs)
12.	MAS NURUL IKHSAN NW SALUT	North Lombok Regency	Kayangan	Salut	Jl. Syekh Suban KM. 6 Salut	Madrasah Tsanawiyah (MTs)

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The levels of building damage are classified into:

a. Not damaged (classification 1)
b. Very slight damage (classification 2)
c. Slight damage (classification 3)
d. Moderate damage (classification 4)
e. Severe damage (classification 5)
f. Very severe damage (classification 6)
g. Non-compliant or missing component (classification 7)

The identification form of school and madrasah buildings damage covers:

a. Damage identification form for a single-storey building
b. Damage identification form for a two-storey and stilt building
c. Damage identification form for a three- or more-storey building

Once the damage levels of all components were identified based on visual observation, the levels of damage building, as a percentage that affect safety, are described as follows:

a. Not damaged if all components are in good condition (damage value 0%)
b. Slight damage (damage value ≤ 30%)
c. Moderate damage (damage value 30% - 45%)
d. Severe damage (damage value > 45%, or one damage of the components affects safety)

SWOT, Internal and External Factor Matrix

According to Sulthon (2020), referring to SWOT analysis, in order to promote long-term customer satisfaction, product and market diversification is necessary. SWOT analysis is a suitable tool to find the problems based on four different perspectives; its applications are as follows:

a. How strengths support existing opportunities.
b. How to address weaknesses that prevent losses.
c. How strengths face threats.
d. How to address weaknesses that turn threats into reality or trigger new threats.

SWOT analysis compares the internal and external factors, classifying them into quadrants. Each quadrant shows different strategy, as shown in Figure 1:

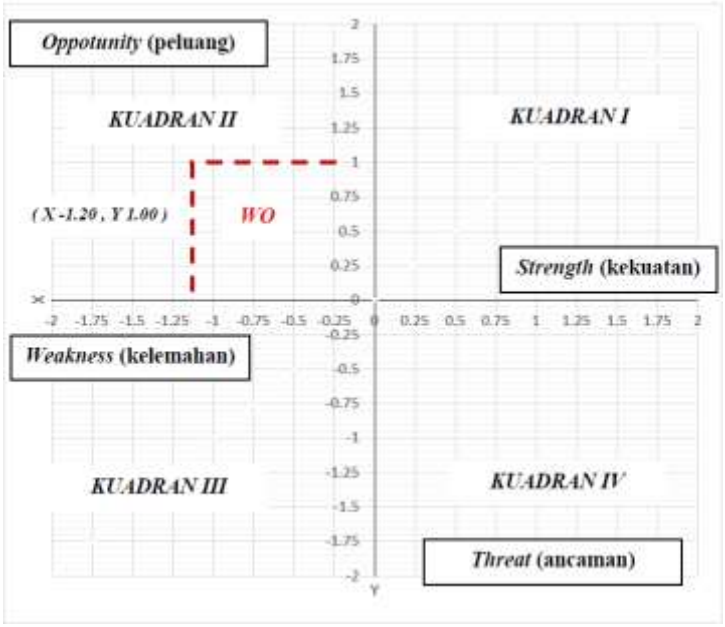

Figure 1. SWOT Analysis Diagram

According to Susdiana (2021), generally, the steps to formulate SWOT analysis are as follows:

a. Identify and collect the data related to the internal and external factors that significantly affect the success and the failure.
b. Construct the matrix of the internal and external factors as the basis of information used to formulate strategic planning.
c. Illustrate the position in the SWOT quadrant based on the results of internal and external factor matrix final analysis.
d. Construct a matrix of SWOT analysis based on the information of internal and external factors and its analysis.
e. Based on the quadrant and SWOT analysis, formulate the strategies and actions to optimally achieve the aim, accelerating the rehabilitation of madrasahs.

The qualitative approach of the SWOT matrix, as developed by Kearns (1992), shows eight quadrants, the top two is a quadrant for external factors (opportunity and threat) while the two left quadrants are for internal factors (strength and weakness). The other four quadrants show strategic issues that arise from the intersection of internal and external factors. Opportunity and threat can be handled by considering the strength and weakness. The four alternatives are as follows:

Table 2. Interaction Among Factors in the SWOT Matrix

INTERNAL / EXTERNAL	**Strength (S)**	**Weakness (W)**
	Identify the strengths of the internal factors	Identify the weaknesses of the internal factors
Opportunities (O)	**Strategy S-O**	**Strategy W-O**
Identify the external opportunity factors	Develop a strategy, using the strengths to promote opportunities	Develop a strategy, minimizing the weaknesses to promote opportunities
Threats (T)	**Strategy S-T**	**Strategy W-T**

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Identify the external threat factors	Develop a strategy, using the strengths to address threats.	Develop a strategy, minimizing the weaknesses to address threats.

The steps of SWOT analysis are as follows:

a. Conduct the input process to construct the SWOT analysis, identifying the internal and external factors based on the visual observation aimed at identifying the levels of building damage and collecting strategic information prior to SWOT construction.
b. Design SWOT research questionnaire, aimed at formulating the strategies based on the internal and external factors. At this stage, ratings use a scale of 1–6 for current conditions and 1–4 for urgency.
c. Identify the cause of the problems
d. Identify the aims and strategic targets.
e. Develop strategic issues, formulation, themes, and mapping, aimed at examining whether the strategic issues and themes promote the vision and mission of the program well. Strategic mapping deals with the mapping planning of the four perspectives. Thus, the perspectives can be integrated to achieve the aim.

Analytical Network Process (ANP)

The ANP model was structurally planned by placing the main objective at the first level, the criteria and the sub-criteria on the second level, and the alternatives on the third level. This model enables feedback among elements. The network structure of ANP becomes the essential basis in designing the pairwise comparison questionnaire, used to analyze the relative importance level of each element within the network. The questionnaire was designed with Super Decisions software. It is important to ensure that the respondents respond to the items consistently and logically. Super Decisions help measure the consistency ratio (CR). If the CR value is below 0.1 (10%), the responses were considered consistent and could be used for the following process. However, if CR value is CR ≥ 0.1, the respondents should clarify or revise their responses. The fundamental rating scale, ranging from 1-9, in ANP is illustrated in Table 3.

Table 3. Fundamental Rating Scale in ANP

Degree of Importance	Definition	Explanation
1	*Equal Importance*	Both elements have equal importance
2	*Weak or Slight Importance*	The scale ranges from 1–3
3	*Moderate Importance*	One element is slightly more important than the other
4	*Moderate Plus*	The scale ranges from 3–5
5	*Strong Importance*	One element is more important than the other
6	*Strong Plus*	The scale ranges from 5–7
7	*Very Strong or Demonstrated Importance*	One element is much more important than the other
8	*Very, Very Strong*	The scale ranges from 7–9
9	*Extreme importance*	One element is extremely more important than the other

RESULT AND DISCUSSION

The analysis on the damage levels refers to Circular Letter No. 47/SE/DC/2020 on Technical Guidelines for Standardized Design of School and Madrasah Damage Assessment. 12 madrasahs with 65 buildings were identified. The findings show that 21.54% (14 buildings) are severely damaged, 13.85% (9 buildings) are moderately damaged, and 64.62% (42 buildings) are slightly damaged. This indicates that rehabilitation intervention has become a priority.

The strategy's formulation through SWOT analysis results in an IFAS matrix score of 0.8 and the EFAS score of 0.25, placing the strategic position in Quadrant I (Aggressive). Hence, the alternative strategies to accelerate the rehabilitation are listed as follows:

1. To optimize the compilation of technical documents, administrative acceleration and the absorption of the state budget (APBN) should be accelerated.
2. To shorten the work duration, there should be earthquake-resistant construction, implementing modular or prefabricated construction innovations assembled by experts.
3. To ensure the building's resilience, the construction should follow the standard of earthquake-resistant construction, mitigate the risk and achieve zero structural failure.
4. To mitigate inflation, strategic contracts should be designed so that the construction is cost effective, involving professional service providers for bulk buying.

Based on the alternatives, ANP analysis was conducted to find out the best alternative. The network model of ANP was developed using Super Decisions 2.10 software, supporting visualization and structured mathematical calculations. This model identified the influential relationships among the sub-criteria in inner or outer dependence.

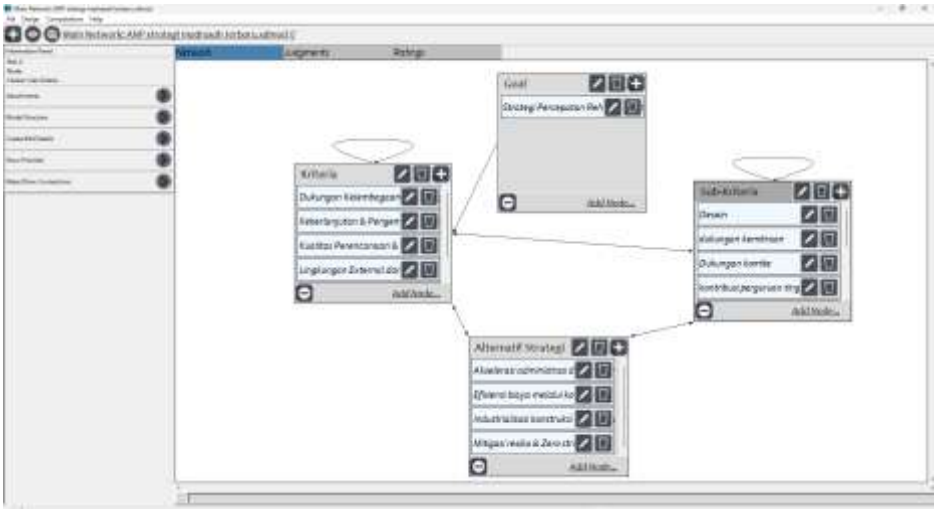

Figure 2. ANP Network Model

Alternative Strategies

The compared alternative strategies to accelerate the rehabilitation are acceleration of administrative processes and state budget (APBN) absorption, industrialization of earthquake-resistant construction, risk mitigation with zero structural failure, and cost efficiency through strategic contracts.

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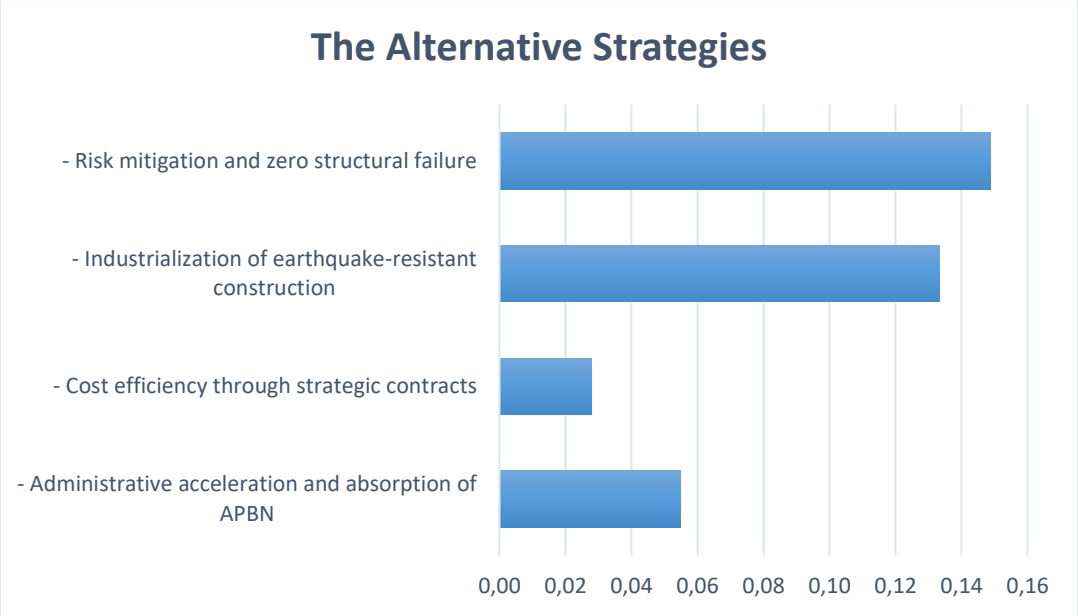

Figure 3. Results of the Madrasahs Rehabilitation Acceleration Strategy

Based on the data analysis using ANP model, the scale priority of each alternative strategy was obtained. Figure 3 visualizes the scale, showing that the dominant value of risk mitigation and zero structural failure is around 0.1487 or 14.87%. This indicates that these aspects should be strongly considered in the decision-making. Meanwhile, industrialization of earthquake-resistant construction, implementing modular or prefabricated construction that reduces fieldwork duration, accounts for 0.1334 or 13.34%.

To assess the agreement of the respondents' or experts' responses, this study employed Kendall's Coefficient of Concordance (W; $0 < W \leq 1$). If the value of W is 1 ($W = 1$), the agreement is perfect. Meanwhile, if the W value is 0 or around 0, the agreement is weak, showing how varied the responses are. The W value of this study is 1, showing perfect agreement among respondents.

Alternative Strategies Priority

Table 4. shows the alternative strategies priority of each criterion from the ANP model.

Table 4. Alternative Strategies Priority

Alternative	Preference (V)	Rank
Risk mitigation and zero structural failure	0,1487	1
Industrialization of earthquake-resistant construction	0,1334	2
Administrative acceleration and absorption of APBN	0,0548	3
Cost efficiency through strategic contracts	0,028	4

CONCLUSION

This study concluded that the assessment of building damage levels in madrasahs in North Lombok Regency identified varying degrees of damage among the observed buildings. Based on the visual assessment of 65 buildings across 12 madrasahs, the majority of buildings were categorized as slightly damaged, followed by severely damaged and moderately damaged buildings. The findings indicated that earthquake impacts remained a significant challenge affecting the safety, functionality, and continuity of educational activities. Therefore,

rehabilitation efforts required a systematic prioritization approach that considered structural safety, earthquake resistance, and the urgency of restoring learning facilities.

The strategic analysis using SWOT and ANP demonstrated that rehabilitation acceleration required an integrated strategy involving technical, managerial, and institutional aspects. The IFAS and EFAS analyses positioned the rehabilitation strategy in a proactive or aggressive quadrant, indicating that available strengths and opportunities could be optimized to accelerate recovery. The ANP results identified risk mitigation and prevention of structural failure as the highest-priority strategy, followed by the implementation of earthquake-resistant construction methods through modular or prefabricated systems. These findings emphasized that accelerating madrasah rehabilitation should not only focus on physical reconstruction but also involve effective planning, stakeholder coordination, budget efficiency, and the implementation of resilient construction approaches.

Future research is recommended to expand the assessment scope by involving more educational facilities and integrating advanced assessment methods, such as structural performance analysis, geographic information systems (GIS), and disaster resilience indicators. Further studies may also examine the effectiveness of post-rehabilitation programs to ensure that reconstructed madrasah buildings provide safer, more sustainable, and disaster-resilient learning environments.

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