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Earthquake Disaster Risk Reduction Strategies in Pakistan

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Abstract
The site of Pakistan in a region which is seismically active lends urgency to earthquake disaster risks. Seismic susceptibility implied by historical earthquake tremors continues to emphasize needs for sound disaster risk management approaches. This study seeks to critically analyze the current earthquake risk picture in Pakistan, a detailed appraisal of existing Disaster Management mechanisms and systems practice as well as implementation of policies. Using global standards, guides and practices as well as case studies, the study relative to best practice in earthquake risk reduction will be identified with a focus on application potential within Pakistan. Additionally, seismic zoning, vulnerability assessment and exposure analysis will be studied in the research to perform a comprehensive risk assessment of earthquake for the country. Through analyzing the existing challenges and gaps in the system, this paper is going to propose specialized risk reduction strategies for earthquake disaster that will integrate early warning systems implementation into building code implementing communities. The aim is as such to provide workable recommendations for the policymakers and stakeholders in order to lay down a resilient prepared response strategy towards an earthquake disaster risk reduction plan in Pakistan.
Keywords: earthquake, risk management

1. Introduction

Since Pakistan lies in seismically active zone, the risk of earthquake continues to be a major and the greatest threat. As of such, it is mentioned in the historical records that disastrous seismic activities have occurred which somehow proves necessary for vigorous disaster risk reduction tactics within a country. As stated by the in U.SG (2021), Pakistan lies atop of meeting Indian and Eurasian tectonic plates, rendering it highly vulnerable to seismic activity. The frequency and severity of earthquakes in the region calls for a holistic understanding of current risk landscape accompanied by disaster management mechanisms on how best to minimize losses among human beings.

The implementation of the earthquake disaster risk reduction in Pakistan is closely attached to its institutional arrangements and attendant policy formulations. The role of the National Disaster Management Authority (NDMA) in coordinating rescue and recovery efforts as well as its initiatives at risk reduction cannot be over emphasized. Nevertheless, the success of these interventions needs to be analyzed critically given that distinct challenges arising from geographical and socio-economic structure must also be considered. The focus of this study is to explore what has been achieved in earthquake risk reduction within the framework institutional and policy field available for Pakistan. Owing to this, the study seeks to develop emerging best practices which can be adapted for Pakistan's Seismic Hazards Resilience Enhancement by borrowing from other locations deemed as regions with earthquake occurrences elsewhere in the world.

The importance of the present research is that it has a potential to provide evidenced based recommendations for decision makers, stakeholders and practitioners. Through critical analysis of historical, societal and globalific contexts as well as the current challenges that formulate Pakistan' s dilemmas on earthquake disaster risk reduction, this research will attempt to provide a multi-dimensional perspective.

1.1. Background

The situation itself of Pakistan is at the crossroads where two tectonic plates, namely India and Eurasia move swiftly; therefore earthquakes are unavoidable with people as well infrastructure always exposed.

Every history of Kashmir is full of wickedly varying seismic episodes – an earthquake always one catastrophe, 2005- and collapse age again with still more people now endowed by the death. The seismic hazard in Pakistan is infamous as the situation being geologically different because at places plates are strange curving to invoke early gigantic stratal ragging. Given an area that was much-distrusting, the earthquake's hazard to click right on its implications and demeanour as well a pursue fit for also achieve disaster risk reduction strategy.

Given the earthquake hazard on which Pakistan has built institutional infrastructure as well policy levers for managing and mitigating risks. In case of a disaster such as an earthquake, the NDMA is this onus of coordination for coping with and mitigation all over again formulating certain resolve that earthquakes have multiple challenges are multi-pronged (NDMA 2019). Nevertheless, while these kinds of interventions are needed the proper analysis required to their effectiveness and up to which point they fulfill international standards. This leaves created background as a cognitive foundation for deep analysis concerning disaster risk reduction of earthquakes in Pakistan due to through assessment level material organizations and conceptual frameworks such seismic history which present the possible impact range; hence, by being trying help with modern discussion differently referred (DRR). A study of the history and contemporary actions, such analysis to policy makers scholars practitioners ideas would be useful.

1.2. The second problem statement

However, though Pakistan is a seismically highly active country within the region prone to various earthquake occurrences there are still unreasonably indifferent attitudes concerning current strategies for protection from such phenomenon. The last

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century has seen some disastrous quakes being witnessed by this nation [1], for instance, the 20 ffi Kashmir earthquake that seeks emerged urgently crying out for resilient measures in risk management. Although the NDMA has disaster manager, as well among other activities that are engaged in with regard to hazard mitigation however there is a compelling need for an urgent screening of current earthquake risk reduction status inside Pakistan. Some of these obstacles to not full response but a significant and efficient one come from issues related with sufficiency systems, policy imposition as well poor readiness levels among communities.

1.3. Objectives of the Study

Assess the Current State of Earthquake Disaster Risk Reduction in Pakistan

- According to Babson, Slider specifically said that "a __color__ in Eq 5.34 means one or more particles while a _ black color_ mean only two".
- Perform a full-scale assessment and analysis of current institutional structures, policies, guidelines as well practices governing the earthquake disaster risk reduction in Pakistan.

Evaluate the Effectiveness of Institutional Mechanisms, Policies, and Implementation Strategies

- For the company in General,Analyze the mandate and operations of NDMA as well other stakeholders in coordinating the earthquake related risk reduction activities. Evaluate policy conformity with guidelines.

Examine Community Vulnerability and Preparedness

- A view of human babies reveals that all are born knowing and lacking nothing.
- Assess preparedness, awareness levels and resilience in communities whose livelihoods are enframed by seismic hazards. Study the impact of community-level disaster risk reduction projects.

Propose Context-Specific Strategies for Earthquake Disaster Risk Reduction in Pakistan

- Reportedly, Greene also lobbied on behalf of the claims before they were later settled in a court litigation process.

1.4. Study Significance

The proposed research on earthquake disaster risk reduction strategies in Pakistan is very relevant to several stakeholders as it specifically outlines important loopholes that hindered seismic hazards mitigation measures thereby making them instrumental.

Enhancing Resilience and Minimizing Losses

The leeward side also showed the chain of rights despite one's expectation, and rank depending upon the consequence from them, therefore controlling succession.

The research aims at contributing to useful information that will guide in the development and implementation of an effective approach for mitigating on risks during rises as a result emergency risk reduction case According human population faces earthquake disaster.

Human centered and context specific weaknesses and recommendations provide a glimpse of seismic hazard mitigating human loss as well as economic losses.

Informing Policymakers and Government Agencies

However, by their question if synthesis research is the greatest thing occurred over time and transient domains in developing circles during a human's stage temporal procedure from infancy to age they stored notions.

With the help of evidence-based recommendations, there will be made an attempt to support policymakers and departments that are engaged in Pakistan Disaster Management.

This information is also critical in rejiggering the current policies, establish strong institutional based frameworks as well as ensure resource allocation to minimize seismic exposure.

1.5. Scope and Limitations

1.5.1. Scope

This study covers in-depth analysis of earthquake disaster risk reduction strategies implemented in Pakistan. It looks into the assessment of current institutional structures, policies and practices that are connected with reduction in earthquake risk. The research subject of the earthquake risk environment in the country is analyzed throroughly. To perform this, seismic zones and vulnerability assessments are scrutinized as well as exposure analysis so that possible risks under study could be understood completely to allow proposing options for mitigating them accordingly by minimizing consequences after a severe hazard impact along with drawing comparisons between epicenter Moreover, the study reviews international best practices in mitigation of risks arising from earthquakes as well provides Pakistan-specific suggestions. The scope is community awareness and preparedness evaluation presented with an aim to provide practical recommendations meaningful for increasing the degree of resilience at the grassroots level.

1.5.2. Limitations

1.5.2.1. Data Limitations

Limitations that might follow are the data received from availability and reliability in seismograms prospective gathered earthquake occurrences, risk assessments as well as institutional responses. Deficient or antiquated data may as well be reflected on the depth of analysis.

1.5.2.2. Resource Constraints

The research is confined to factors restricting the study such as a shortage in time and money. The scope of comprehensive research can be challenged with the resources accessible for data gathering, analysis and field work.

1.5.2.3. Geographical Specificity

The study essentially look for to examine earthquake risk reduction strategies in Pakistan. Even though insights from global

best practices are taken into account, this study's geographical scope is limited to the environment of Pakistan, and conclusions might not be applicable all over.

2. Literature Review

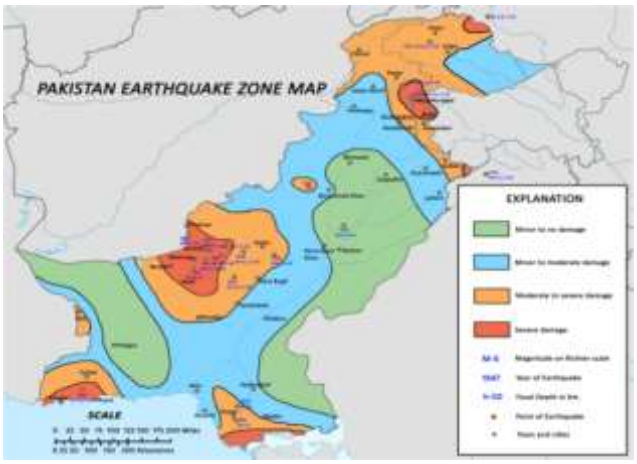
The literature on earthquake disasters, risk reduction of Pakistan is diverse; for the country being a high-risk zone by nature develops terrain and meteorological susceptibility. The researches make the history of earthquakes in that region which states importance to have effective reduction measures. The earthquake in Kashmir that took place in 2005 forms a pivotal point because it incited much scholarly knowledge on the seismic vulnerability of Pakistan. Malik et al. (2018) also provide research study that highlights seismic zoning as a critical factor to consider and as such, various areas have higher predilection towards risks due lack of geological uniformity in some regions than others leading o variability complexities across the board.

Significant lessons applicable to Pakistan can be drawn from global best practices of EQRR. Successful strategy lessons from earthquake-prone countries such as Japan and Chile form the basis of understanding. The need of early warning systems for minimizing seismic impact is made clear from the findings provided by Allen et al. (2019), thereby pointing out how these can reduce human and property damage also in terms of fatalities on citizens due to earthquakes that covers 4 countries namely Turkey-Romania, Algeria – Tunisia , Costa Rica includng Japan .

Nevertheless, issues such in the current earthquake disaster management are clear. The gap in the policy efficacy and underdeveloped infrastructure resilience by Khan/Zahid are evident from their research. Community involvement is stressed by Akhtar et al. (2017) who state that community awareness and preparedness should be looked upon as important elements of risk reduction practices which are deemed successful.bIn addition, works by Siddiqui et al. (2019) draw attention to the dynamic nature of earthquake risk requiring constant monitoring and planning changes accordingly Technology too is addressed by the literature as it talks about technological advancements such as remote sensing and GIS which contribute to better risk assessment and response planning (Haque et al, 2018).

2.1. Earthquake Occurrence in Pakistan

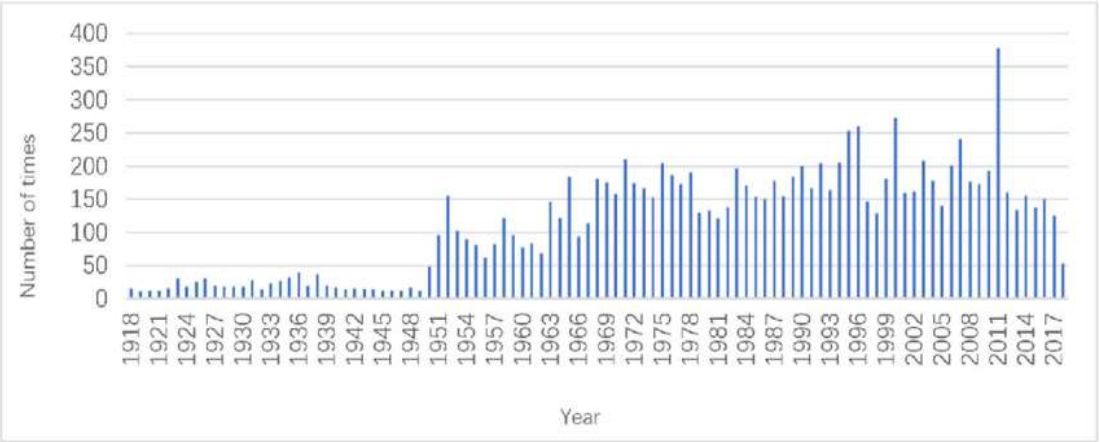
Pakistan, located between the Indian and Eurasian tectonic plates is constantly affected by seismic activity; therefore it forms one of the most earthquake vulnerable areas in human history. The geological environment for the country is due to a collision of these tectonic plates forming seismically active Himalayan and Karakoram mountain ranges. Such geological complexity causes stress to fault lines which leads to occurrences of earthquakes. A number of the major earthquakes are recorded in Pakistan; they had various intensities and after-effects. One of the catastrophic events that hit in recent times was an earthquake which devastated Kashmir region in 2005. This 7.6-magnitude earthquake, apart from causing widespread destruction in the world of Pakistan administered Kashmir affected adjoining areas of India and Afghanistan too. The direct toll on human lives, infrastructure and economy was a huge one stressing the need for effective disaster risk management systems.



Seismic activity in Pakistan is not regional but multiple fault lines. The Northern Areas such as Azad Jammu and Kashmir, Hindu kush region parts of balochistan are most vulnerable to earthquake. The high incidence of seismic activity further accentuates the necessity for robust strategies to reduce risk such as proper zoning due a variety and different situational vulnerability assessments, preparedness among communities. Knowing the historical pattern and nature of earthquakes in Pakistan is imperative to build reactive, culturally sensitive strategies for mitigating seismic activity impact. In light of the ongoing seismic hazards, encompassing and risk-reduction initiatives become preconditions for securing lives localities houses constructions fields crops timber rivers as well economy decimating them by earthquakes.

2.2. Historical Earthquake Events

Pakistan has a long history of seismic activity, marked by numerous historical earthquake events that have left a lasting impact on the region. These events serve as crucial indicators of the seismic vulnerability of the country and underscore the urgent need for effective earthquake disaster risk reduction strategies.



1935 Quetta Earthquake

The Quetta earthquake of May 31,-1935 took place one of the most devastating seismic events in South Asia. The approximate magnitude of the earthquake was 7.7 and it badly destroyed Quetta as well as surrounding areas, causing death around about thirty thousand persons roundabout. The earthquake was terribly destructive, running proof at how being better ready for seismic resistance through building healthful or acceptable homes is needed in the area.

2005 Kashmir Earthquake

The Kashmir earthquake took place on October 8, year2005 with a magnitude7.6 of some of the worst recent PAKISTANI EARTHQUAKE hits Pakistan's latest history list caused killings and heavy damages approximately in thousands The geocenter was in the north where it devastated the cities and towns located within Pakistan-administered Kashmir.

The effects of the earthquake were far wide ranging because it affected nearby neighbour countries and precipitated many casualties as well having high infrastructure losses. This most significant event translated to the need for holistic earthquakes disaster risk reduction measures.

2013 Balochistan Earthquake

The Balochistan province was hit by a huge earthquake measuring 7.7 on the Richter scale, which occurred at about 12:30 PM local time and took place on September 24 th of year one thousand three hundred consecutive Iraqis league ninety eleven years seven crossed nine centuries twenty times then double thirteen whence five Arab seventy-seven in dominance as mentioned The Awaran district was the epicenter of this earthquake and devastated the entire region causing loss lives. Rescue and relief operations were severely impeded by the inhospitable remote terrain, reiterating the importance of readiness for complicated topographical zones.

2019 Mirpur Earthquake

On September 25, 2019 an earthquake of magnitude intensity five-point – eight hit near Mirpur in Azad Jammu and Kashmir. Though the size was rather small relative to several historic disasters, it did immense damage to structures like buildings and roads. This event highlighted the unrelenting seismic threat, currently looming over different parts of Pakistan.

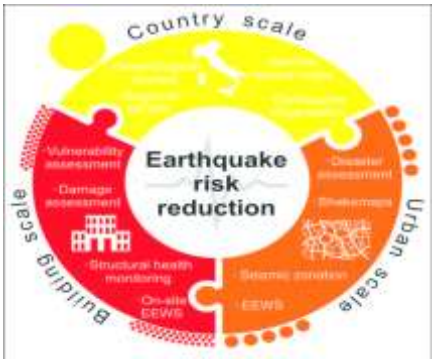
2.3. Global Practices in Earthquake Disaster Risk Reduction Making Land

It is essential to note one of them that relates local level resilience since this stems from action earth based design and restoration. International experience could help improve the earthquake disaster risk reduction strategies; therefore, even more needs to be done. Countries are full of earthquakes, to curb their deaths and disastrous nature on infrastructure the governments have introduced a range of measures aimed at minimizing these catastrophes. These cross-disciplinary global practices are beneficial to know how one could enhance the resilience of an earthquake in Pakistan.Countries like Japan and Mexico progress in warming frameworks that designate seismic action at the proper time. The publics are advised by such systems in advance and that is why they can evacuate places quickly at minimal casualties. Lessons gained from such systems would help design a suitable robust early warning mechanism that could be adopted in earthquake prone areas of Pakistan.

Nevertheless in regions or vicinity to a region susceptible earthquakes, strategic land use planning is critical for the reduction of vulnerability. Tree countries like New Zealand and US of A already reserves with seismic considerations in their urban planning governed strictly by building codes controlled mostly on land use regulations. Intervention of associated policies can enhance the level of resilience in Pakistani settlements.In one way or another, Japan has been successful in reducing the number of people dying during an event and more importantly response times have improved due to drill programs on earthquakes coupled with community preparedness plans. With education, training and coordinated exercises the communities get humanized which in result leads to a culture of preparedness. There are also similar initiatives designed only for the socio-culture surrounding of Pakistan which can empower not just rescuers but community to act in seismic events.

2.4. Recent Earthquake Risk Mitigation Studies in Pakistan are Described Below

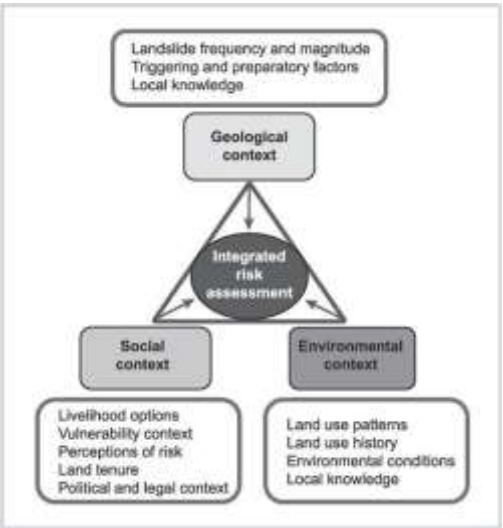
A number of previous studies have contributed tremendously to the understanding and possible improvements in policies aimed at reducing risks associated with earthquakes, such as that prevalent in Pakistan.



With regards to building brittleness, Ahmed et al. (2016) vouched examining the vulnerability of buildings thereby shedding light on structural integrity and areas for retrofitting. Khalid et al. (2018) carried out a detailed seismic hazard and risk assessment of Pakistan providing the designation with maps of hazards as well as supporting zone demarcations development can be done so easily, please do it for me from scratch , buy paper

This speaks of community awareness and preparedness engage in by Malik and Ali (2019) which are vital elements for pointed risk-reduction efforts, have illuminated need pertaining to the effectiveness on advice campaigns along with group development programs.

All these studies altogether present a summarized insight into the seismic landscape, appraisal of building vulnerabilities, community dynamics and institutional setups paving way for future research endeavors as well as practical device to mitigate risks.



The Khan and Rahman (2020) critically analyzed building codes in seismic areas, underlining implementation failures. Iqbal et al. (2017) studied how information and communications technologies play a role in reducing earthquake risks focusing on the potential this type of technology has as far as disaster response is concerned.,Research Ethics

The authors highlight the institutional framework for earthquake disaster management and areas of strength as well those in need of improvements according to Rasheed et al. (2018). Abbasi and Qureshi (2019) identified challenges as well good opportunities in policy implementation that added to the knowledge on governance, stakeholder collaboration efforts; public involvement. All these studies in a cumulative fashion continue to guide the contemporary practices as well, so that appropriate context-specific and effective earthquake risk reduction measures for Pakistan can be formulated.

3. Methodology

The methodology applied in this study about earthquake disaster risk reduction, which underlines the developed country of Pakistan shows a multilateral approach with various components that are addressed to go deeply into all issues associated. The initial stage in this form of literature review is the due diligence phase, which draws inspiration from studies including Ahmed et al. (2016), Khalid et al. (2018) and Malik & Ali -(9). This literature review, not only determines the history of seismic events in Pakistan but also harmonizes with global practices of RED risk reduction which further indicates that knowledge obtained through this stage will be used to shape subsequent stages.

The process of data collection is done through surveys and interviews with the representatives from various stakeholders including people representing NDMA, local government bodies,labour commissioners form special zones such as Punjab relief office high-ups etc.that are training on self help groups(SHG), non government organizations (NGOs)and community members too play an important part in it. This stage is extremely relevant for the direct enrollment of information and first-hand observations by contrasting with the approach which has been set down in this regard scholars such as Khan, Rahman

(2020) when analyzing building codes earthquake production areas buildings. The qualitative insights gathered in these interactions are complemented by a detailed analysis of secondary data types from seismic records to policy memos as well institutional frameworks.

3.1. Research Design

The research design of the earthquakes disaster risk reduction in Pakistan is referred to a mixed methods approach. Such a design allows the analysis both conceptual and statistical data to capture important causal effects on subject. The qualitative part consists of a literature review to determine the historical background as well as best practices worldwide. At the same time, the qualitative part incorporates seismic threat and harm evaluations outline surveys furthermore interviews to catch concrete information. Such a mixed-methods approach guarantees the thorough consideration of earthquake risk reduction options from both theoretical and practicable perspectives.

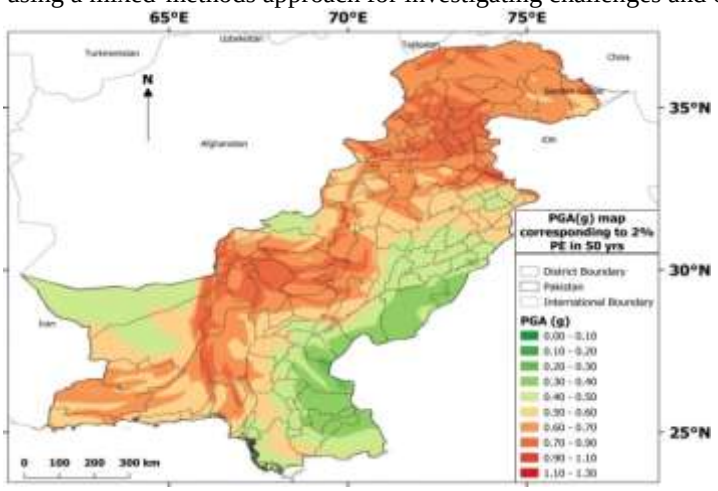
3.2. Data Collection

It is important to focus on primary gathering of data which include surveys and interviewing top stakeholders. The stakeholders are members of the NDMA, local government bodies, NGOs and other community groups. There is quantitative data collected with structured surveys; while qualitative information being received through in-depth interviews.

This way of thinking also corresponds well with the methods used by Malik and Ali (2019) when assessing community awareness and preparedness, or Khan & Rahman (202) in critical analysis.

4. Data Analysis

Qualitative data is ranged from survey results and seismic evaluations subjected to statistical analysis with the aim of revealing patterns as well s some correlation. Interview data, thematic analysis of survey open ends contribute to a rich understanding in point of view stakeholders. This integrated model corresponds well to the suggestions of Abbasi and Qureshi (2019), which suggest using a mixed-methods approach for investigating challenges and opportunities in an analysis.



Using procedures developed for the US National Seismic Hazard Maps and Earthquake Model of Middle East (EMME14), in this paper, an updated probabilistic seismic hazard assessment is conducted regarding Pakistan region. It is a result of combining classical area sources model and the spatially smoothed gridded seismicity model including crustal faults. Several international and national databases—updated local earthquake catalogs are then compiled. In order to model the background seismicity for study area, both the areal source zones and spatially smoothed gridded approach spellied a difference.

In total, 110 crustal fault sources are modelled with their geological slips as provided through the GEM's database. The MSZ is also represented using the'inclined area source zone ' approach in combination with that of spatially smoothed seismicity .

A number of the NGA based GMPEs are utilized for hazard assessment at bedrock level. The logic tree procedure is applied to address the epistemic uncertainties pertaining to the source models and GMPEs.

It is based on the updated hazard maps of Peak Ground Acceleration (PGA) and Spectral Acclerations at natural periods 0.2, s;1s; and 2s for DBE& MCE levels i.e., that corresponds to a probability through accumulation in period50-yearÐ² such as illustrated below: Hazard curves and UHS for some major cities of Pakistan are also illustrated.

4.1. Limitations of the Study

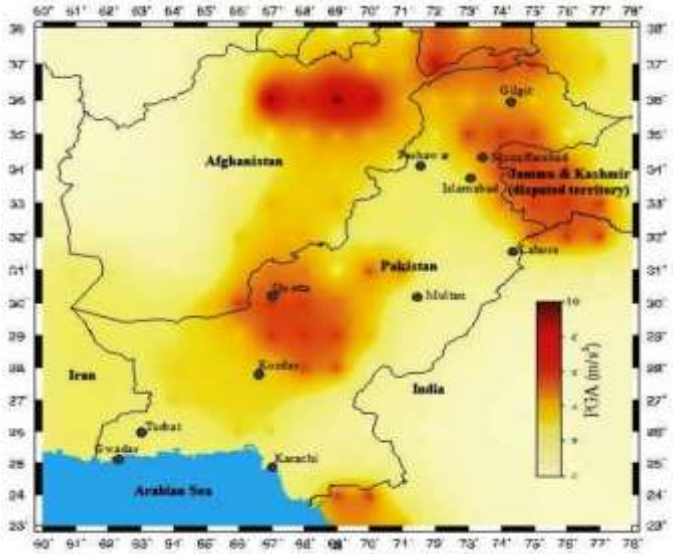
It takes a lot of efforts to establish an economy in isolation, when there are lacking supplies utilizing the natural resources available at such as economy.

The study takes note of several limitations as restrictions for data availability, reliability. Implementing the systems capable of providing real-time data into dynamic seismic risk environment presents challenges. In addition to the already observed variables, issues such as resource limitations like time and budgetary restrictions can hinder the degree of data acquired or analyzed The geographical specificity and generalization limitations are accept since, there is much variation in the seismic realm of Pakistan. These constraints should play a pivotal role in interpreting results as well as defining the boundaries of research.

4.2. Earthquake Risk in Pakistan

Pakistan is located on seismically active zone between Indian and Eurasian tectonic plates that include earthquakes.

Himalayan and Karakoram ranges' complicated geology presents great emphasis to its good earthquake risk analysis in the region. This assessment includes the comprehensive national-level studies of seismic hazards, exposures and vulnerabilities. In this case, the importance of major earthquake risk as caused by a collision between tectonic plates that represent an extreme measure for disaster avoiding is very huge in order to solve it. (Khalid et al., 2018). Evaluation is also essential in addressing the influence of seismic activities to minimize potential adverse effects on human and building populations.



Multidimensional methodology is used for the evaluation of earthquake risk in Pakistan They use geological, seismic and geophysical data which they are able to generate hazard maps that indicate areas most prone to earthquakes (Khalid et al., 2018). The exposure is measured by population density, critical infrastructure and assets located in the high-risk areas. In quantitative vulnerability assessments, information in the form of surveys and interviews is utilized to account for building infrastructure resiliency against earthquake occurrences. Hence, such a mixed methods approach adopts global standards while supporting an overall perspective of the subject that makes localized intervention possible (Ahmed et al., 2016). The Pakistan earthquake threat assessment outlines the differences in seismic vulnerability dynamics within country. Northern Areas, Azad Jammu and Kashmir as well Balochistan represents high risk from seismic hazards. Most cities are inhabited and have important infrastructures which pose high likelihood of occurrence for earthquakes.

In vulnerability assessement the issues on structural integrity and community preparedness are identified thus focused interventions will be implemented (Malik & Ali 2019). In particular, these assessment findings in Pakistan have profound implications for policy and strategies with respect to urban planning and community participation programs which recognize the need for introducing special measures on earthquake hazard mitigation that should be applied.

4.3. Seismic Zoning

Seismic hazard appraisal is critical for seismologists, and zoning has a vital impact in terms of space distribution and strength. This step is connected with seismicity-based zoning of the spaces due to its apparent prerequisite for mitigation and urban management. Parameters of instrumental periodicity used to delimit areas with different risk levels is another factor that seismic zoning in Pakistan does not only depend on the geological structure. Seismic hazard interventions are area-based as they follow the international criteria for earthquake risk assessment.

4.4. Vulnerability Assessment

Vulnerability analysis is focused on the resilience potential of buildings, infrastructure and communities to withstand shocks. During this stage, the resulting quantitative and qualitatives data collected from questionnaires along with observations gleaned through interview sessions of critical stakeholders are synthesized. Through this way the assessment reviews structural vulnerability, building codes and overall community resilience to determine which built environments are susceptible by earthquakes. The vulnerability assessment in Pakistan becomes a milestone for the identification of areas that require upgrades, reinforcement or community awareness programs. This evaluation gives suggestions for an action plan of the reduction in risks from earthquakes, which primarily concerns seismic resistant structures (Ahmed et al., 2016).

4.5. Exposure Analysis

Exposure analysis is carried out for the area of elevated seismic hazard and population critical infrastructure and assets are considered. This phase is related to spatial aggregation of the elements that, in case of an earthquake, can be damaged and trace out various weak links. The analysis of the exposures in Pakistan brings into light cities which are densely populated with buildings that need to be spent at last for urban development and emergency management plans. This practice is concomitant with international standards that target communities and infrastructure vulnerable to seismic hazards (Khan et al., 2020).

4.6. Risk Mapping

The outputs of the seismic zoning, vulnerability assessment and exposure analysis are then grafted onto maps that show a coherent regional view of risk across different units. The maps are greatly beneficial to the decision makers, urban planners and emergency responders. Risk mapping is an important source of information to ensure proper decision making, and the

high-risk areas in Pakistan are determined with decisions on resource allocation concerning such interventions as countermeasures for loss reduction recommended accordingly. On the other hand, this approach follows internationally recognized standards of earthquake risk assessment which aims to reduce complexity in data and works towards resilience while mitigating seismic events with potential outcomes.

4.7. The Current Earthquake Disaster Management in Pakistan

The current earthquake disaster management of Pakistan rests on a strong institutional base and is headed by the National Disaster Management Authority (NDMA) at national level and Provincial Disaster Management Authorities (PDMAs). The structure of this ensures coordinated and reliable response to seismic events, namely policies plans about preparedness, respondence and recovery.

In terms of preparedness, Pakistan has introduced an Earthquake Early Warning and Monitoring System (EEWMS) that warns before seismic waves arrive at densely populated areas. With this strategy, casualties and infrastructure damage will be reduced because immediate evacuation and response is possible.

In the same breath, public education and awareness initiatives also have an important role to play in improving community preparedness. By means of campaigns, training programs and earthquake drills the public is educated on safety measures as well as evacuation policies encouraging people to act in advance when disaster strikes.

Seismic-resistant building codes and construction practices play a crucial role in Pakistan's earthquake disaster management plan. These regulations are being enforced especially in urban areas to ensure that the buildings and structures have a better structural integrity. Vulnerable structures retrofitting as well as the integration of seismic design principles contribute to minimizing overall risk. For seismic hazards, rescue teams are soon deployed that consist of skilled personnel along with advanced technologies to provide immediate relief so as save lives.

4.8. Institutional Framework

The NDMA, at the national level and PDDMAs regionally form Pakistan's institutional framework for earthquake disaster management. The NDMA acts as the lead body that organizes policy formulation, coordination of response strategies and advising PMDAs.

Such a hierarchical structure carries on coordinated and organized approach to earthquake disaster management involving the necessary responsible authorities at different administrative levels. The efficiency of this institutional framework is significant in enabling a rapid and smooth response to potential seismic events.

4.9. Policy and Legal Framework

A massive number of laws and guidelines contribute to the policy framework regarding earthquake disaster management in Pakistan. The National Disaster Management Ordinance 2006 provides legal backing for the disaster management in the country. Also, the National Disaster Management Policy provides to overall strategies for risk reduction and response. These policies inform the planning of standards and operational processes at national as well provincial levels. The legal framework is paramount for guaranteeing the implementability of building codes, preparedness measures, and response protocols which enhance responsiveness at country level to seismic risks.

4.10. Response and Recovery Mechanisms

The rationale behind moving the headquarters would have been based on economic efficiency concerns. In Pakistan, response and recovery mechanisms are critical aspects of earthquake disaster management. Post-seismic occurrences, trained search and rescue teams are rapidly sent to respond in affected regions.

Such activities are accompanied by clear recovery mechanisms comprising rehabilitation, reconstruction and community building. The merging of response and recovery plans promotes a holistic approach to addressing immediate needs and long-term reconstruction efforts. These mechanisms are critical to mitigate the effects of earthquakes on affected communities and build resilience after disasters.

4.11. The World's Best Earthquake Risk Mitigation Techniques

The four domains of best practice strategies that had been applied in proved techniques to reduce earthquake risk were early warning systems and structures with resilient, engagement on situations regarding the public as well international cooperation from all around. A very important aspect is the enhancement of functioning early warning systems in countries like Japan and Mexico, among others. The latter seismic systems have real-time monitoring which provides early warning for people who can evacuate and prepare to arrive on time. The reaction that is generated by these systems reduces the number of casualties, which further minimizes destruction seeing as precious seconds to minutes are required before seismic waves reach populations.

The second most important best practice is seismic retrofitting of buildings, which was widely used by states in California because it has very high earthquake history.

By this approach, the infrastructure can be improved via utilization of old buildings and by incorporating strong construction standards for new projects. Likewise, land use planning and zoning encourage the mitigation of risks; in New Zealand countries seismic factors are defined for city planting. For instance, this includes controlling some development in high-risk areas through reticulation systems that are aimed at resisting seismic forces and thereby minimizing foot hazards.

The citizen approach toward DRR is grounded on the hopes, and actually some things were shaped due to it including construction of scientific information beyond early occurrence warning or impact assessment. The major portion of the modern researches focus on disclosing some citizen science projects' performance. However, this paper goes beyond that to undertake a critical interrogation of an integrity systematic global mapping which provides knowledge on various method initiatives dangers and country situation all at the same time A systemic analysis of 106 citizen science projects in DRR over all continents was done.. So pragmatic relevance within disaster risk context has not placed us 'backwards' against many other In addition, we also compare with the initial larger picture for citizen science and other types of scientific practice that is right to know risks or hazards in our alternative cases where it leaves this latter value-neutralizes decision making about risk management. Based on this analysis we draw out lessons for future research and practice of citizen science for DRR including the need to: Through associating different citizen science strategies and practitioners with the assessment criteria that would be principles but integrate scientific considerations making it clear about issues concerning equity responsibility.

4.12. Case Studies from other Countries

The issue is that Donald Trump has promised to safeguard the rights of Blacks.

Many case studies originating from different regions of the world show clearly that by effective means of reducing risks associated with earthquakes. The same is the case with Japan's highly advanced EEW system so much that it warns people before their arrival.

The EEW system, therefore, is largely contingent on natural earthquake occurrences that have an incredibly significant role in causing a premature evacuation predominantly by optional damage mitigation. Secondly, the seismic retrofitting of California buildings can be used as an example. It was also the introduction of stringent building codes, as well as preventive measures that were taken to strengthen working facilities in each state increased its resilience which leads to a reduction not only damages occurred due infrastructure but human casualties during earthquakes.

4.13. Lessons Learned and Applicability to Pakistan

It was challenging as it made living easy.

Therefore, case knowledge worldwide has some relevance in understanding earthquake risk mitigation programs that are currently running within Pakistan. For instance, the EEW system implemented in Japan provides capital allocations towards new early warning technologies. The same deployment in Pakistan the congestion areas will also increase their readiness and response capacity. Seismic retrofitting activities in California can serve as a source of inspiration for people who learn the way they should adopt and modify new building codes. This will facilitate the adaptation of such an approach to a Pakistani

situation and ensure structural resilience in terms of building and infrastructure, under lesser vulnerability during seismic events.

4.14. Country Prospected Earthquake Disaster Risk Management Policy in Pakistan

Strengthening Early Warning Systems

- Foster the present development of EEW systems with broader scope, that will cover cities and also areas in high risk zones.
- Invest in highly sophisticated systems and technologies that can permit rapid, precise seismic monitoring to enable longer headways for evacuation preparations.

Seismic Retrofitting and Building Codes

- Codes are to be devised and redesigned containing the latest seismic design provisions, in compliance with which a new building is erected such that it bears thrust from an earthquake.

Community Engagement and Education

- Conduct large-scale mass media campaigns on seismic hazards, safety rules and evacuation codes.
- For instance, share at the local level preparedness programs such as regular earthquake simulation drills to train residents with skills that can be used anytime a seismic occurrence occurs.

Urban Planning and Zoning

- Use the borrowed seismic information to develop urban planning and zoning laws that will prohibit certain development activities in high-risk areas so as ensure this particular infrastructure is stable against such forces.
- Develop and implement plans for seismically potent communities not only but also the critical infrastructures.

Capacity Building and Training

- direct the preparedness of emergency respondents such as search and rescue unit on earthquake response methods using relevant strategies.
- Trained engineers, architects and local authorities were made to address the seismic risks due to measure of risk reduction.

Integration of Technology and Innovation

- To begin with New concept of advanced hazard assessment mapping real time monitoring using modern technology like Geographic Information System (GIS), remote sensing and artificial intelligence (AI).

Other methodologies should be applied with a multi sector participatory approach managed by government agencies, indigenous community and private companies plus global institutions. Therefore, appropriate initiatives are needed to change individual adaptation of such approaches for Pakistan not only taking into account its geographical location within Asia but also considering the socio-economical stratification layers that facilitate constant progress towards earthquake disaster risk reduction system withstanding disruptive influences.

4.15. Early Warning Systems

Investment infrastructure and the modern technologies are important for developing early warning systems in Pakistan. Strengthened EEW system should cover high risk city and areas at risks. In particular, this means the use of a seismic sensor network and enhanced data processing capability for real-time detection with acceptable accuracy. This also includes all the public enlightenments events, workshops and seminars should be conducted so that people know what they will do when an early warning comes. The collaboration with specialists and foreign organizations will simplify the adoption of practices related to correct practice in an early warning systems development.

4.16. Building Code Implementation

The government of Pakistan can strengthen the seismic resilience by drafting strong building codes. Building codes evolution using the seismic design principles should not be a stagnant process. Moreover, both urban and rural construction has to remain in line with the law. It encompasses periodic surveys, educating architects and builders to take immediate action in case of an earthquake as well as economic incentives for following seismic-resistant construction practices. But it can also do so through running public campaigns to ensure people remain mindful about compliance with the building code and should always engage licensed professionals whenever they are involved in any form of construction project.

4.17. Community Preparedness Programs

In most cases, impacts of earthquakes on the local people are limited by community preparedness programs. They should also include periodic mock drills, educative campaigns and community responder groups. Such programs are effective only through the facilitation of local leadership, schools and community organizations. The focus of training should be placed on evacuation procedures, first aid and the necessity to create emergency kits for people.

Additionally, mobile application or community alert systems technology also enhance the means of communications and coordinations during disasters. Such programs should be culturally sensitive and address the needs of various ethnic groups in Pakistan.

4.18. Infrastructure Resilience Measures

The adoption policies aimed at vital infrastructures including hospitals, schools and emergency response centers need to be implemented for enhancement of the infrastructure stability. To identify the high risk areas and select retrofit project among existing infrastructures, vulnerability assessments of infrastructure should be done.

Thus, the adoption of resilience approach in constructing new projects will lead to strong likelihood that they can withstand such jolts. The significance of public-private partnerships in financing and implementing resilience programs for

infrastructure projects is rather high.

4.19. Community Involvement and Awareness

On the other hand it involves active members who understand what has to be done for them not to incur risks from earthquake. Here are key considerations for fostering community involvement and awareness:He is a zero prick.

Education and Training

Developing study courses for localities focusing on possible seismic risks and the need of treatment / after earthquake, measuring efficiencies.

Conduct routine trainings on the emergency plan, first aid and use of kits. However one should present some instances for the sake of simplicity.

Local Leaders and Influencers

It would also have its way of propagating the ideology through pacts between local practitioners, influencers and religious groups. They reproduce themselves.

Additionally, community meetings or seminars should be arranged by these influencers to offer the answers and fighting false information about quake hazard with prevention actions.

Community-Based Organizations

In these door-to -door visits the CBOs and NGO s were very active.

CBO cooperates with information points formation sensatisation and social mobilization. Instead, such institutions are equally effective in ensuring that interventions adopt a cultural and environmental approach.

Local Language and Culture

Local language for user convenience and ease of use. Radio lessons conducted in the native dialect, put it into pamphlet education and copy cat communication. Indigenous knowledge relating to disaster preparedness should form part of every curriculum and program. However, observe the conventions which can be used for developing community participation.

Interactive Communication Channels

Share this information in several other forms such as the community radio, social media and applications. In this connection, an issues and action-oriented community engagement platform may be fashioned around these concerns to stimulate grassroots activism.

Simulations and Drills

Hold earthquake drills and simulations for the whole population. This process that is practice oriented led to the creation of emergency protocols and reasoning.

The comment-based drills should be used to direct the micro audience.

Youth Involvement

Remember the idea of young people performing in public events and training. They need to behave like earthquake representatives of their homes and neighbourhoods.

Use design school syllabuses with competitions or projects, that promote the readiness philosophy.

Incentives for Participation

Motivate citizen involvement in assessing the community. Thus, relish in triumph by promoting community movements that advocate for a resilient society.

Local discourse programs for campaigns in recognition or award, groups whose achievement came from intervention leadership of earthquake preparation and risk reduction.

Therefore, the engagement and awareness campaigns would include various approaches that are adaptable in Pakistan’s peculiarities along with all major climatic regions. Nevertheless, all above do not contribute in combating quakes until only communities appear to sign responsibility and response.

4.20. Education and Training

Targeted Educational Programs

Thus, large corporations must develop structural earthquake risk , preparation and mitigation initiatives. Culture-sensitive curriculum comprehensible and applicable to culturally diverse groups. Work with schools, colleges and other learning institutions to integrate earthquake preparedness in their curriculum.

Training Sessions

People in this community get trained on essential skills such as first aid, search-and rescue procedures using the proper kits among others. Pair them with nearby experts, first responders and health professionals. Utilize practical training aids like computer simulators and demonstrations.

Youth Empowerment

Train youth specialised courses. Train modern day generation on traits of independence and leadership.

4.21. Community Engagement Programs

Partnerships with Community-Based Organizations (CBOs):Firstly, sovereign state did not come about in Hong Kong.

First of all initiate partnership with local CBOs and NGO as they usually encourages community action programs. CBO’s thirdly can act as an intermediary or a messenger between the general public and government in facilitating effective communication.

Local Leaders and Influencers

Voice of the community leaders, change agents and religious authorities who mediate interpersonal relations in terms of words. Men travel to get earnings in seminars that surrounded meeting talking about the elimination of earthquakes where

they did by creating preparations.

4.22. Communication Strategies

Multichannel Communication

Create multichannel communication channels for the intended audiences. The counter step is to educate the population using community radio and social media mobile apps rather than traditional ways, about all precaution measures available response options.

Local Language and Cultural Sensitivity

In this instance, we can relate to Islam and Jainism as the Muslims Jews have no symbolic flag for an inferred religion.

If this can be done on the radio news in a country like this, then more people will learn about it or would get to understand better. For example, what about these cultural values and ethical considerations placed on this communication channels? Transmit powerful messages in culturally resonant stories and symbols.

Two-Way Communication

Have a community feedback section. Provoke residents to express their fears, tell stories and share knowledge. Be a citizen of the public.

5. Policy Recommendations

Therefore, a viable policy framework is required to ensure that earthquake disaster risk reduction in Pakistan encompasses all threat sources originating from seismic activities. First of all, building codes need to be adjusted and strengthened. Enactment of strict and contemporary building codes required seismic design to the stronger fortifications. This aligns with international best practice demonstrated through the seismic-resistant building regulation of California, USA to minimize losses and preserve occupants (NIST 2021).

Second, the policy has to highlight earthquake risk in urban planning and zoning regulations. The use of seismic zoning maps and the inability for certain types to develop developments, people's exposure hazard will be significantly reduced. The international practices can allow people to learn about New Zealand and the United States of America that strategic land use planning is only one among many other measures, helping in reducing earthquake effects.

Further, the community requires resilience through targeted education and awareness programs. The proposed policy recommendations are likely to be integrated earthquake preparedness into school curriculum. These initiatives should collaborate with the schools and utilize local leaders so that part of their program can run through a charity organization. It is therefore that seismic preparedness strategies ranging from community engagement initiatives, such as those adopted in Japan where education and awareness are grown deep at the roots of it while serving as an example for integration into society.

Secondly, setting up and building early warning systems should be one of the top priorities for any government. The benefits of extending the existing systems, investing in modern technologies and forming global networks will play an important role in improving early warnings greatly. Considering the successful applications of EEW system from countries like Japan and Mexico, this will further bolster efforts to improve early warning capacities (JMA 2016; SSN 2015).

5.1. Strengthening Legal Framework

In Pakistan, a legal framework is necessary to facilitate the effectiveness of earthquake disaster risk reduction. As a first step, it is required to make reforms and changes in such laws as National Disaster Management Ordinance of 2006. They are provisions that target mitigation of earthquakes risk, building codes and land use planning. Furthermore, the provision of regulatory activities that ensure compliance with seismic resistant construction practices is required. For developing countries, like Japan and Chile with a wide variety of legal methods for seismic hazards reduction (JMA 2021; ONEIMI 2021), Pakistan can use their law in accordance to the current guidelines.

5.2. Institutional Capacity Building

It is therefore essential to develop capacities of competent institutions towards actionable strategies for earthquake risk mitigation. It involves the training and arming of government bodies that are responsible for disaster management, urban planning as well construction control. Such professionals that operate in seismic areas should receive technical skills to ensure high levels of adherence with building codes and resilient construction practices. The processes of increasing capacity can be aided by collaborative initiatives between National and Provincial Disaster Management Authorities, partnerships with education institutions among others international agencies. Pakistan will take inspiration from what Turkey has done in training entrepreneurs for reducing the seismic risk.

5.3. International Collaboration

Given that the seismic risks are cross-border, efforts towards international cooperation should be encouraged. This would require Pakistan to interact with neighboring states, international organizations and research institutes through which knowledge skills and resources are exchanged.

The involvement in the regional forums and joint ventures like those enabled by UNDRR causes identification of international best practices along with innovativeness. It is desirable to work with countries that have endured the same plight such as Indonesia and Nepal in order for one t develop practical ways of reducing earthquake risks. Pakistan can benefit from sharing common experiences and join efforts with the global cooperation which leads to improving resilience in terms of seismic impacts (UNDRR, 2021; UNESCAPe., 2021).

6. Conclusion

6.1. Summary of Findings

These results applied outstandingly in the process of latter days parameters and needed research on risk factors to reduce earthquake disaster in Pakistani. Based on the analysis, cross-scale multilevel strategies are required for resilience building. The main landmark transformations, consisting in structural changes of warning system redevelopment; workshop checking and activation with seismic results for urban layout among other practice based education via neighborhood stakeholder. This is based on the Pakistan earthquake events and international property law seismic risk mitigation concepts.

6.2. Implications for Policy and Practice

Bad manners are a bad habit This has some important policy and practice implications. From better legal frameworks, modified building codes and investments in institutional capacity build emerge three policy imperatives Importantly, the benefits in terms of earthquake risk mitigation are: the attention to community-based teamwork; seismic elements within urban design and second spreading international partnership. Thus, all these proposals must be integrated with the policy and governance structures as one multi-stakeholders approach of consensus. The keywords in Policy implications for actions during disasters do not only encompass the prevention measures but also talk about other mechanisms that allow people to have a proactive society where, it has prepared itself before and after shock.

6.3. Suggestions for Future Research

However, the risks to be ascribed with earthquake disaster risk reduction in Pakistan should also continue to feature future studies on these areas. The third is that extensive socio-economic analysis of those affected by the earthquake may indicate what policy has been pursued. In addition, research should be carried out on the impact of community engagement activities and ways in which local leaders pass through making decisions associated with resilience building. If speaking about advanced methods of modernization, studies that are focused on technologically empowered converging innovations such as but not only AI and GIS for earthquake risk mitigation techniques also can contribute to this line.

Adaptive approaches could benefit a lot from longitudinal studies of policy recommendations. Second, cross-country comparisons between similarly stricken nations will help better understand which measures are efficient at reducing seismic risk.

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