A Multidimensional Approach Based on the Analytic Network Process for Earthquake Vulnerability Assessment and Policy Development: A Case Study of Ayacucho, Peru

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ABSTRACT

Purpose: This study introduces a decision-making framework based on the Analytic Network Process (ANP) to assess seismic vulnerability and enable the design of specific mitigation strategies for the city of Ayacucho in Peru, an Andean region prone to seismic hazards. The model evaluates vulnerability through a multidimensional approach, incorporating environmental, social, and economic criteria to generate a comprehensive vulnerability index and prioritize strategic interventions.

Methodology: The methodology involves an extensive literature review and consultations with local experts in disaster risk management (DRM) to identify specific vulnerability factors of the city of Ayacucho across three key dimensions: environmental, social, and economic. The identified vulnerable elements are integrated into the ANP framework, which models the interrelations among these elements and the dimensions they belong to. The resulting model provides a detailed vulnerability index and a ranked list of critical risk factors. Based on these findings, strategic policies and mitigation actions are developed in conjunction with stakeholders, emphasizing local needs and feasible implementation pathways.

Findings: The analysis highlights the environmental dimension as the most significant contributor to Ayacucho's seismic vulnerability, particularly due to the prevalence of predominant building material, housing location in unsafe areas, age of building construction, main occupation of the population (employment), building elevation configuration, and terrain topography. Social factors, including age group (population age), illiteracy, and gender predominance as household head, further exacerbate the city's susceptibility. Proposed mitigation strategies include modernizing essential infrastructure, enhancing public awareness campaigns, and integrating seismic risk considerations into urban planning policies.

Originality and Value: This case study demonstrates the adaptability and utility of the ANP framework for local disaster risk management. By focusing on Ayacucho's unique vulnerabilities, the research provides practical insights for policymakers and underscores the importance of involving local expertise and community input in developing effective

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mitigation measures. This approach offers a replicable model for other regions with similar seismic and socioeconomic conditions.

Keywords: ANP, seismic vulnerability, Ayacucho, disaster risk management, mitigation strategies, infrastructure resilience.