



(RESEARCH ARTICLE)



Identifying and analyzing disaster mitigation strategies for sports hall

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Abstract

A Sports Hall is a facility designed to support various sports activities and can also be used for non-sporting events involving large crowds. Ensuring the safety, health, and comfort of users is paramount in both the design and maintenance of such buildings. This study aims to identify and analyze effective disaster mitigation strategies for the Manado State Polytechnic Sports Hall. The research utilizes drone technology for mapping the landscape and environment around the Sports Hall. The data obtained are processed using Global Mapper and AutoCAD Civil 3D software. Initial findings indicate that the Manado State Polytechnic Sports Building is generally in good condition but some aspects need improvement in disaster mitigation. As a result, this study recommends several strategies aimed at improving the building's resilience to various disasters, including earthquakes, fires, and floods.

Keywords: Sports Hall; Disaster mitigation; Drone mapping; Evacuation; Building's resilience

1. Introduction

A Sports Hall is a public facility specifically designed to accommodate various sports activities, ranging from routine training sessions to major competitions. As a venue frequently used by large numbers of people, including participants and spectators, a Sports Hall plays a vital role in supporting physical activities and hosting significant events, such as concerts, exhibitions, and other social gatherings. However, given the large capacity and frequent use of Sports Hall, the safety, health, and comfort of users are critical factors that cannot be overlooked. In this context, one of the main challenges is how to design and manage Sports Hall to effectively address the potential risks posed by both natural and non-natural disasters, such as earthquakes, fires, and floods.

Manado State Polytechnic, a leading higher education institution in North Sulawesi, has a Sports Hall that is regularly used for various academic and non-academic activities. Given that Indonesia, particularly the North Sulawesi region, is prone to various natural disasters, including earthquakes, fire and floods, this study is highly relevant.

The purpose of this study is to identify the condition of the Manado State Polytechnic Sports Hall and to develop mitigation strategies that can be implemented to increase building resilience. Disaster mitigation in Sports Hall is important, considering the potential losses that can arise if a disaster occurs without adequate preparedness.

Understanding the various strategies implemented to reduce the vulnerability of people and infrastructure during hazardous events is crucial for developing tailored mitigation plans [1]. Mitigation efforts can be categorized into three stages: pre-disaster, during disaster, and post-disaster [2]. Stages such as mapping, inspection, investigation, monitoring, and socialization are essential for reducing ongoing disaster vulnerability risks [3]. Disaster risk reduction can be achieved through well-planned disaster mitigation strategies aimed at minimizing threats and vulnerabilities [4]. The Regional Disaster Management Agency conducts both passive and active flood disaster mitigation. Passive

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mitigation includes a range of integrated and collaborative activities, while active mitigation emphasizes the importance of sustained socialization efforts and the enhancement of facilities and infrastructure in areas with high disaster potential [5].

A healthy ecosystem plays a key role in disaster risk reduction (DRR) by providing ecosystem services (ES) that contribute to hazard mitigation [6]. DRR has become a global policy priority, with community-based disaster risk reduction shifting from the traditional top-down, reactive disaster management approach to a more proactive strategy [7]. The implementation of community-based disaster mitigation carried out through the application of Disaster Alert Villages based on aspects such as planning, implementation, monitoring and evaluation [8].

Synergistic collaboration between scientific knowledge and local wisdom has proven effective in disaster management and mitigation [9]. Involving early childhood education institutions, teachers, and parents in disaster mitigation programs is crucial for introducing children to these concepts from an early age [10]. Students must be equipped with the knowledge to detect and anticipate potential disasters in their surroundings, a practice known as disaster mitigation [11]. Disaster mitigation in the form of evacuation route planning is designed as the shortest path equipped with safety signs, along with land management and rehabilitation of school buildings to provide safety and comfort in teaching and learning activities at school [12].

The government has mandated that all buildings and public facilities be equipped with disaster mitigation and safety facilities to maintain the security and safety of people carrying out activities within the building. These buildings must provide evacuation facilities, including exit access, evacuation routes, and other support systems that guarantee safe evacuation in the event of a disaster or emergency [13] [14] [15].

2. Material and methods

This study uses several methods to identify, analyze, and develop effective disaster mitigation strategies at the Sports Hall of the Manado State Polytechnic. Drone mapping was conducted to obtain an overview of the Sports Hall's landscape and environment, including topographic conditions that may influence potential disaster risks. A DJI Mavic Pro 2 Small Unmanned Aerial Vehicle (SUAV) was used for aerial photography, and an Emlid Reach RS2 Geodetic GPS was employed to capture Ground Control Point (GCP) coordinates. The location data collection utilized the SUAV to take aerial photos, providing an accurate visual representation of the building's position [16]. Field measurements were conducted to create a detailed layout of the building and its surrounding environment. These measurements were essential for obtaining precise dimensional data for the Sports Hall.

The data obtained from drone mapping and field measurements were processed using Global Mapper and AutoCAD Civil 3D software. These visualizations were then used to analyze potential risks and determine appropriate mitigation strategies.

3. Results and Discussion



Figure 1 Manado State Polytechnic location [17]



Figure 2 Study area

Mapping with drones produces highly detailed 2D and 3D topographic maps, providing a comprehensive view of the landscape around the Manado State Polytechnic Sports Hall. These maps reveal land contours, vegetation, and other structures surrounding the Sports Hall. The mapping results indicate that the Sports Hall is situated in a relatively low-lying area compared to its surroundings, which increases the potential risk of flooding, especially during the rainy season when rainfall is heavy.

The 3D visualizations highlight that some areas around the Sports Hall are relatively flat, which could lead to prolonged water stagnation if an effective drainage system is not in place. Additionally, the mapping reveals that several points around the Sports Hall have steep slopes, which could channel rainwater directly toward the building, further heightening the risk of flooding. To mitigate these risks, improvements to the existing drainage system are necessary



Figure 3 Sports Hall



Figure 4 Interior visualization of the Sports Hall

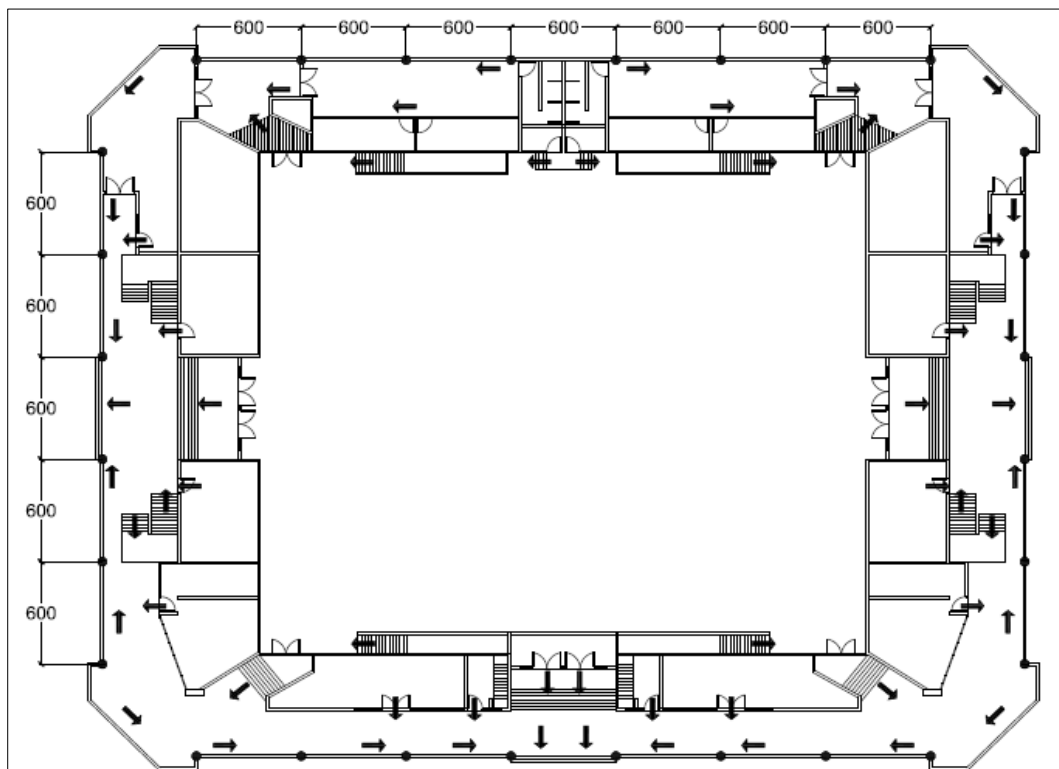


Figure 5 Evacuation routes

The resulting layout highlights several critical areas within the Sports Hall that require improvement. The current evacuation route is suboptimal, and the lack of clear evacuation signs could impede the evacuation process during an emergency. It is essential to redesign the evacuation route and install clearer, more visible evacuation signs.

Given that the Manado State Polytechnic Sports Hall is located in an earthquake-prone area, due to North Sulawesi's proximity to an active fault line, regular maintenance and inspections of the building structure are crucial. These measures will help anticipate and mitigate the risk of building collapse or severe structural damage during an earthquake.

The current fire detection system is inadequate and requires enhancement. This includes increasing the number of smoke detectors, sprinklers, and portable fire extinguishers throughout the Sports Hall.

This study reveals that the Manado State Polytechnic Sports Hall has several vulnerabilities that could heighten the risk of various disasters. It is imperative to make immediate improvements and implement the recommended mitigation strategies to enhance the building's resilience and provide better protection for its users. The application of modern technology, such as drone mapping and software analysis using Global Mapper and AutoCAD Civil 3D, has proven effective in providing accurate data and detailed visualizations to support risk analysis. This also underscores the potential of technology as an integral part of future disaster mitigation efforts

3.1. Disaster Mitigation Strategies

Based on the findings of this research, the following disaster mitigation strategies are recommended to enhance the resilience of the Manado State Polytechnic Sports Hall against potential disasters such as earthquakes, fires, and floods.

- Routine inspection and maintenance; The Sports Hall should undergo regular inspections and maintenance to ensure that all structural elements are in good condition and capable of withstanding earthquake loads. These inspections must be conducted by experienced structural experts, and the findings should be used to carry out any necessary repairs.
- Optimization of evacuation routes; The existing evacuation routes should be redesigned to ensure they are efficient and easily accessible in an emergency. The width of these routes must meet the minimum standards to accommodate a large number of users. Additionally, evacuation routes should be kept free of any obstacles that could impede swift movement.
- Installation of evacuation signs; Clear and easily recognizable evacuation signs should be installed throughout the Sports Hall. These signs must be visible from various angles, particularly in areas with low visibility. Emergency lights that automatically activate during a power outage should also be installed along the evacuation routes.
- Improved fire detection and suppression system; A robust fire detection system should be installed throughout the Sports Hall, including in rooms with a higher potential for fire outbreaks.
- Smoke and heat detectors; Install smoke and heat detectors in all enclosed spaces, such as changing rooms and storage areas. This system should be integrated with a fire alarm that can be heard throughout the building.
- Sprinkler installation; Automatic sprinklers should be installed in areas with a high fire risk, such as kitchens and storage rooms for flammable materials. These sprinklers should be set to activate automatically when a fire is detected.
- Portable fire extinguishers; Portable fire extinguishers should be strategically placed throughout the Sports Hall, such as near exits, kitchens, and storage rooms. These extinguishers must be regularly checked and refilled to ensure they are functional in an emergency.
- Fire training and simulation; Sports Hall staff and other users should receive regular training on how to use fire extinguishers and the appropriate actions to take during a fire. Periodic fire simulations should also be conducted to ensure that all individuals are prepared and know how to respond effectively in an emergency.
- Drainage system improvement and enhancement; Given the high risk of flooding, the existing drainage system should be redesigned to manage rainwater flow more effectively. The capacity of drainage channels around the Sports Hall should be increased to ensure that rainwater is quickly drained and does not pool around the building.
- Addition of infiltration wells; Install infiltration wells at strategic points to help reduce surface water flow and prevent flooding. These wells will also alleviate pressure on the main drainage system.
- Routine cleaning and maintenance; Regular cleaning of existing drainage channels is essential to prevent blockages that could cause flooding. Routine maintenance is crucial to ensure the drainage system functions properly, especially during the rainy season.
- Development of education and training programs; Educational programs for Sports Hall users about disaster risks and the necessary mitigation steps should be implemented. This can include disseminating information through posters, videos, or live training sessions.
- Evacuation training; Regular evacuation drills should be conducted to ensure that all Sports Hall users understand evacuation procedures and know how to respond in an emergency. These drills should include scenarios for various types of disasters, such as earthquakes, fires, and floods.
- Collaboration with the Regional Disaster Management Agency; Manado State Polytechnic should collaborate with local disaster management agencies to receive support in disaster mitigation planning and implementation. This collaboration is also vital for accelerating response and assistance in the event of a disaster.
- These disaster mitigation recommendations are designed to provide comprehensive and practical guidance for the management of the Manado State Polytechnic Sports Hall, enhancing the building's resilience to various

potential disasters. The goal is to ensure that the Sports Hall is safer and better prepared to face potential disasters in the future

4. Conclusion

The Manado State Polytechnic Sports Hall is generally in good condition but faces potential risks from various disasters that must be proactively addressed. The use of modern technology, such as drone mapping and software analysis, has proven effective in providing accurate data and detailed visualizations that support risk analysis. Integrating technology into future disaster mitigation efforts can significantly enhance preparedness.

Disaster mitigation strategies in the form of routine inspections and maintenance, optimization of evacuation routes, improvement of fire detection and extinguishing systems, fire training and simulations, improvement and improvement of drainage systems, development of education and training programs, and cooperation with external parties are expected to increase the resilience of the Sports Hall and ensure the safety of all users.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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