



Building Inventory and Seismic Vulnerability Assessment of Government Office Buildings in Pokhara Metropolitan City

Amrita Dhakal¹ *, Dipesh DC¹, Sujata Shakya Bajracharya¹

¹ *Paschimanchal Campus, Institute of Engineering, Tribhuvan University, Nepal*

**Corresponding email: amreeta.dhakal@gmail.com*

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Abstract

Government office buildings play a critical role in public service delivery and emergency response, yet their inventory and seismic performance remain insufficiently documented in many seismically active regions of Nepal. This study presents a comprehensive building inventory and preliminary seismic vulnerability assessment of 111 government office buildings (94 offices) located within Pokhara Metropolitan City, an area of high seismic hazard. The inventory documents key spatial, structural, architectural, and functional attributes of the buildings. The inventory indicates that the building stock is dominated by low to mid-rise reinforced concrete moment-resisting frame structures, with a substantial proportion constructed prior to the enforcement of the Nepal Building Code and several having undergone post-construction modifications. Seismic vulnerability was evaluated using two widely applied visual-inspection-based screening approaches: the Empirical Vulnerability Method and the FEMA P-154 Rapid Visual Screening method. Buildings were classified into vulnerability categories based on method-specific scoring frameworks, and results were compared at both aggregate and individual-building levels. Both screening methods consistently classify the majority of buildings within the low to moderate vulnerability categories, with no buildings identified as very highly vulnerable. However, FEMA P-154 generally yields more conservative vulnerability classifications compared to the empirical method, primarily due to fewer penalizing score modifiers. The building-wise comparison demonstrates strong agreement between the two approaches, with most buildings differing by no more than one vulnerability class.

Keywords: *Building inventory, Seismic vulnerability, Government buildings, Rapid visual screening.*

1 Introduction

Pokhara Metropolitan City though situated within a high seismic hazard zone is a significant administrative hub in western Nepal has a diverse stock of government office buildings with a wide range of construction ages, structural systems, materials, and code compliance. Seismic performance and damage potential of government buildings are significantly impacted by mentioned variability. Jaiswal and associates (2010). Nevertheless, there is still a lack of systematic documentation and seismic assessment for these structures, which makes it difficult to prioritize retrofitting and risk-reduction strategies. Thus, methodical framework for recording spatial, structural, architectural, and functional characteristics that directly affect seismic behavior and damage potential, a thorough building inventory is an essential part of seismic risk reduction (Brzev et al., 2013).

For public assets and critical facilities in particular, accurate inventory data are crucial for comprehending the features of the current building stock and serve as the foundation for vulnerability assessment, loss estimation, and emergency response planning (Silva et al., 2022). International practices have shown that municipalities typically use reactive management strategies in the absence of standardized building inventories, which limits their capacity to prioritize retrofitting, allocate resources efficiently, and implement proactive seismic resilience strategies (World Bank, 2014). Preliminary seismic vulnerability assessment using visual inspection-based methods has proven to be an efficient and useful substitute when detailed structural drawings, material test data, and analytical models are not available (FEMA, 2015).

Rapid Visual Screening (RVS) followed by Empirical vulnerability scoring techniques allow large building stocks to be evaluated efficiently by identifying observable deficiencies, structural irregularities, construction practices, and site conditions associated with increased seismic risk (Applied Technology Council, 1985). The FEMA P-154 methodology, in particular, has been widely adopted internationally due to its standardized scoring framework and adaptability to different seismic regions (Harirchian et al., 2020).

However, government office buildings in PMC remain largely unassessed using such standardized methodologies. This study addresses this gap by integrating a comprehensive building inventory with a multi-method seismic vulnerability assessment of government office buildings in PMC. This study integrates a comprehensive building inventory with a multi-method preliminary seismic vulnerability assessment of government office buildings in PMC, providing a basis for comparative evaluation of screening approaches and informed seismic risk prioritization.

2 Materials and Methods

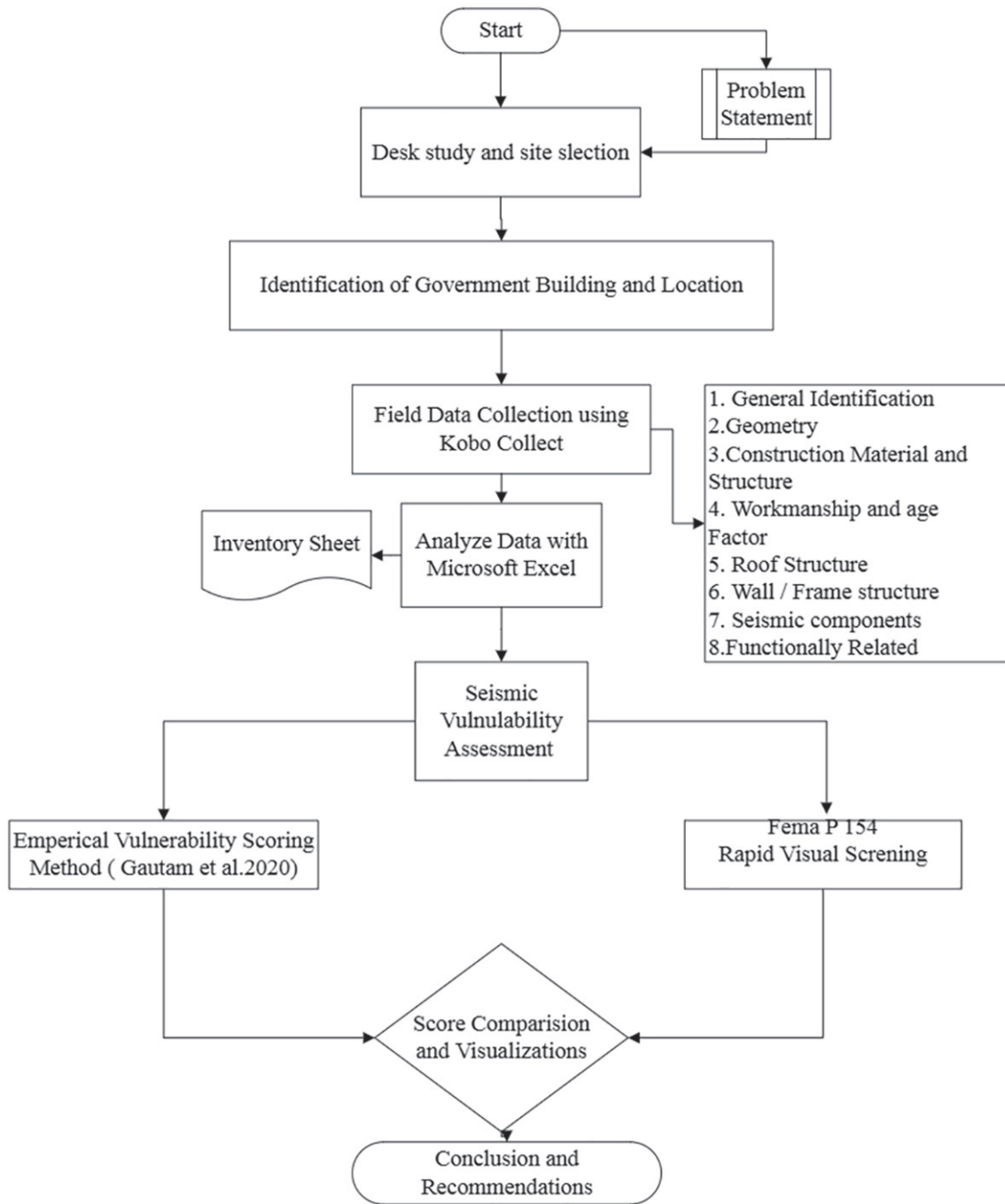


Figure 1: Methodology of Study

2.1 Study Area

The study was conducted within the administrative boundary of Pokhara Metropolitan City, Kaski District, Nepal. The selection of Pokhara Metropolitan City as the study area was motivated by its high concentration of federal, provincial, and metropolitan government buildings infrastructure, varied building ages and

construction types, and its location in a seismically active region.

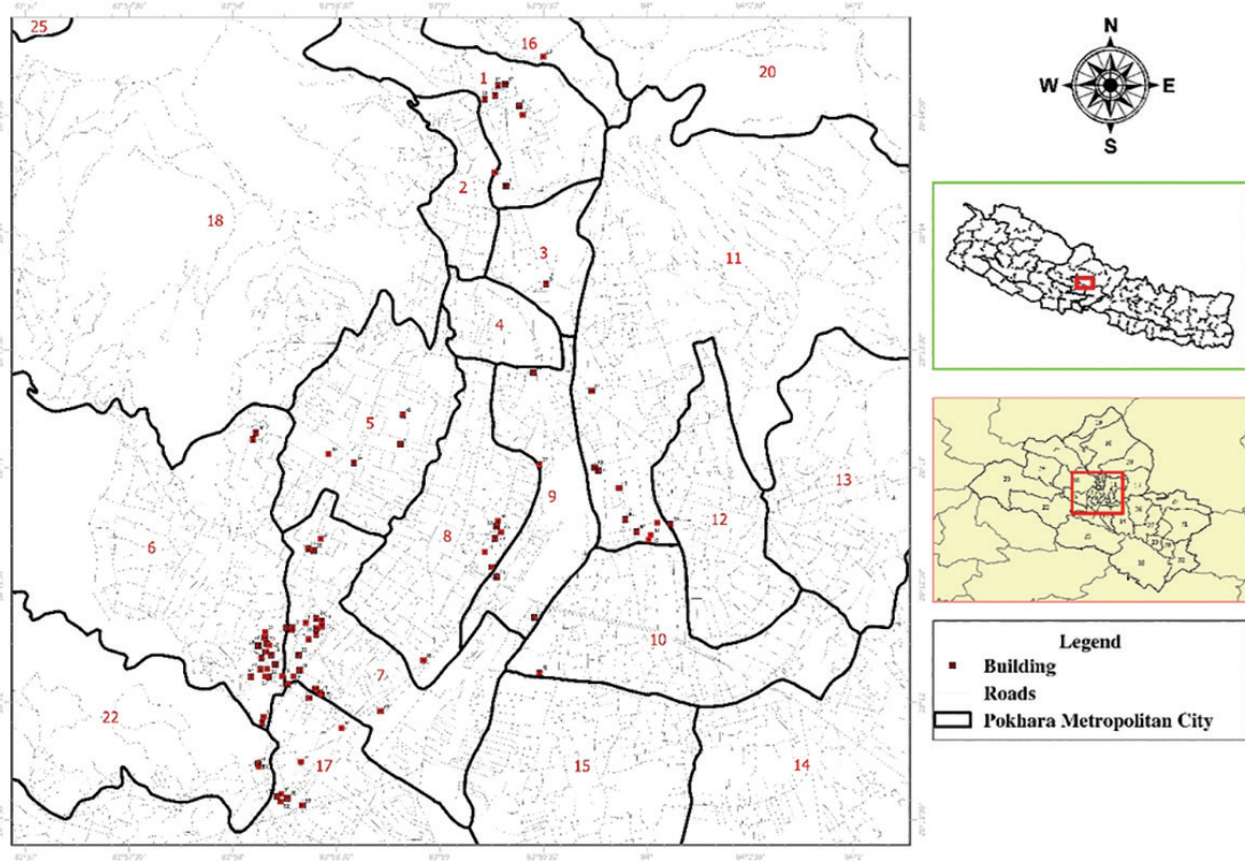


Figure 2: Study Area Map

2.2 Data Collection and Data Sources

Data for this study were obtained from both primary and secondary sources. Primary data were collected through field surveys and visual inspections of government office buildings conducted between July and August 2025 using the Kobo Collect mobile application. Of the 125 federal and provincial government offices listed, 94 offices comprising 111 building blocks were selected for assessment. Offices occupying rented premises and those associated with security services were excluded. A standardized survey form was used to record data on building identification, construction age, geometry, structural system, construction materials, vertical and plan irregularities, maintenance condition, functional suitability, and post-construction modifications. Supplementary information was gathered through informal interviews with office personnel to verify building use, modification history, and maintenance practices. Secondary data sources included municipal and departmental records, policy documents, and relevant literature, which were utilized to support building classification and contextual analysis.

2.3 Building Inventory

Collected data were processed and compiled into a comprehensive inventory sheet.

Table 1: Categories for Building Inventory

Category	Key Features
General Identification	Location, office name, building age
Geometry	Dimensions, storeys, plan shape, irregularities
Structural Characteristics	Structural system, materials, code compliance modifications
Functionality	Accessibility, maintenance, service condition

2.4 Seismic Vulnerability Assessment

Seismic vulnerability was evaluated using three visual screening methods:

- Empirical Vulnerability Scoring Method
- FEMA P-154 Rapid Visual Screening

Each method assigns vulnerability scores based on observable structural and non-structural parameters, which were subsequently classified into vulnerability categories. The empirical method as defined by (Gautam et al, 2020) was selected as it is specifically calibrated for Nepalese building practices and allows calculation of seismic vulnerability based on observable structural attributes.

3 Results and Discussion

3.1 Building Inventory Characteristics

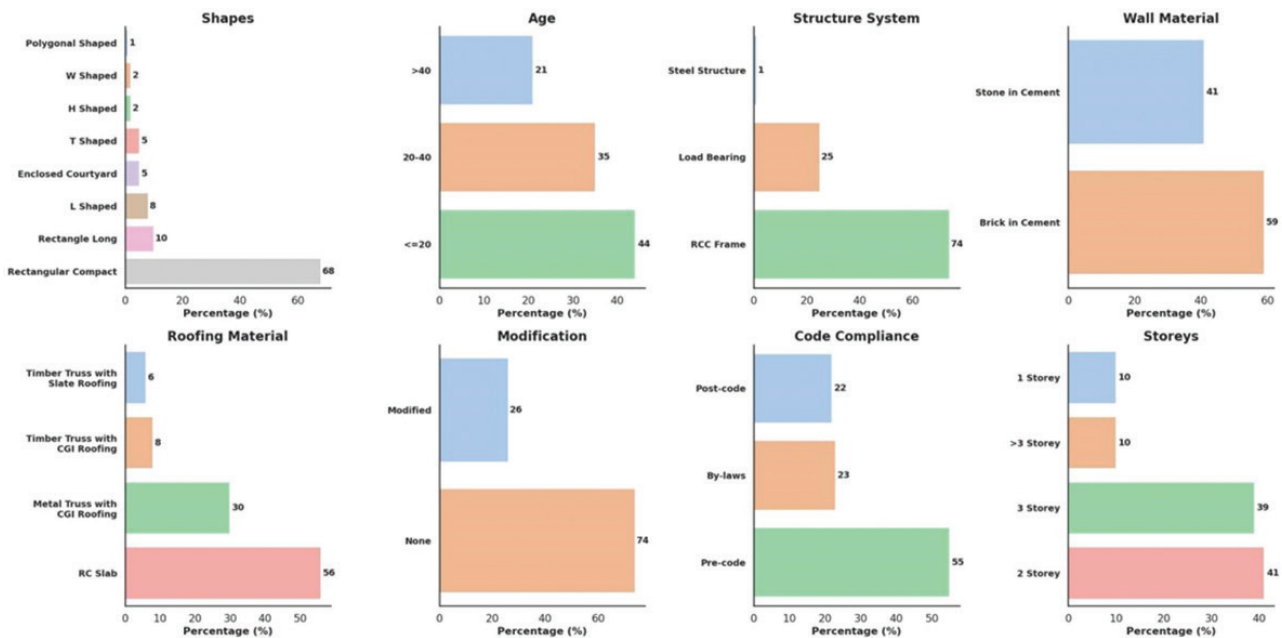


Figure 3: Visualization of Inventory Sheet

The main features of the government office buildings surveyed are shown in Figure 3. The majority of

the inventory's rectangular-plan, low- to mid-rise reinforced concrete (RC) frame buildings were built prior to the Nepal Building Code's implementation, which led to a low level of NBC compliance. Typical characteristics that indicate possible seismic vulnerability include RC slab roofing, masonry infill walls, and frequent post-construction modifications. Additionally, field observations showed that none of the buildings were fully accessible to individuals with disabilities and that parking facilities were generally inadequate in offices with high public demand. But it was found that basic utilities like lighting, drainage, and ventilation were generally sufficient.

3.2 Seismic Vulnerability Assessment Results

3.2.1 Empirical Method

Seismic vulnerability was evaluated using the Empirical Method developed by Gautam et al. (2020), which employs an attribute-based weighted scoring system incorporating parameters such as workmanship and age, geometric configuration, structural system, and seismic factors. For each building, an Empirical Vulnerability Score (EVS) was derived as the weighted sum of the individual parameter scores. Figure 4 illustrates the relative contribution of individual components to vulnerability. Component-wise results show that geometric and structural factors contribute most significantly to vulnerability, followed by workmanship and age, whereas seismic factors dominate only for a limited number of buildings.

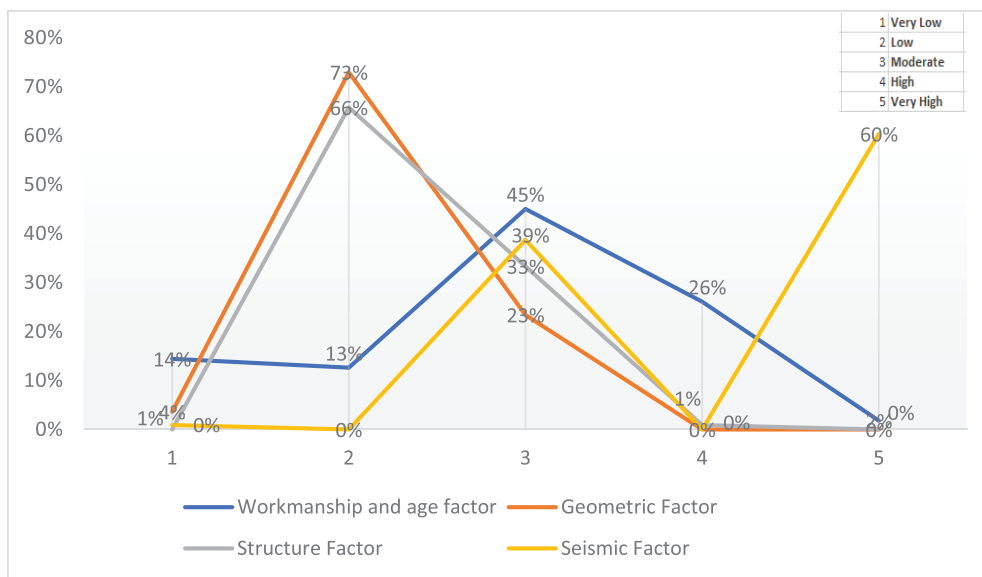


Figure 4: Vulnerability Score of each Component in Empirical Method

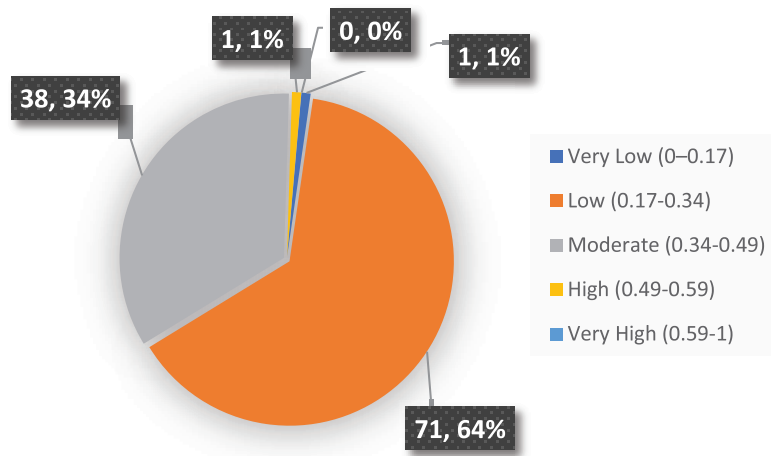


Figure 5: Empirical Vulnerability Score Distribution

The Overall Empirical Vulnerability Score of the assessed buildings were categorized into five vulnerability classes. The results indicate that the majority of buildings fall within the low (71 number 64%) and moderate (38 buildings, 34%) vulnerability categories, with only a negligible proportion classified as highly vulnerable.

3.2.2 FEMA P-154 Method

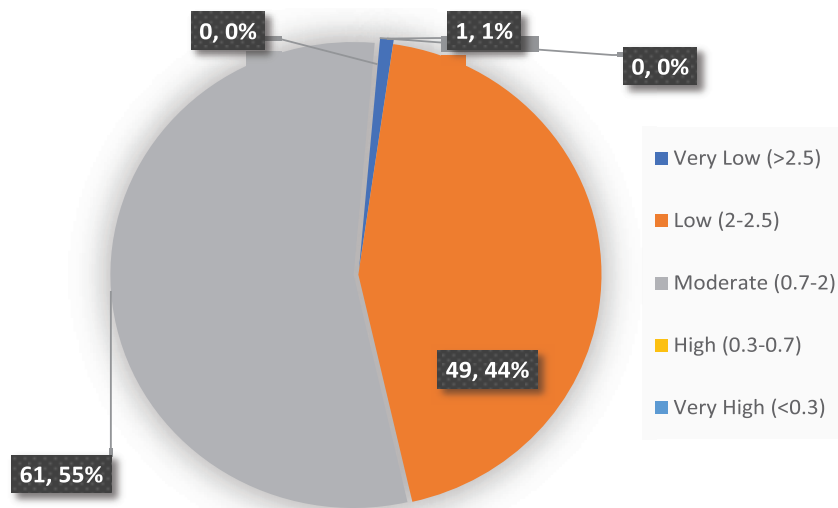


Figure 6: FEMA P 154 Vulnerability Score (EVS) Distribution

The FEMA P-154 Rapid Visual Screening procedure was applied by first assigning a Basic Structural Score based on building type and seismic-topographic setting. The resulting final screening scores represent the relative seismic vulnerability of individual government buildings. Following the damage-grade-based classification proposed by Harirchian et al. (2020), the assessed buildings were categorized into five vulnerability classes. The results indicate that the majority of buildings fall within the moderate (61 number, 55%) and low (49 building, 44%) vulnerability categories, with only 1% classified as very low vulnerability and no buildings falling into the high or very high vulnerability classes.

3.3 Comparison of Vulnerability Assessment Methods

The vulnerability distributions from the Empirical Vulnerability Method (Gautam et al., 2020) and the FEMA P-154 Rapid Visual Screening method are shown in Figures 5 and 6, respectively, and Figure 7 compares the vulnerability levels from the two methods building-wise. Both approaches consistently show that the majority of the government office buildings surveyed fall into the low to moderate vulnerability categories, with no buildings classified as highly or very highly vulnerable.

The building-wise comparison demonstrates a high degree of consistency as the vulnerability levels assigned by the two approaches are either the same for the majority of buildings or differ by just one vulnerability class. In contrast to the empirical approach, FEMA P-154 tends to assign comparatively higher vulnerability levels for specific buildings. The conservative approach of FEMA P-154, which uses penalizing score modifiers for plan and vertical irregularities, code non-compliance, soil conditions, and possible pounding effects, is primarily responsible for this discrepancy. Gautam et al.'s (2020) empirical approach, on the other hand, favors the predominance of reinforced concrete frame buildings found in the inventory because it is locally calibrated and gives more weight to structural system type, construction age, and workmanship.

Overall, the comparative results indicate that although both approaches produce consistent vulnerability trends, the empirical method offers a context-specific assessment that reflects Nepalese construction practices, while FEMA P-154 offers a more conservative screening outcome appropriate for prioritization. The results of the vulnerability assessment are more reliable because of the strong agreement between the two methods.

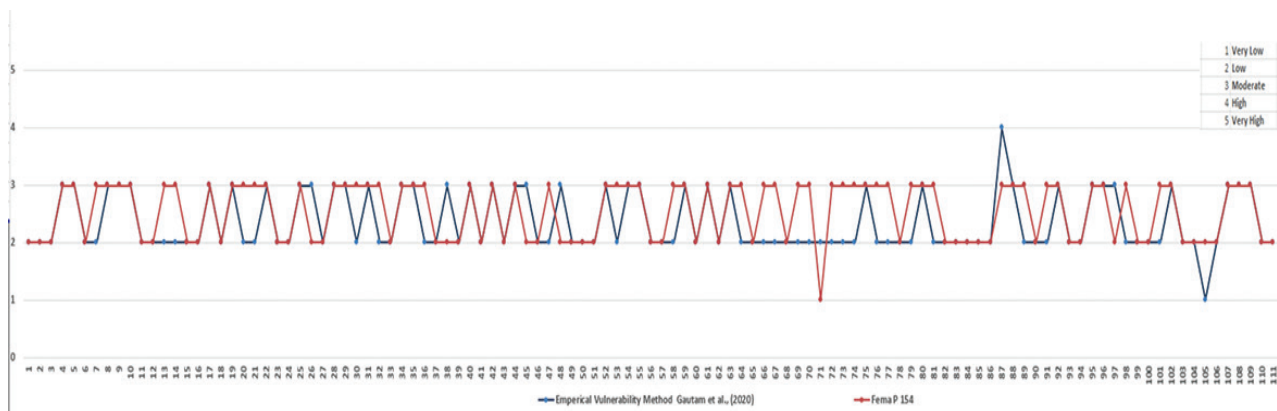


Figure 7: Building-wise Comparison of Vulnerability Levels

4. Conclusions

A comprehensive assessment of government office buildings in Pokhara Metropolitan City shows that the building stock is largely composed of low- to mid-rise reinforced concrete frame structures, with notable concerns related to pre-code construction, geometric irregularities, post-construction modifications, and limited functional accessibility. Preliminary seismic vulnerability evaluation using the empirical method of Gautam et al. (2020) and the FEMA P-154 Rapid Visual Screening approach indicates that most buildings fall within low to moderate vulnerability categories, with no buildings identified as very highly vulnerable. Comparative analysis reveals strong consistency between the two methods, although FEMA P-154 generally yields more conservative classifications due to its penalty-based scoring of irregularities, code non-compliance, and site conditions. The main variables affecting seismic risk are structural system type, construction age, irregularity of the plan, and unapproved modifications. The results emphasize the necessity

of giving vulnerable buildings top priority for thorough evaluation supported by material testing and site-specific geotechnical data to validate and refine rapid screening results and guide retrofitting strategies in order to increase the seismic resilience of crucial government infrastructure.

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