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ASSESSMENT OF VULNERABLE BUILDING AND REQUIREMENT FOR THEM TO PREVENT FROM DISASTER: A CASE STUDY FROM KATHMANDU METROPOLITAN CITY, NEPAL

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ABSTRACT

The study aims to assess the vulnerability of buildings in Kathmandu Metropolitan City which is susceptible to natural disasters, particularly earthquakes, floods, landslides and and identify the requirements necessary to prevent disaster-related damage. This study evaluates the current state of building vulnerability, focusing on the structural integrity of residential, commercial, and public buildings, and the effectiveness of existing regulations in mitigating disaster risks. The research utilizes a combination of field surveys, structural assessments, and interviews with local authorities, engineers, and residents to identify critical areas where vulnerability is most pronounced.This study underscores the urgent need for a holistic approach to disaster risk management, involving both government agencies and local communities, to safeguard Kathmandu Metropolitan City from future disasters.

Keywords: *Vulnerable buildings, disaster prevention, National Building Code (NBC), building code enforcement, retrofitting, earthquake resilience, disaster risk reduction*

1. INTRODUCTION

Nepal ranks among the world's most disaster-prone countries because it lies within the highly seismically active Himalayan belt. The 7.8-magnitude Gorkha earthquake in 2015 caused extensive destruction, claiming nearly 9,000 lives and severely damaging infrastructure, particularly in the Kathmandu Valley. The event highlighted the fragility of Nepal's built environment, which is dominated by unreinforced masonry buildings and inadequately constructed high-rise structures that fail to meet seismic safety requirements. Although the National Building Code (NBC) was introduced in 1994, its implementation and enforcement have remained limited, especially in rapidly expanding urban areas characterized by unplanned development (1).

Most of Kathmandu's building stock continues to face high risk due to weak execution of retrofitting programs and inadequate urban planning frameworks (2). Although being non homogeneous, concrete is treated as homogeneous material in design. The method of manufacturing and ingredient materials results on change in its strength and structural properties. To increase tensile strength of concrete, sometimes steel reinforcement is included which is known as Reinforced Cement Concrete (RCC) also called reinforced Concrete simply (3). Even though the RCC construction was started in early 1980s, engineered construction was only felt after enforcement

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of building codes in 2006 and almost 70 % of existing RC buildings are either owner-built constructions constructed with the help of contractors following by-laws or 3 constructed as per the mandatory rules of thumbs as suggested by Nepal Building Code (4). While planning, developing, and building structures to meet our requirements, we should think globally and act locally. Some of the most crucial criteria for developing resilient buildings are the choice of acceptable locations, the availability of community infrastructure, the use of appropriate technologies, and following to building codes and byelaws **(5).**

2. MATERIALS AND METHODS

The research problem was idenfied, data were collected through primary and secondary survey and data were analysed and interrelated using RRI method.

2.1 Study Area

The survey for this study was carried out in   Kathmandu Metropolitan City.

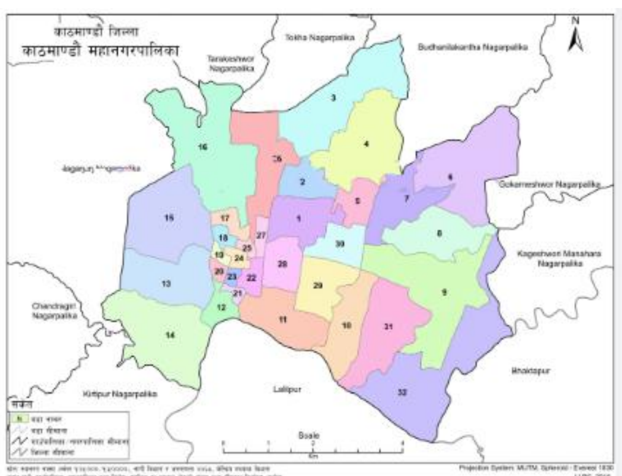

Fig. 2.1: Map of Study area 2.2 Study Period

The overall duration of this research was approximately six months, spanning from November 2025 to April 2026.

2.3 Sampling Technique, Sampling Size and Data Collection

In this study, the population means all the stakehodders of projects, including personnel of Client, Consultant including relevant expert on the field, Contractor, Sub-Contractor, the total population (N) size is taken as 33968.

$$n = \frac{N}{(1+N(e)^2)}$$

Where,

N= Population Size (N=33968)

e= Desired Level of Precision

e=7%=0.07

Then,

n= 33968/ (1+33968*(0.07)^2)

n=202.86~203

2.4 Data Analysis and Interpretation

Theory of data analysis is Relative Importance Index (RII): The formula for deriving RII for each factor is given as follows:

Table 1.1 :RII Table

Item	Excellent	Very Good	Good	Poor	Strongly Poor
Scale	5	4	3	2	1

Relative importance index (RII) = $(\sum W)/AN = (5n_5+4n_4+3n_3+2n_2+1n_1)/5N$
Where w the weightage is given to each factor by the respondent, ranging from 1 to 5;

- n_5 number of respondents selecting total Excellent or always;
- n_4 number of respondents selecting Very Good or often;
- n_3 number of respondents selecting neutral or sometimes;
- n_2 number of respondents selecting Poor or rarely;
- n_1 number of respondents selecting total Strongly Poor or never; and
- N the total number of respondents.

3. RESULTS AND DISCUSSIONS

3.1 Characteristics of Respondents

3.1.1 Gender of Respondents

The total respondents were classified according to the gender. Among 160 respondents, 66.25 percent were Male and 33.75 percent were Female. The percentage of the classification is shown in the Fig. below

3.1.2 Age of Respondents

The respondents were classified according to their age. Among the total, 3.21 percent were of below 20 years, 25.79 percent were between 20 to 30 years, 30.45% were between 30 to 40 years and 27.88% of them were between 40-50 and 12.67 percent of them were between50-60 years. The percentage classification is shown in the Fig. below.

3.1.3 Profession of Respondents

The sample size of 160 nos. was selected and interviewed in this process. Out of 160 respondents, there were differences in the numbers of Engineers/Overseers, Consultants, and Contractors, Business and others, students and others who participated in the questionnaire's survey from the study areas. Among them, 13.96 percent were from consultants, 11.35 percent were from Business sector, 5.53 percent were Contractors, 45.76 percent were Engineers/Overseers, and 23.4 were form others. The percentage of the respondents is presented in the Fig. below.

3.1.4 Education of Respondents

Among the total respondent’s 17.75 percent were Intermediate/+2 Level, 29.73 percent were Bachelor, Level 41.21 percent respondents were Master Level and 11.31 percent of the respondents were PhD the percentage of the classification is shown in the Fig. below.

3.2. Problems in Assessment of Vulnerable Building and Requirement for Them to Prevent from Disaster: A Case Study from Kathmandu Metropolitan City Nepal

In the ranking based on the Relative Importance Index (RII) values, Problems On Problems in Assessment of Vulnerable Building and Requirement for Them to Prevent From Disaster: A Case Study From Kathmandu Metropolitan City Nepal is “Lack of Comprehensive Risk Mapping” which has received the highest rank with an RII of 0.90. Conversely, “Inadequate Post-Disaster Recovery Plans” received the lowest rank with an RII of 0.59, as depicted in Fig. 3.5.

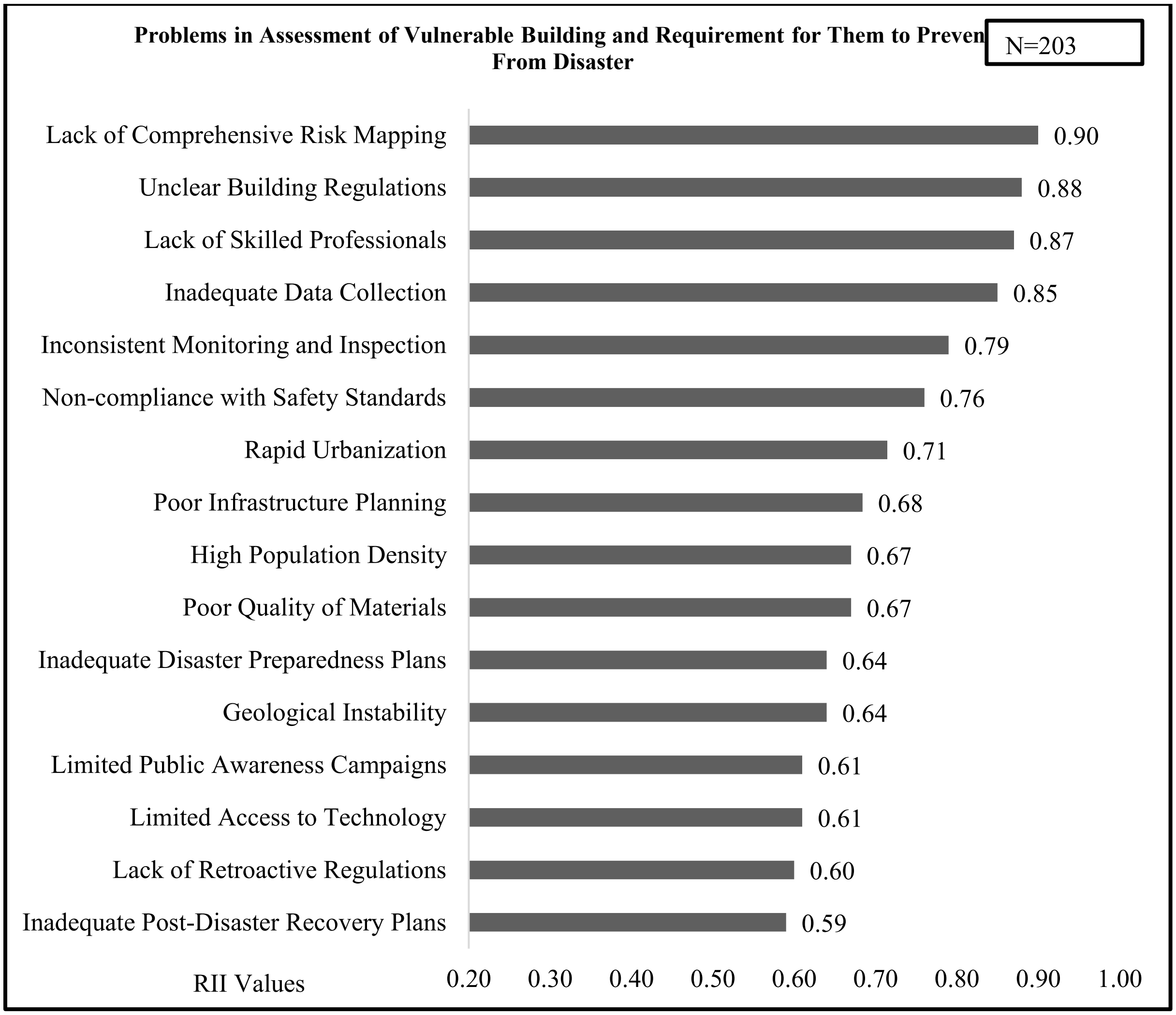

Fig. 3.1: Problems in Assessment of Vulnerable Building and Requirement for Them to Prevent from Disaster

3.2.1. Causes and Effects of Lack of Comprehensive Risk Mapping

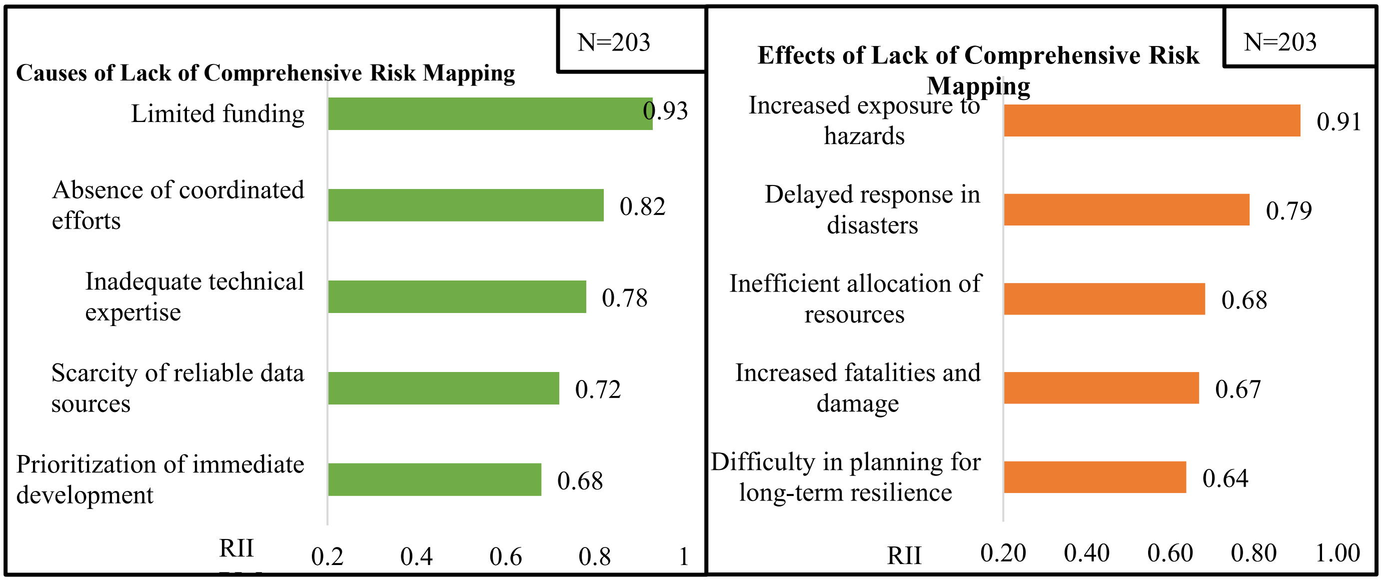

Fig. 3.2: Causes and Effects of Lack of Comprehensive Risk Mapping

3.2.2. Causes and Effects of Unclear Building Regulations

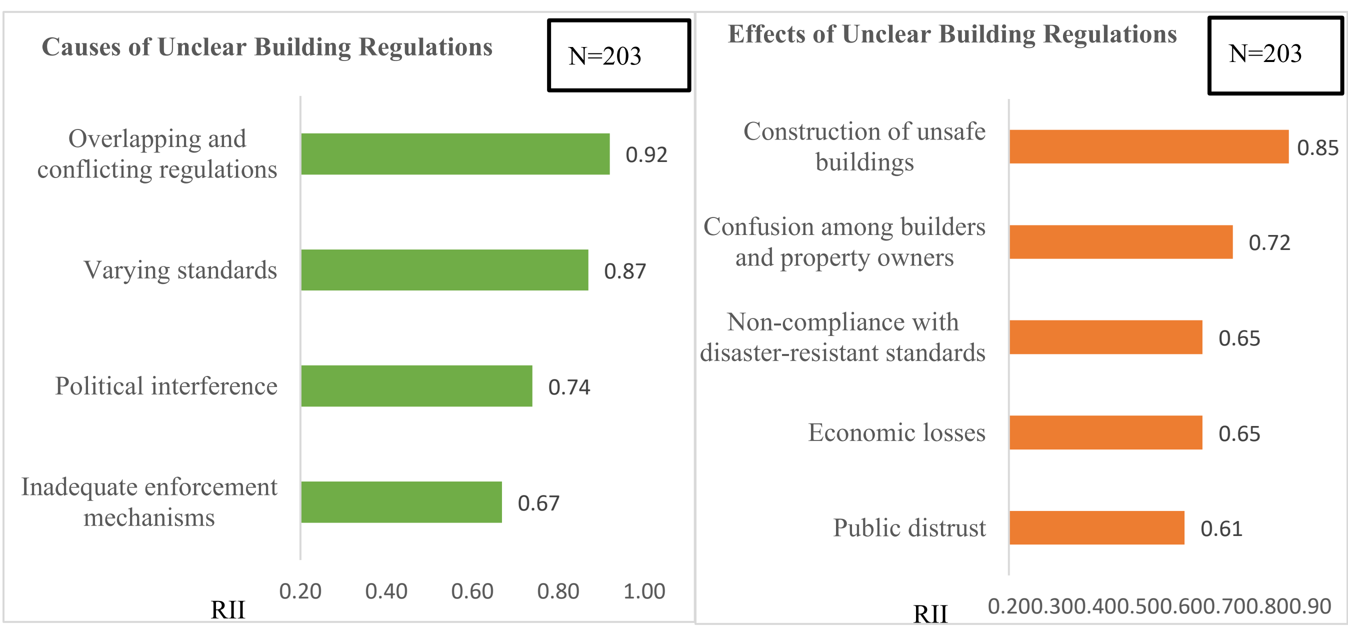

Fig. 3.7: Causes and effects of Unclear Building Regulations

3.2.3 Causes and Effects of Lack of Skilled Professionals

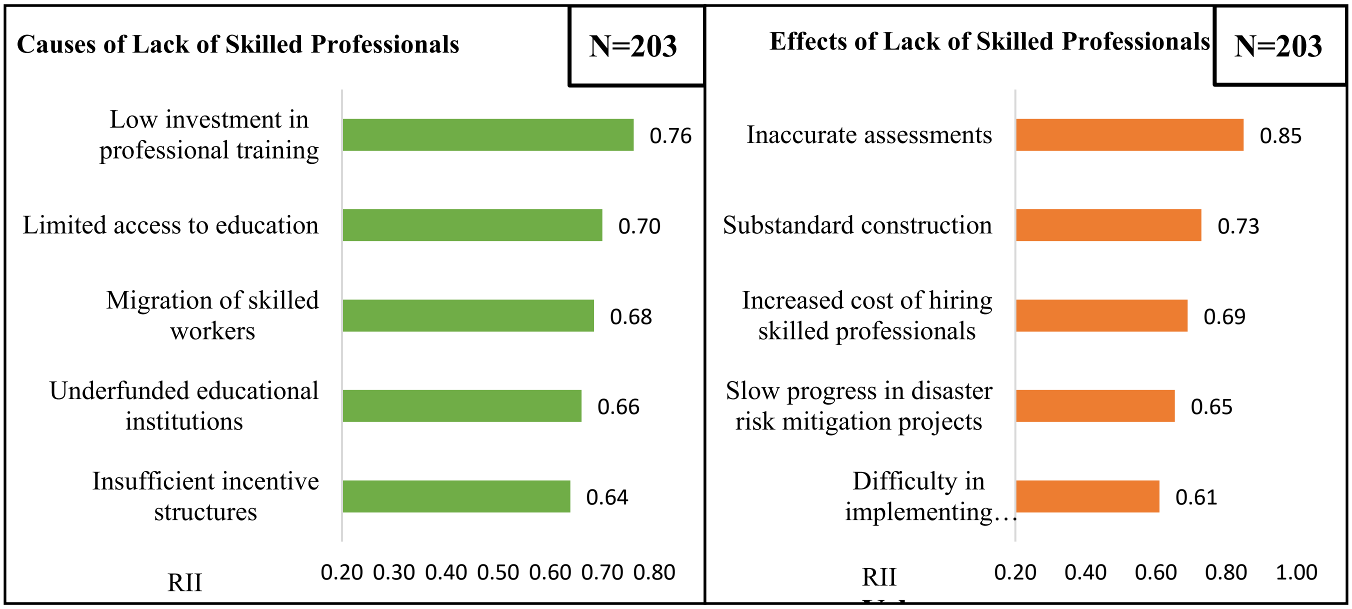

Fig. 3.8: Causes and effects of Lack of Skilled Professionals

3.2.4 Causes and Effect of Inadequate Data Collection

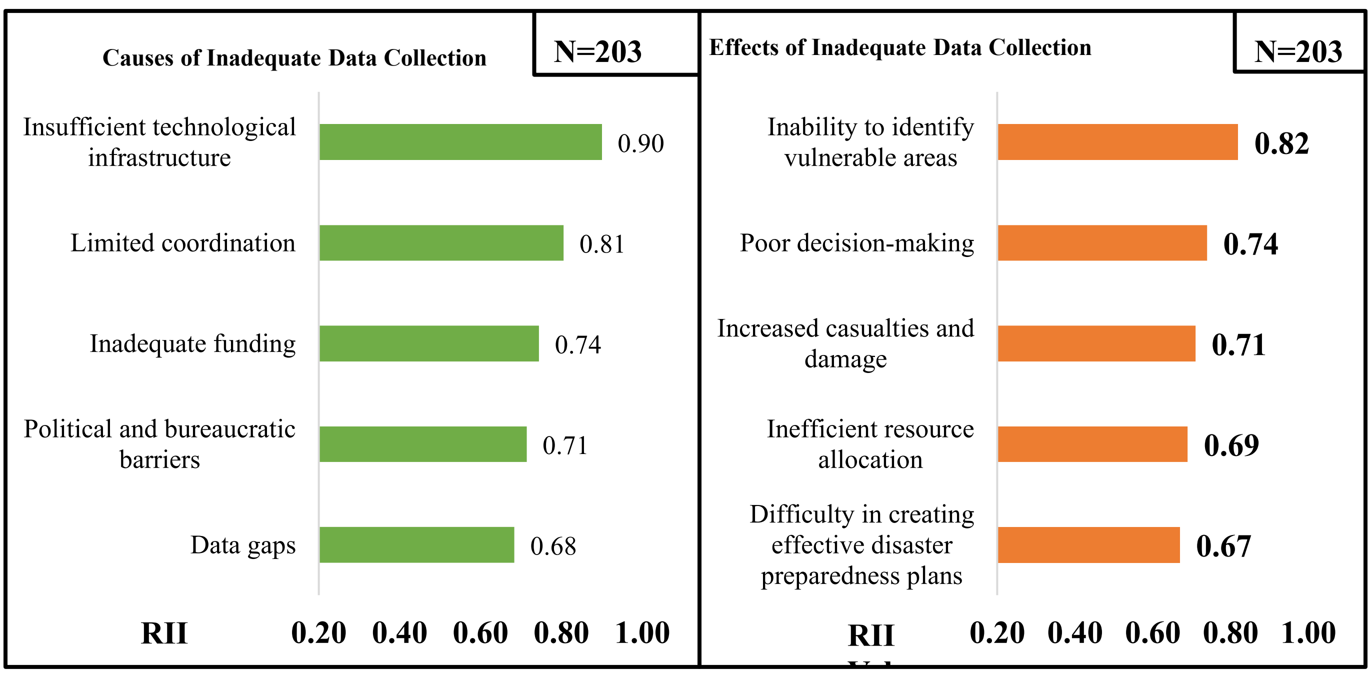

Fig. 3.9: Causes and Effects of Inadequate Data Collection

3.2.5 Causes and Effects of Inconsistent Monitoring and Inspection

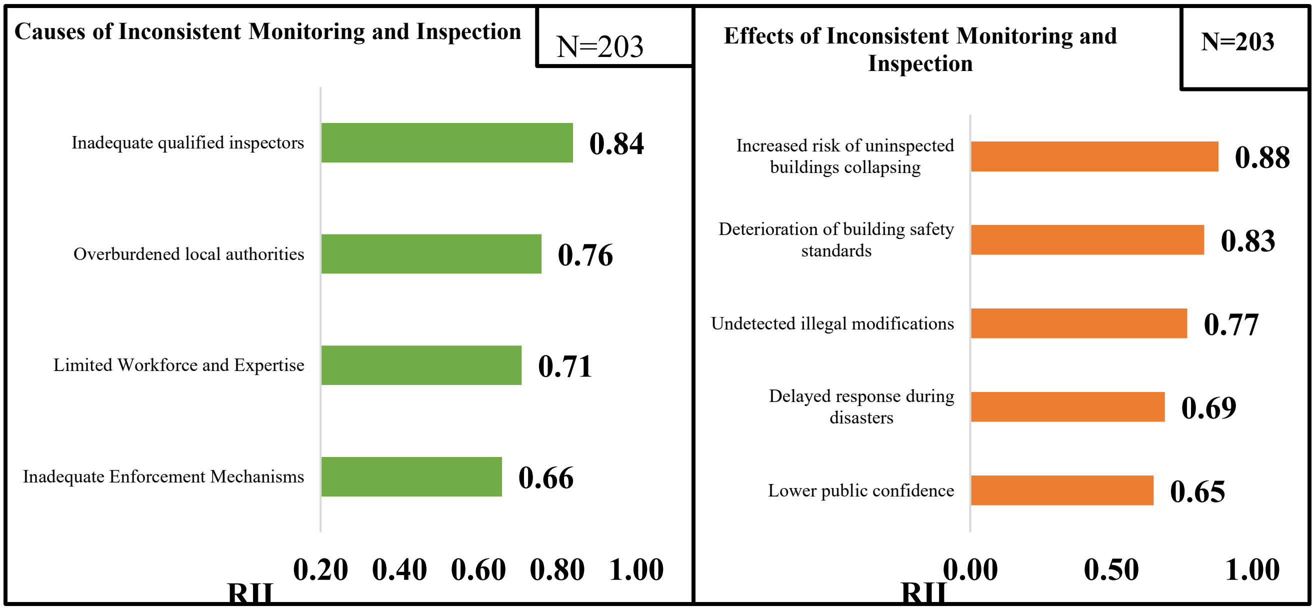

Fig. 3.10: Causes and effects of Inconsistent Monitoring and Inspection

3.2.6 Causes and Effects of Non-compliance with Safety Standards

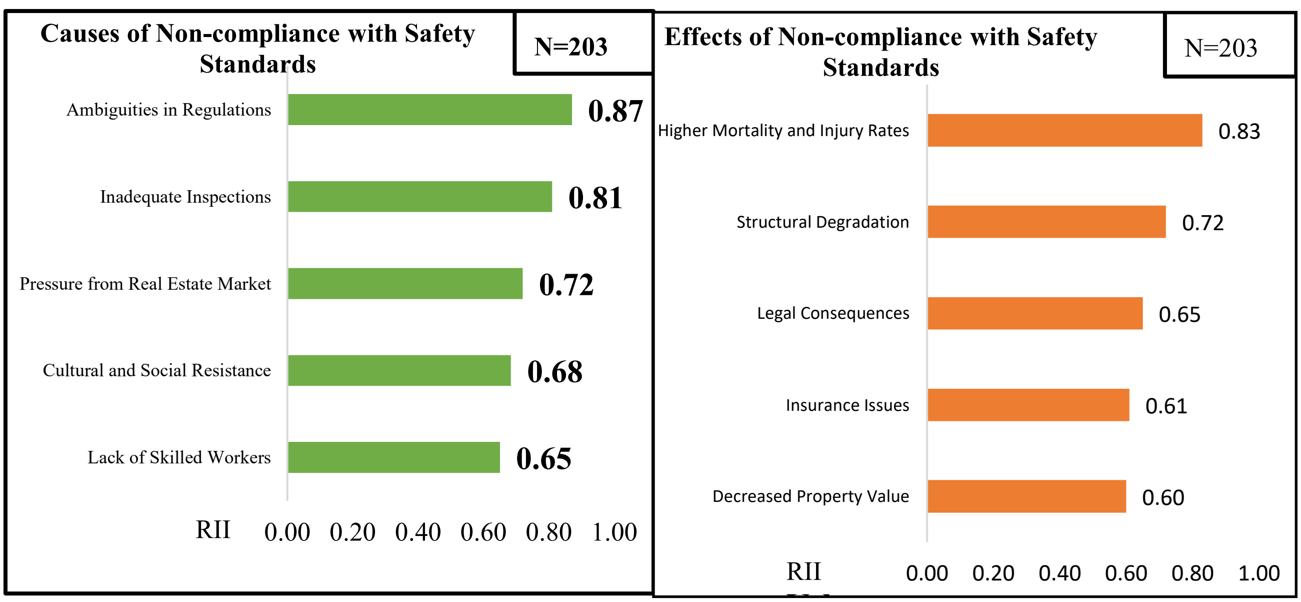

Fig. 3.10: Causes and Effects of Nom Compliance with safety standards

3.2.7 Causes and Effects of Rapid Urbanization

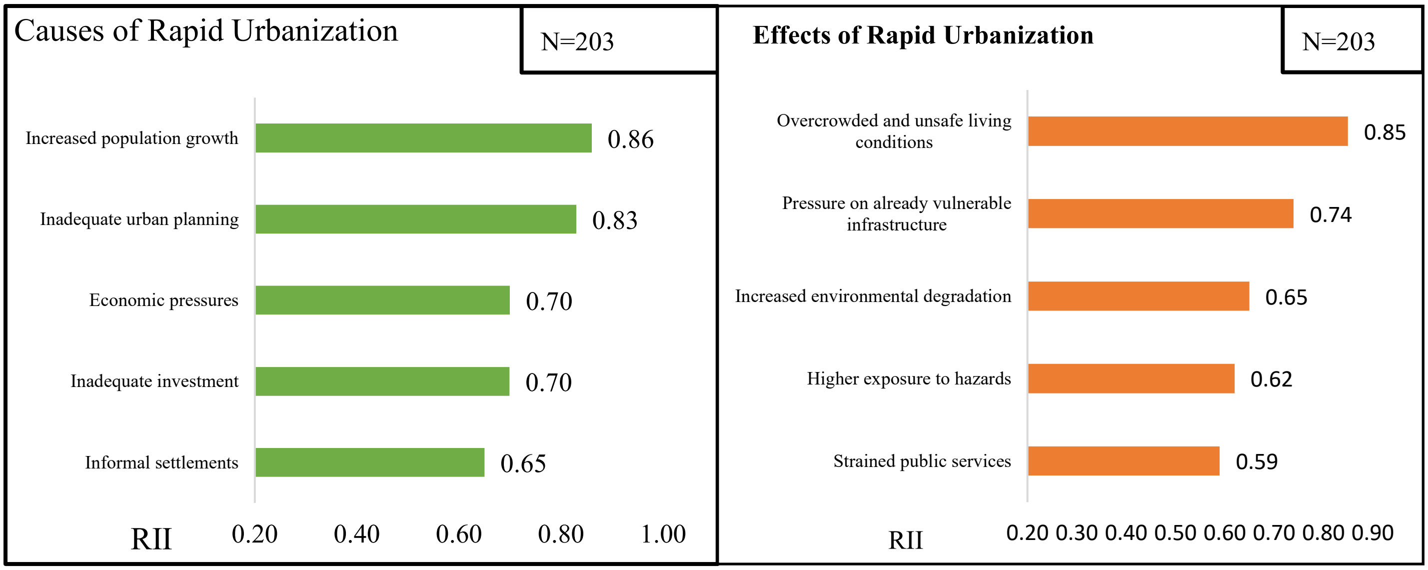

Fig. 3.11: Causes and effect of Rapid Urbanization

3.2.8 Causes and effects of Poor Infrastructure Planning

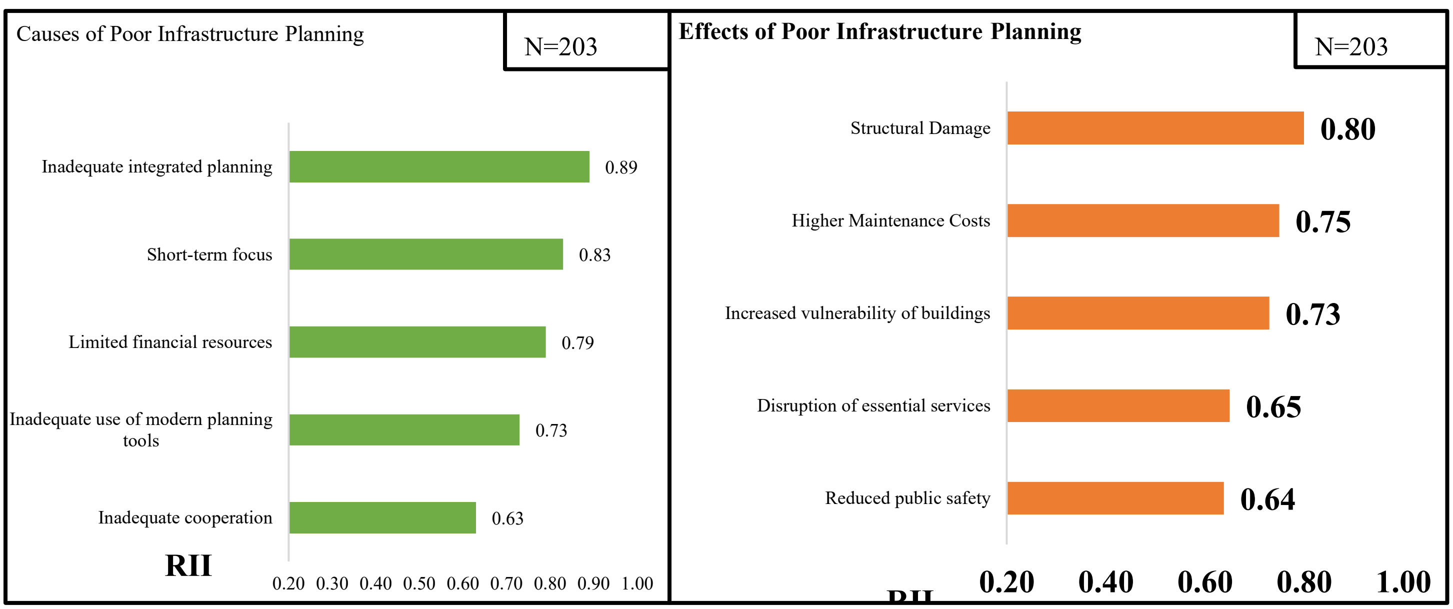

Fig. 3.12: Causes and effects of Poor Infrastructure Planning

3.2.9 Causes and Effects of High Population Density

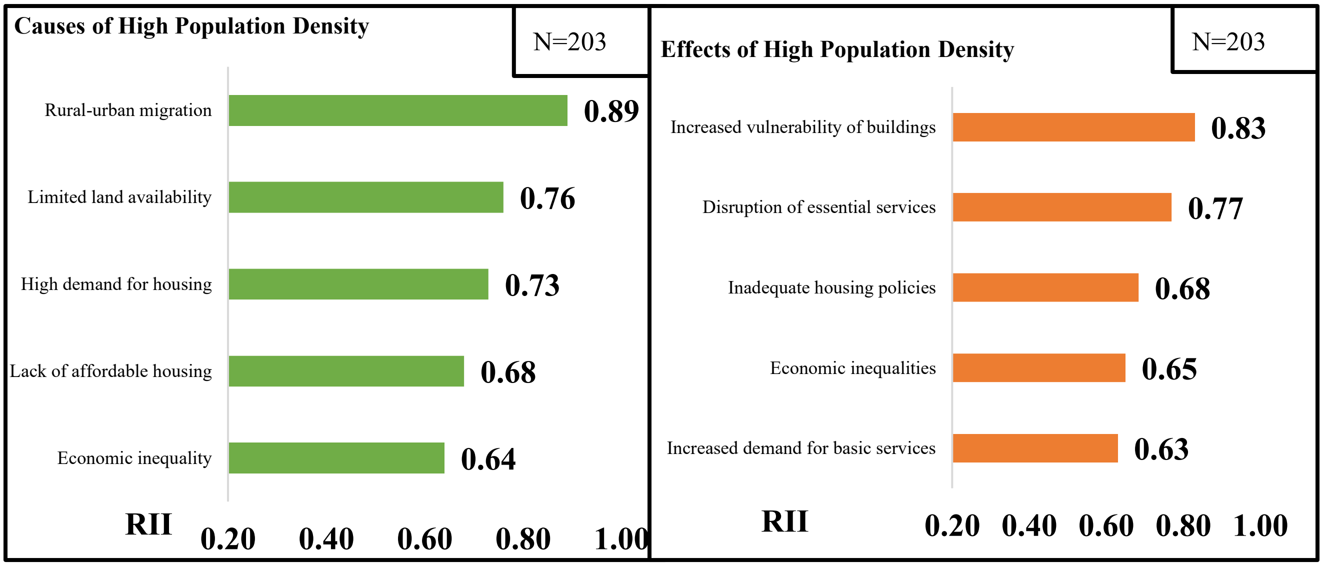

Fig. 3.13: Causes and effects of High Population Density

3.2.10 Causes and effects of Poor Quality of Materials

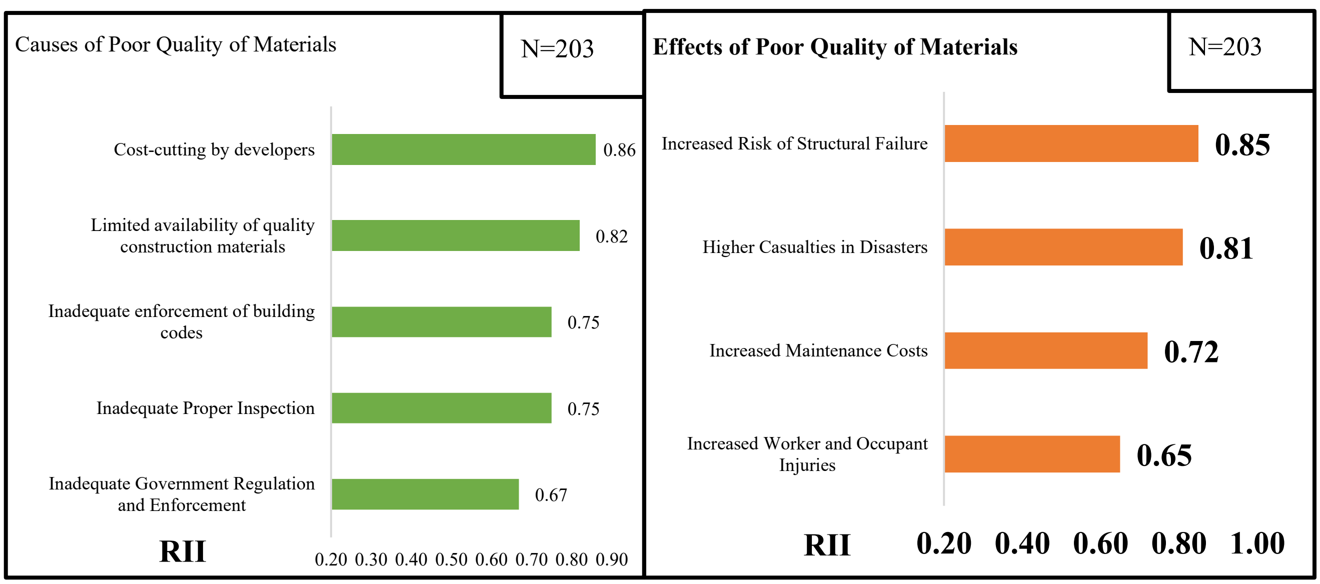

Fig. 3.14: **Causes and effects of** Poor Quality of Materials

3.2.11 Causes and Effects of Inadequate Disaster Preparedness Plans

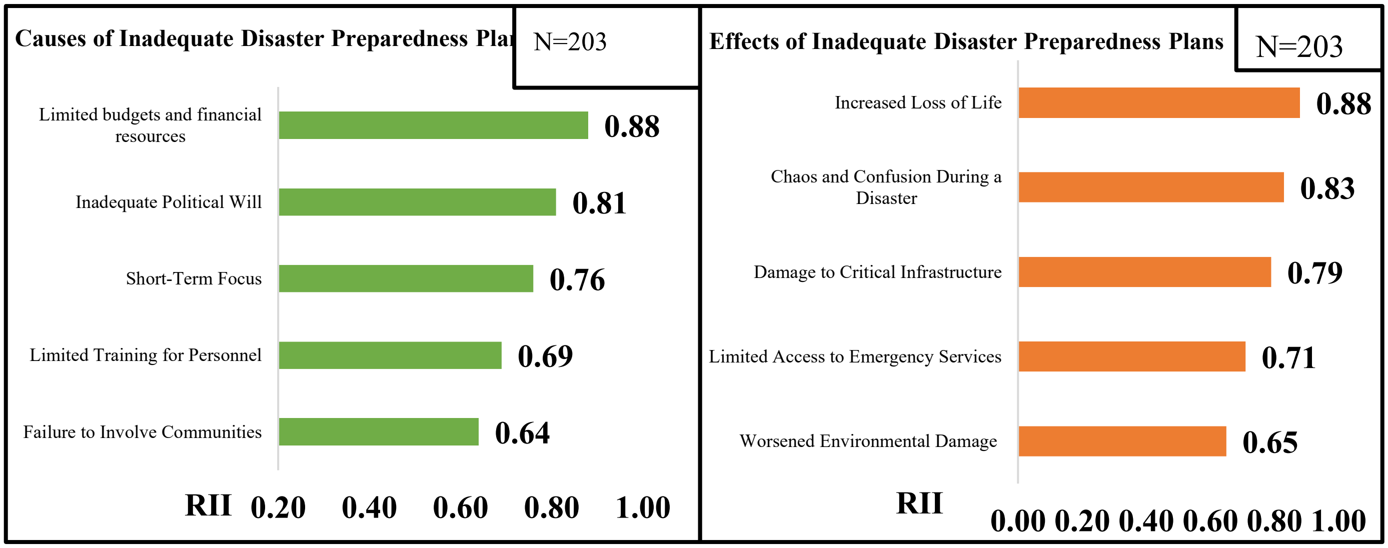

Fig. 3.16: **Causes and effects of** Inadequate Disaster Preparedness Plans

3.2.12 Causes and Effects of Geological Instability

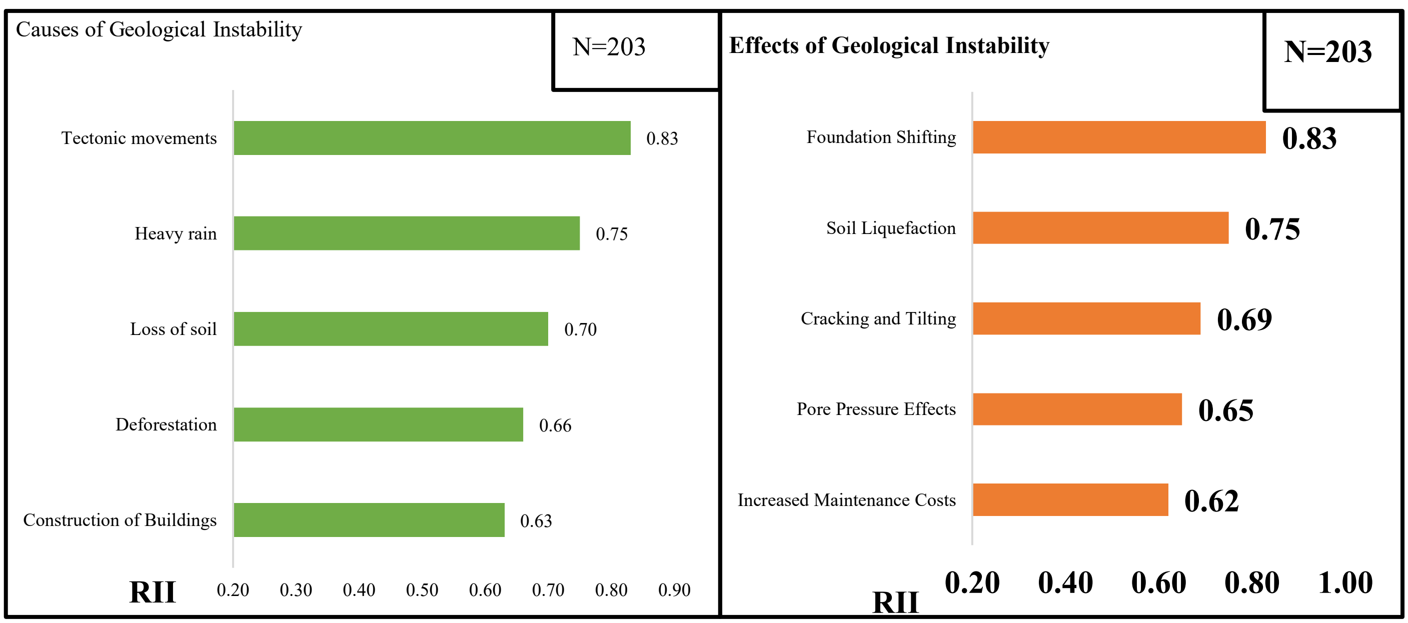

Fig. 3.17: Causes and effects of Geological Instability

3.2.13 Causes and Effect of Limited Public Awareness Campaigns

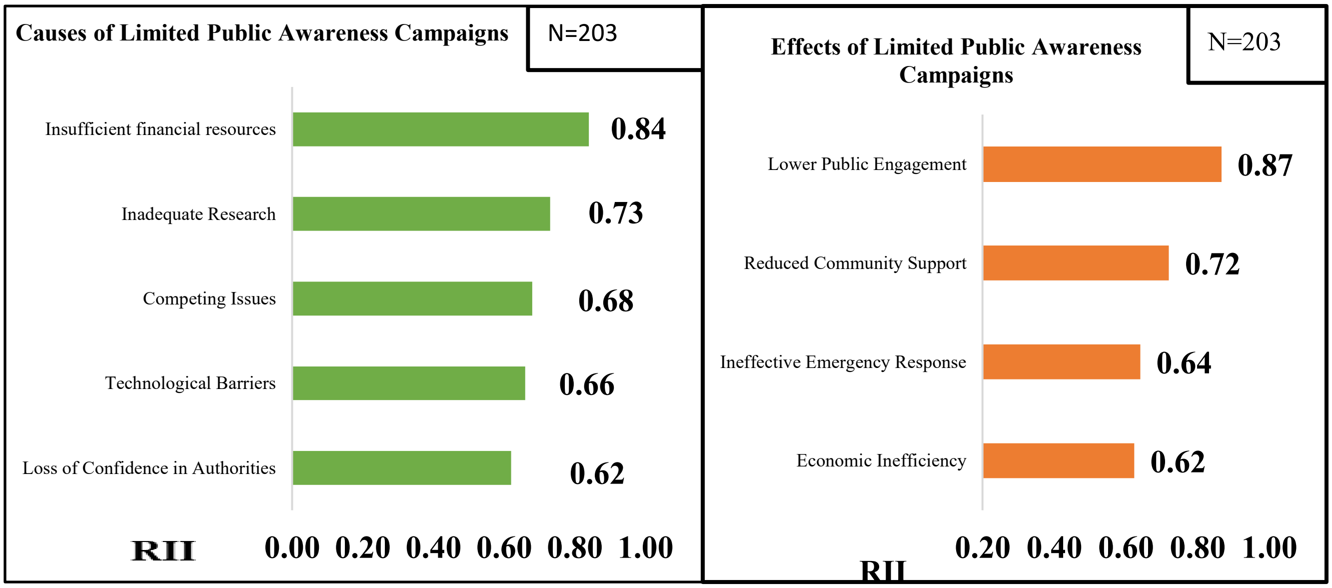

Fig. 3.18: Causes and effects of Limited Public Awareness Campaigns

3.2.14 Causes and Effect of Limited Access to Technology

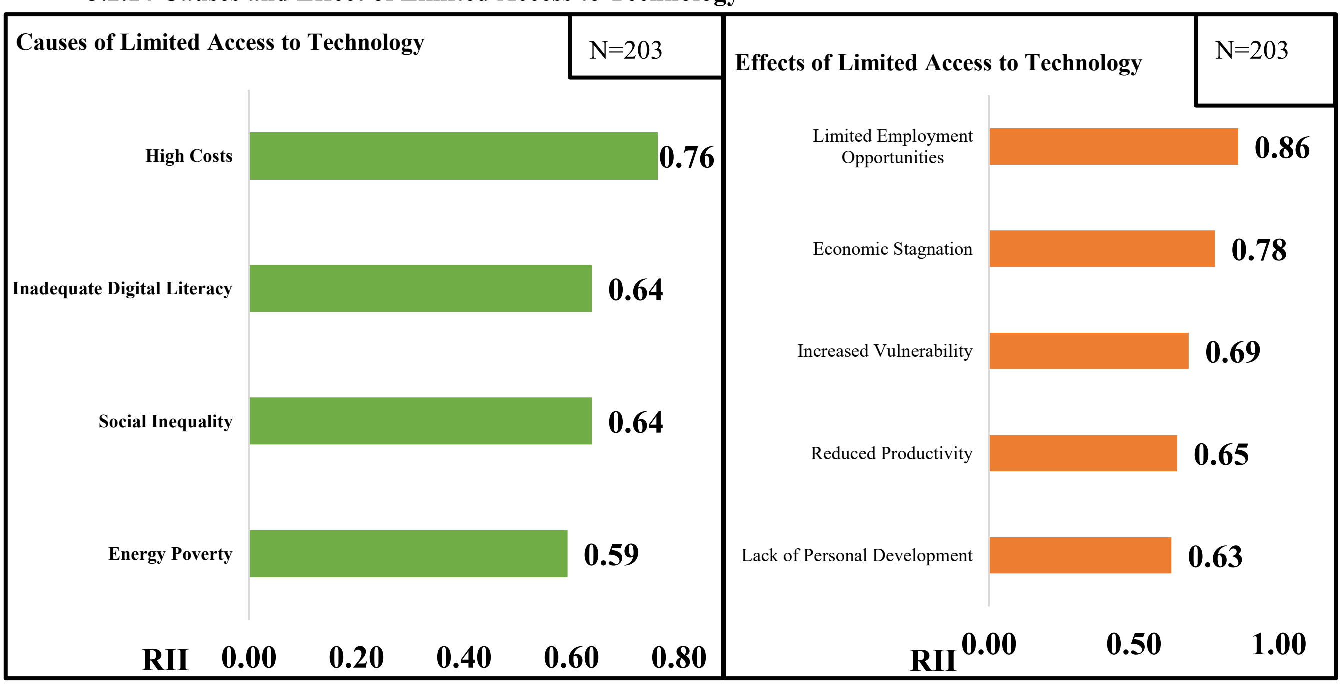

Fig. 3.19: Causes and effect of Limited Access to Technology

3.2.15 Causes and effects of Retroactive Regulations

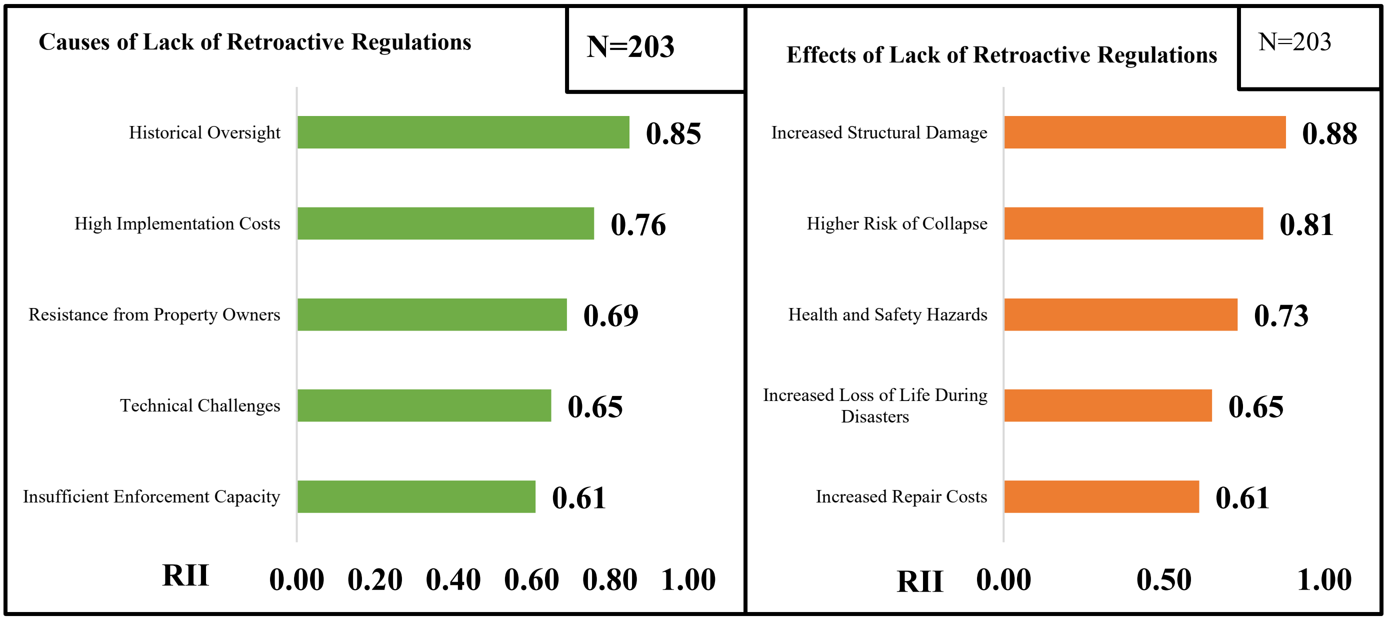

Fig. 3.20: Causes and effects of Retroactive Regulations

3.2.16 Causes and effect of Inadequate Post-Disaster Recovery Plans

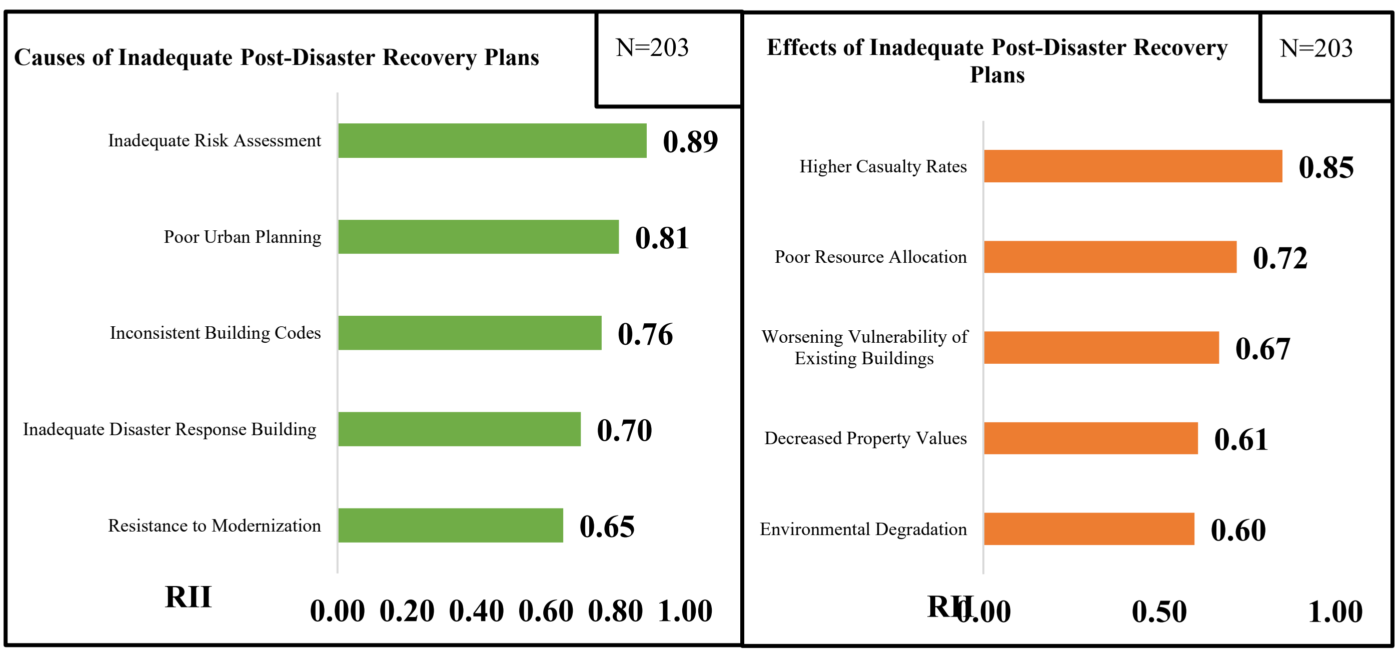

Fig. 3.21: Causes and effect of Inadequate Post-Disaster Recovery Plans

3.2.17 Mitigation Measure in Assessment of Vulnerable Building and Requirement for Them to Prevent from Disaster

In the ranking based on the Relative Importance Index (RII) values, the main Mitigation Measure in Assessment of Vulnerable Building and Requirement for Them to Prevent from Disaster is “Develop and implement detailed risk maps using GIS technology” which has received the highest rank with an RII of 0.89. Conversely, is “Develop comprehensive post-disaster recovery plans” received the lowest rank with an RII of 0.61 as depicted in Fig. below:

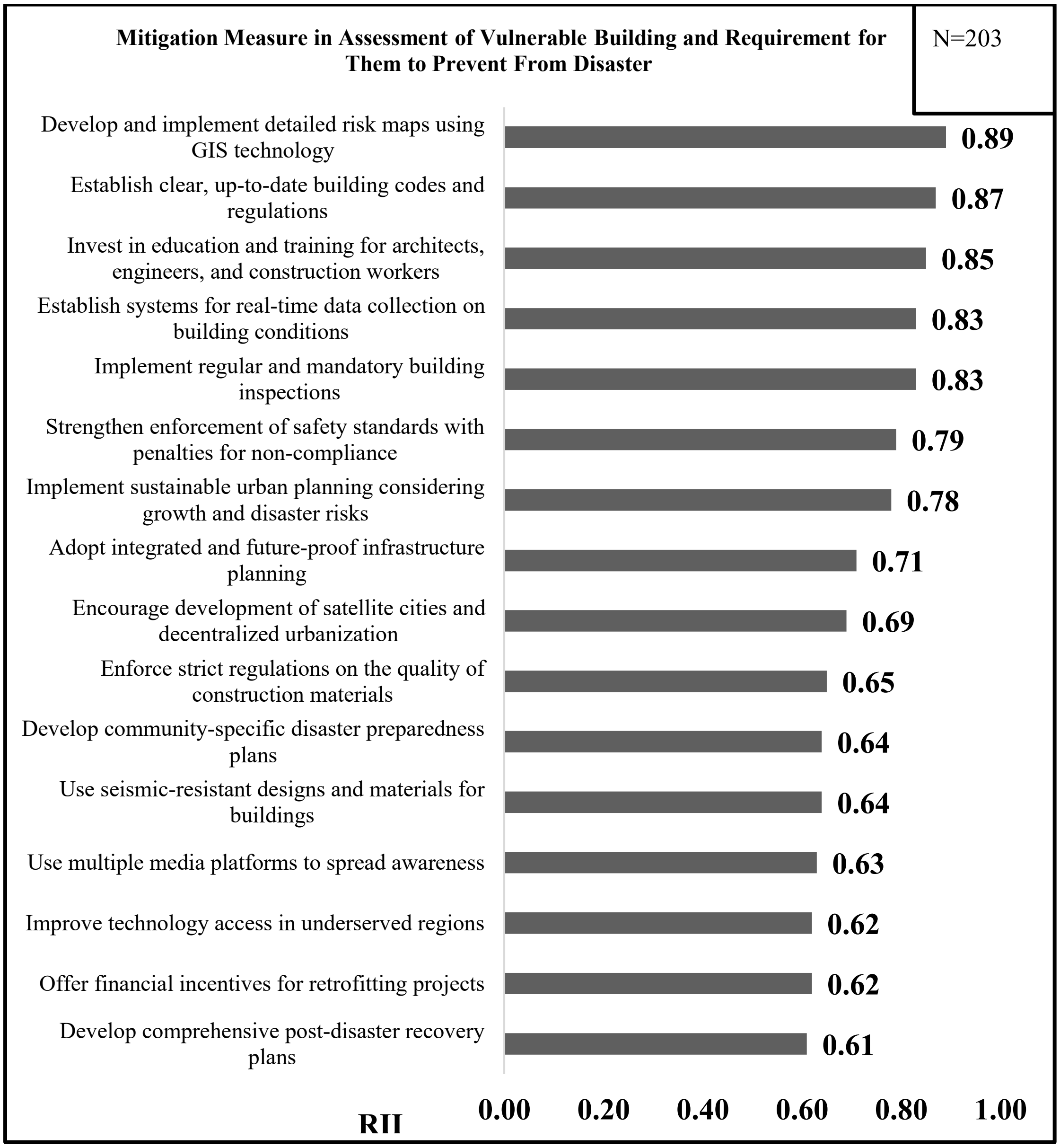

Fig. 3.22: Mitigation Measure in Assessment of Vulnerable Building and Requirement for Them to Prevent from Disaste

3.3 Summary of Multi Hazard Tool Index

Vulnerability assessment of Ward No.20

The vulnerability assessment of Ward No.20 is shown in the Fig. 4.45. The building has the compliance index of 0.28. The architectural has the compliance index 0.15. The structural has the compliance index of 0.15 where the nonstructural has the compliance index of 0.13.

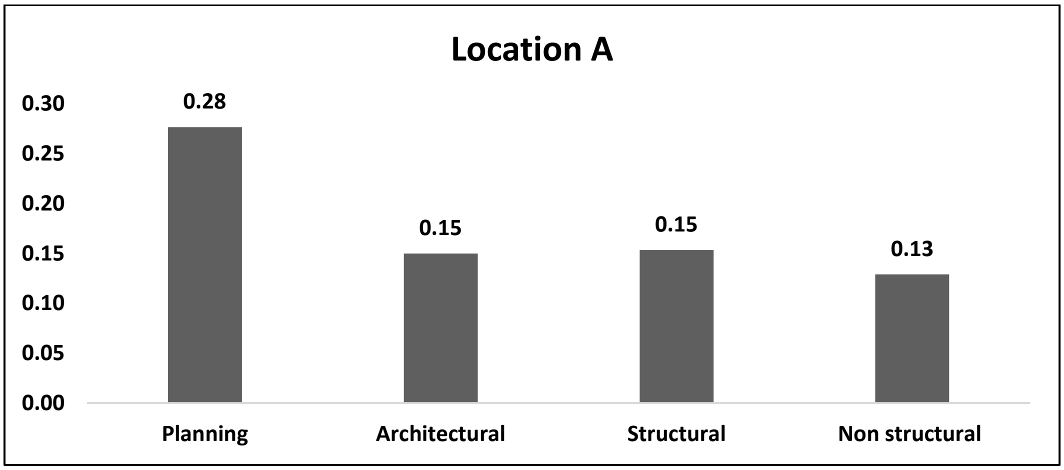

Fig. 3.23: Vulnerability assessment of Ward No.20

Vulnerability assessment of Ward 19 & 25

The vulnerability assessment of Ward 19 & 25 is shown in the Fig. 4.46. The building has the compliance index of 0.26. The architectural has the compliance index 0.29. The structural has the compliance index of 0.23 where the nonstructural has the compliance index of 0.13.

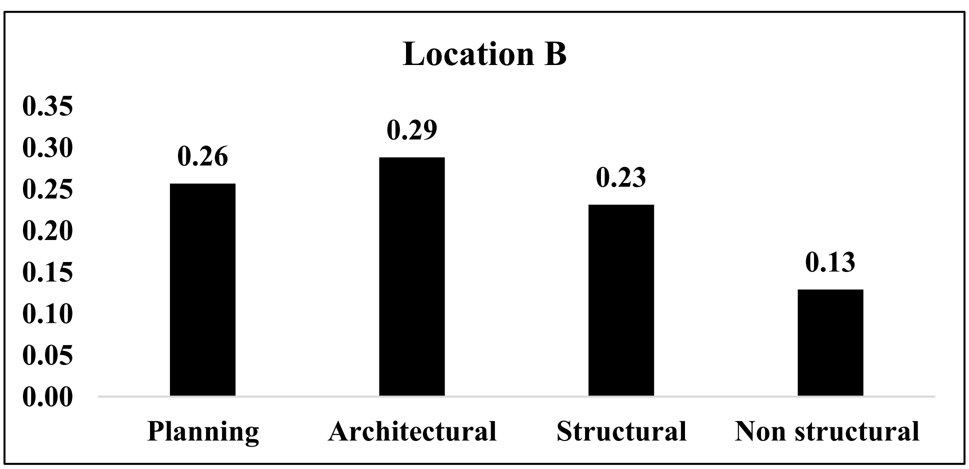

Fig. 3.24: Vulnerability assessment of Ward 19 & 25

Vulnerability Assessment of Ward 20 & 21

The vulnerability assessment of Ward 20 & 21 is shown in the Fig. 4.47. The building has the compliance index of 0.55. The architectural has the compliance index 0.39. The structural has the compliance index of 0.30 where the nonstructural has the compliance index of 0.13.

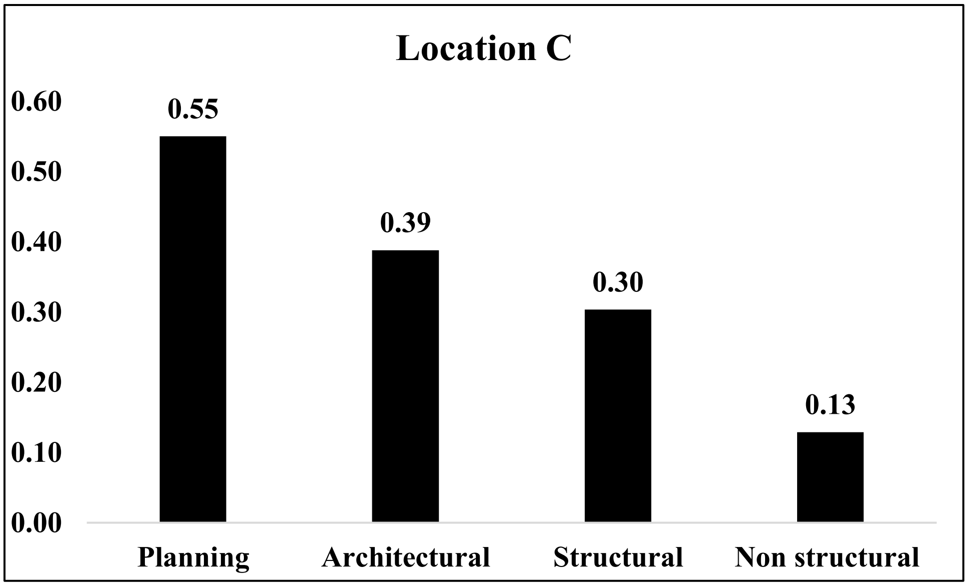

Fig. 3.25: Vulnerability assessment of Ward 20 & 21

Vulnerability Assessment of Ward 12

The vulnerability assessment of Ward 12 is shown in the Fig. 4.48. The building has the compliance index of 0.38. The architectural has the compliance index 0.26. The structural has the compliance index of 0.21 where the nonstructural has the compliance index of 0.13.

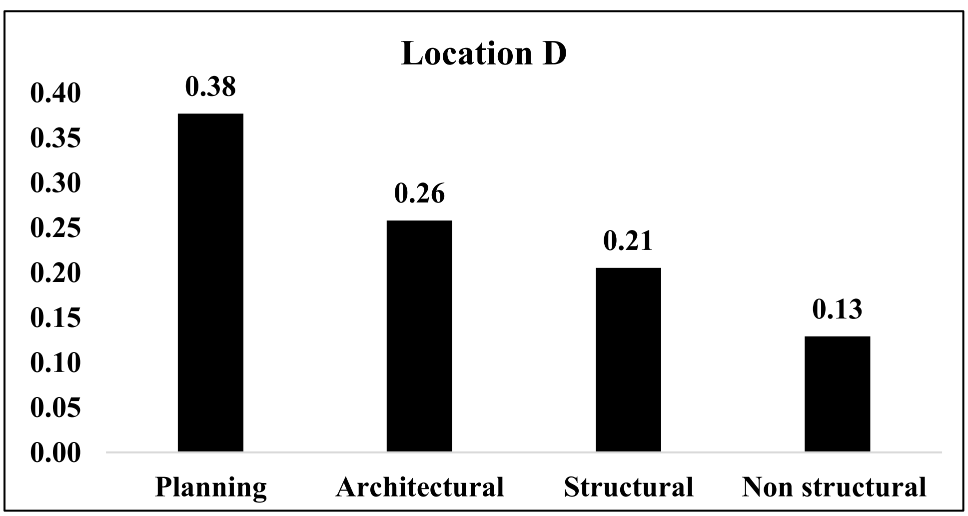

Fig. 3.26: Vulnerability assessment of Ward 12

Vulnerability Assessment of Ward 21

The vulnerability assessment of Ward 21 is shown in the Fig. 4.49. The building has the compliance index of 0.61. The architectural has the compliance index 0.67. The structural has the compliance index of 0.63 where the nonstructural has the compliance index of 0.40.

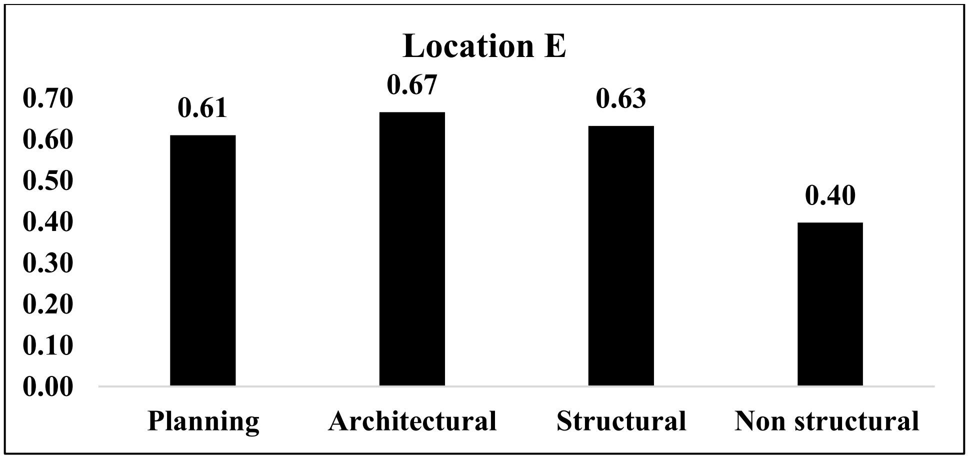

Fig. 3.27: Vulnerability assessment of Ward 21

Vulnerability Assessment of Ward 12 & 22

The vulnerability assessment of Ward 12 & 22 is shown in the Fig. 4.50. The building has the compliance index of 0.52. The architectural has the compliance index 0.23. The structural has the compliance index of 0.32 where the nonstructural has the compliance index of 0.13.

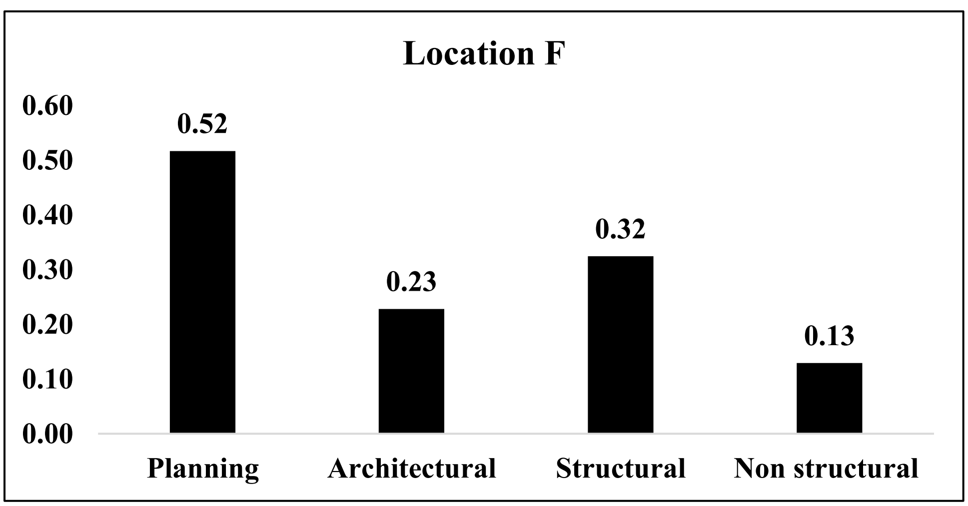

Fig. 3.28: Vulnerability assessment of Ward 12 & 22 d

Vulnerability Assessment of Ward 21 & 22

The vulnerability assessment of Ward 21 & 22 is shown in the Fig. 4.51. The building has the compliance index of 0.76. The architectural has the compliance index 0.55. The structural has the compliance index of 0.60 where the nonstructural has the compliance index of 0.40.

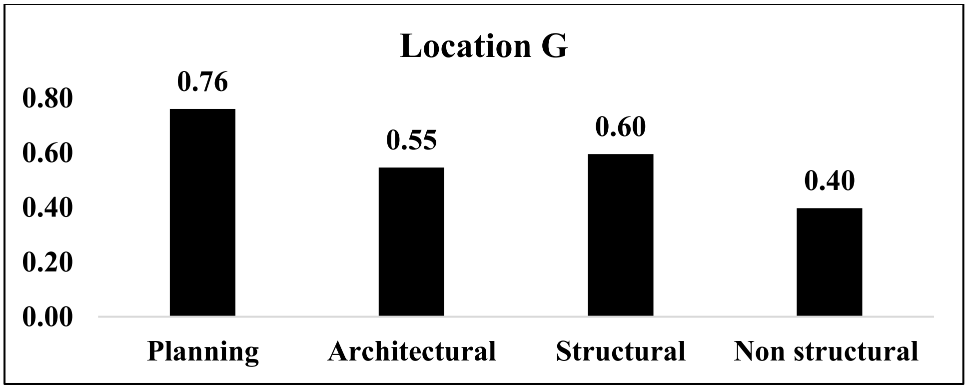

Fig. 3.29: Vulnerability assessment of Ward 21 & 22

Vulnerability Assessment of Ward 23 & 27

The vulnerability assessment of Ward 23 & 27 is shown in the Fig. 4.52. The building has the compliance index of 0.48. The architectural has the compliance index 0.61. The structural has the compliance index of 0.86 where the nonstructural has the compliance index of 0.25.

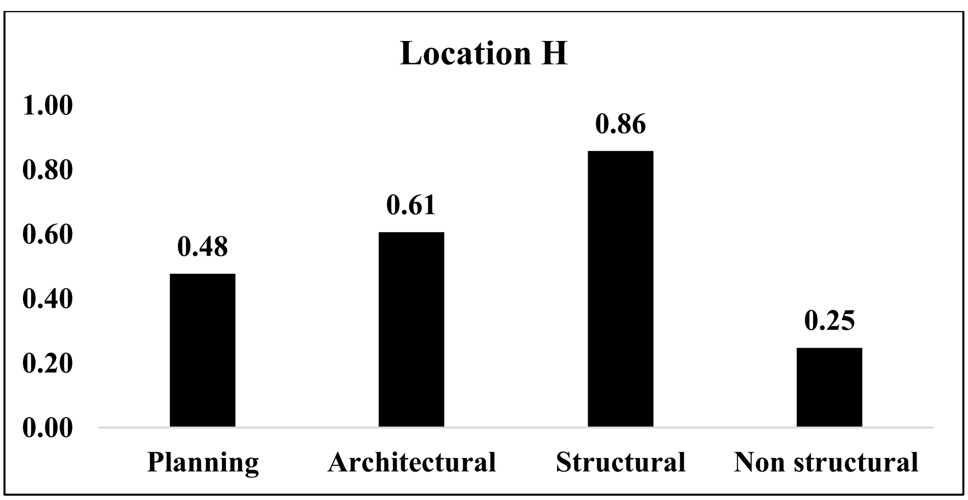

Fig. 3.30: Vulnerability assessment of Ward 23 & 27

Vulnerability Assessment of Ward 25

The vulnerability assessment of Ward 25 is shown in the Fig. 4.53. The building has the compliance index of 0.54. The architectural has the compliance index 0.40. The structural has the compliance index of 0.22 where the nonstructural has the compliance index of 0.13.

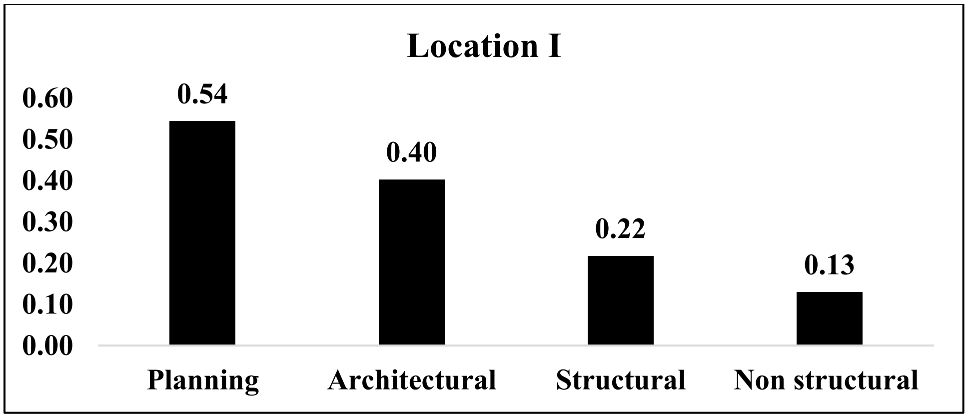

Fig. 3.31: Vulnerability assessment of Ward 25

Vulnerability Assessment of Ward 12 & 23

The vulnerability assessment of Ward 12 & 23 is shown in the Fig. 4.54. The building has the compliance index of 0.42. The architectural has the compliance index 0.26. The structural has the compliance index of 0.23 where the nonstructural has the compliance index of 0.13.

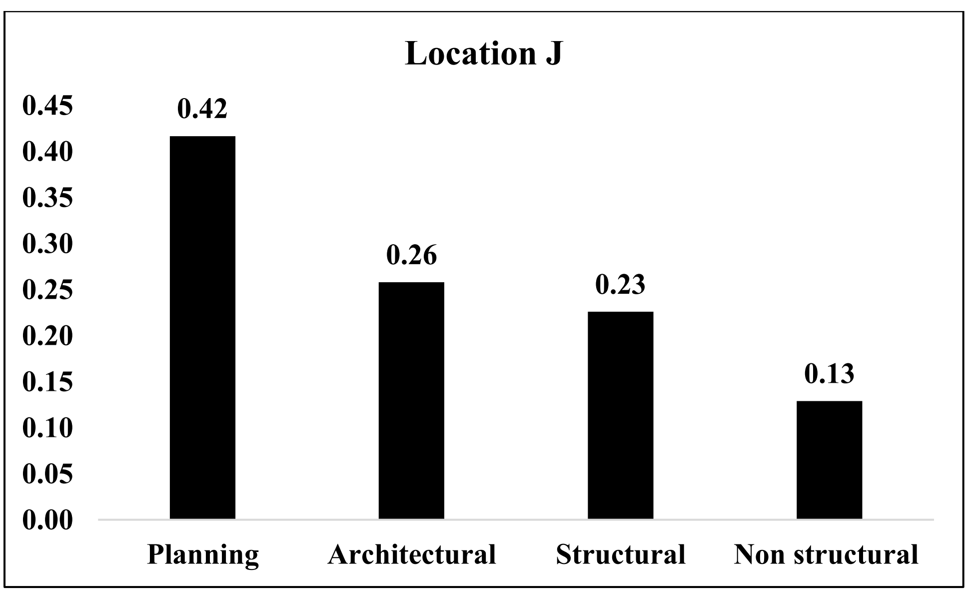

Fig. 3.32: Vulnerability assessment of Ward 12 & 23

Vulnerability Assessment of Ward 17

The vulnerability assessment of Ward 17 is shown in the Fig. 4.55. The building has the compliance index of 0.69. The architectural has the compliance index 0.61. The structural has the compliance index of 0.58 where the nonstructural has the compliance index of 0.13.

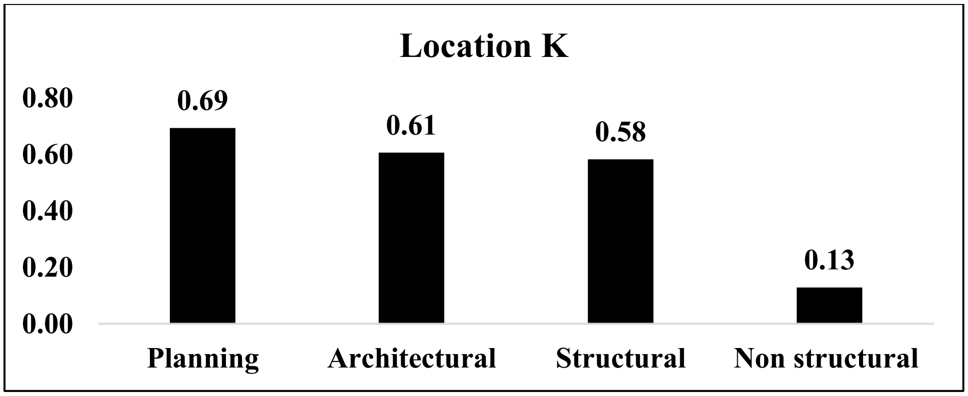

Fig. 3.33: Vulnerability assessment of Ward 17

Vulnerability Assessment of Ward 18

The vulnerability assessment of Ward 18 is shown in the Fig. 4.56. The building has the compliance index of 0.47. The architectural has the compliance index 0.55. The structural has the compliance index of 0.30 where the nonstructural has the compliance index of 0.13.

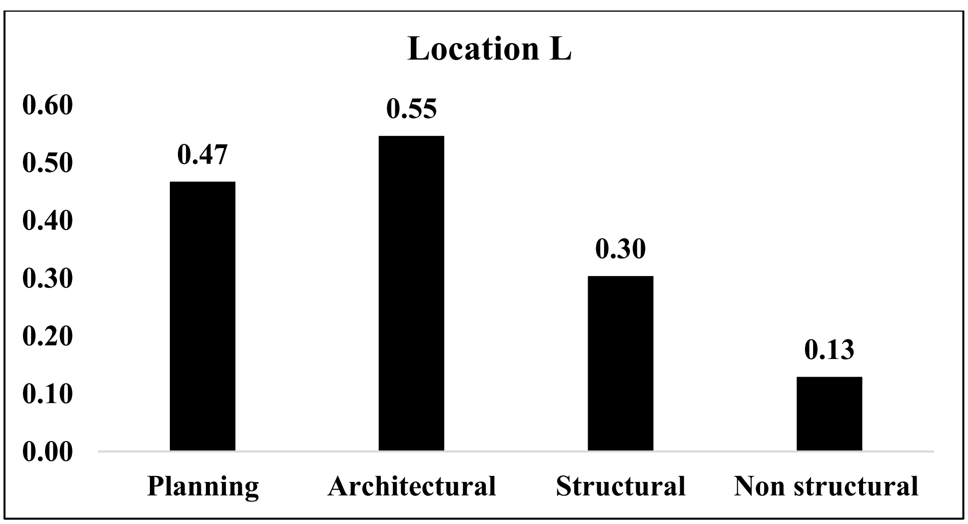

Fig. 3.34: Vulnerability assessment of Ward 18

Vulnerability Assessment of Ward 19

The vulnerability assessment of Ward 19 is shown in the Fig. 4.57. The building has the compliance index of 0.22. The architectural has the compliance index 0.10. The structural has the compliance index of 0.15 where the nonstructural has the compliance index of 0.13.

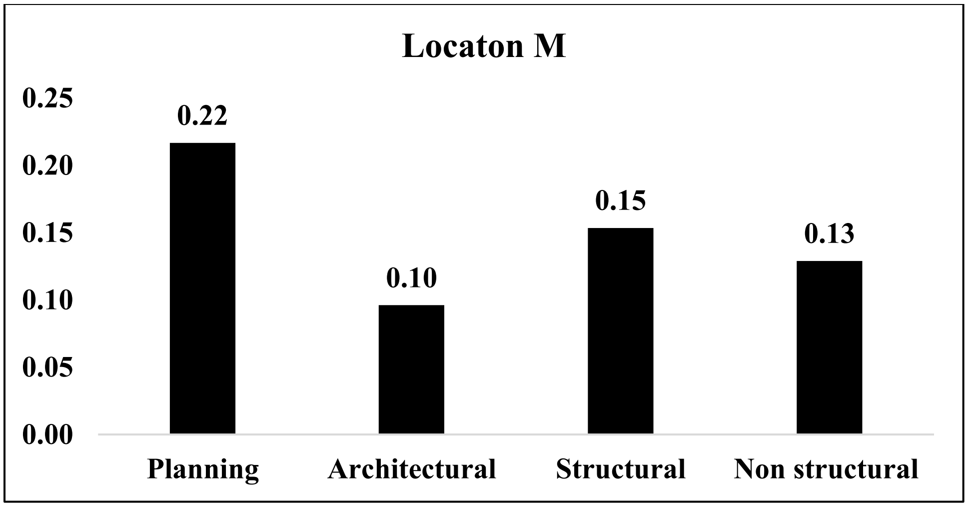

Fig. 3.35: Vulnerability assessment of Ward 19

Vulnerability Assessment of Ward 24

The vulnerability assessment of Ward 24 is shown in the Fig. 4.58. The building has the compliance index of 0.66. The architectural has the compliance index 0.35. The structural has the compliance index of 0.35 where the nonstructural has the compliance index of 0.38.

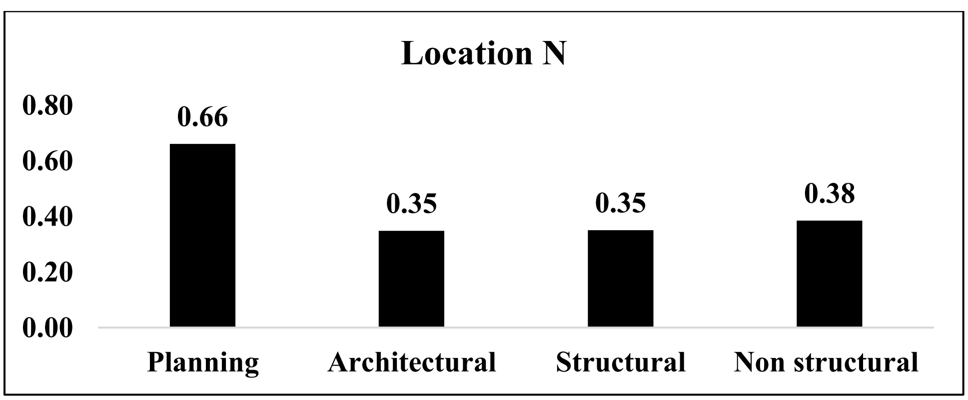

Fig. 3.36: Vulnerability assessment of Ward 24

Vulnerability Assessment of Ward 18 & 19

The vulnerability assessment of Ward 18 & 19 is shown in the Fig. 4.59. The building has the compliance index of 0.55. The architectural has the compliance index 0.31. The structural has the compliance index of 0.35 where the nonstructural has the compliance index of 0.38.

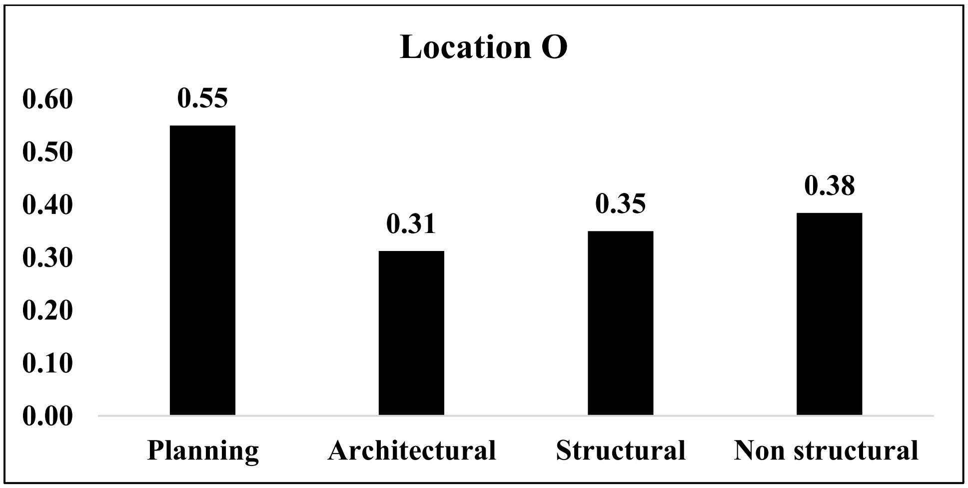

Fig. 3.37: Vulnerability assessment of Ward 18 & 19

3.4 Discussion

i) Findings from Field Observations

During the field visits, it was observed that while some newer buildings are built with better safety measures, many still do not follow proper construction guidelines. There is a visible lack of compliance with building codes and regulations, especially in informal settlements. The community's awareness about disaster risks is also low, and many residents have not made sufficient preparations for a potential disaster. It was clear that improving building safety, retrofitting old structures, and enhancing public awareness and preparedness are critical steps to reduce the risk of disaster-related harm in Kathmandu.

ii) **Findings from In-depth Interviews**

To prevent disaster-related damage and loss of life, the interviews emphasized the need for strict building regulations and better enforcement of construction standards. Experts suggested retrofitting old buildings to improve their seismic resistance and providing proper training and resources for builders and contractors. Additionally, raising public awareness about disaster preparedness, such as conducting regular drills and educating people on evacuation procedures, was seen as a crucial step to ensure community resilience. Implementing these measures would significantly reduce the risk posed by earthquakes and other disasters in Kathmandu.

iii) Findings from Focus Group Discussion

The focus group discussions in Kathmandu Metropolitan City highlighted concerns about the vulnerability of buildings to earthquakes and other natural disasters. Participants, including local residents, engineers, and government officials, agreed that many buildings in the city are not built to withstand strong earthquakes. They pointed out that many of these buildings are old, have weak foundations, and are constructed with low-quality materials. The group emphasized the need for better enforcement of building codes and the retrofitting of older buildings to make them more resilient to disasters. There was also a shared belief that many people in the community do not fully understand the risks they face or how to prepare for disasters.

4. CONCLUSIONS

In conclusion, Kathmandu Metropolitan City faces significant risks due to the vulnerability of its buildings, particularly in the context of earthquakes and other natural disasters. Many of the buildings in the city, especially those in older areas, were constructed using outdated techniques, weak foundations, and substandard materials. These buildings do not meet modern safety standards, making them highly prone to collapse when exposed to strong seismic forces. The lack of proper enforcement of building codes and regulations has led to the continued existence of these vulnerable structures, which pose a major threat to the safety of residents. As a result, it is crucial to prioritize strengthening building codes and ensuring that all new constructions adhere to these standards. Additionally, retrofitting and reinforcing older buildings would be a cost-effective and efficient strategy to minimize the risks associated with earthquakes and other disasters. Strengthening the overall quality of construction in Kathmandu is a fundamental step toward protecting the city's population and infrastructure from disaster-related damage.

REFERENCES

[1] National Planning Commission. (2015). "Post Disaster Needs Assessment (PDNA) - Nepal Earthquake 2015." Government of Nepal, National Planning Commission.

[2] National Society for Earthquake Technology-Nepal (NSET, 2019). Earthquake Safety Program: Training and Capacity Building for Disaster Resilient Construction. NSET.

[3] Sutherland, H. W., & Clifford, M. (1926). "Reinforced Concrete Construction." Journal of Structural Engineering, 42(6), 230-240.

[4] Gautam, D. B., S. K. Shrestha, & R. P. Tiwari. (2016). "Status of Reinforced Concrete Construction in Nepal." Journal of the Nepal Engineers' Association, 15(1), 45-53.

[5] Thapa, S. (2016). "Building Resilience in Nepal: A Study of Construction Practices." Journal of Construction Engineering, 12(4), 215-222.