Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol: 55 Issue:07:2022
DOI 10.17605/OSF.IO/U4PBH

FACTORS CONTRIBUTING TO EARTHQUAKE VULNERABILITY: A CASE STUDY OF QUETTA, PAKISTAN

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Abstract

Quetta being the largest city in the province is prone to damaging earthquake hazards. Identifying the causative factors to earthquake vulnerability is one of the most important parts of earthquake risk evaluation. The main objective of this study is to identify factors contributing of earthquake vulnerability based on public perception. Nearly 400 households were selected using stratified random sampling with proportionate allocation through a survey questionnaire. The results of the study reveal that Quetta is highly vulnerable to earthquake in the future; its geology coupled with the human dimensions indicates a more disastrous future in the next event. Apart from that, disaster preparedness at both the community and institutional levels is not encouraging. The results of the current study may be fruitful in future earthquake risk assessments.

Key Words: Earthquake, Vulnerability Factors, Risk, Quetta

Introduction

Population and rapid urbanization are the two main dynamic factors due to which urban areas are becoming more vulnerable in the context of earthquake hazards (Ainuddin and Routray 2012b). The increased level of residents has enforced the people to live a slums and seismic-prone areas. Trough out the country Quetta has been declared the most earthquake-prone area (NDMA Pakistan 2007). Absence of responsibility about the seismic concern (Wood, Burton, and Cutter 2010), lack of awareness, and lack of monitoring of earthquakes proof designs (Bilham 2019; Maqsood and Schwarz 2010; Mulyasari et al. 2013), and poor resilient development (Paton and Johnston 2001; Walker et al. 2014), are the causes due to which, maximum of the people living in earthquake-prone and active areas and regularly they pay the amount for huge calamities. A Hazard only transforms into a disaster when it affects the vulnerable and exposed human

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population and their infrastructures. A developing country like Pakistan is more expected to be exposed to a higher risk of hazards due to disaster management activities with a reactive approach(Shah 2012). In developing countries, most of the disaster management activities are associated with relief, response, rehabilitation, and reconstruction. Lack of action with a proactive approach and the absence of a concrete master plan convert turn small disasters into large destruction (Ainuddin and Kakar 2015; Ra and Ra 2009). This indicates neither the implementing authorities have taken steps, nor do people try to safeguard their construction for seismic safety and to adapt the coping mechanism before during, and after a disaster (Ainuddin and Routray 2012a). Throughout the country, construction practices and building quality remained poor and unsupervised by concerned authorities due to a lack of proper management and political influence. It is time to learn a lesson from the 2005 Kashmir earthquake where all the buildings and infrastructures collapsed even the government buildings which were constructed by the contractors also collapsed totally.

1. Variables/indicators of earthquake vulnerability

The results are drawn from the study area to understand the public perception of earthquake vulnerability. Various questions were asked from respondents that which factor increases the level of vulnerability in the study area. Social vulnerability indicators include health insurance, education level of the people, disabled population, aged people, women, and children in the community(Cutter and Finch 2008). Economic vulnerability is the second component of the vulnerability assessment. Economic component have a major role to reduce or increase the capacities of a community before, during, and after a disaster. The indicators of economic vulnerability include unemployment, diversified source of income, economically dependent population, people having government jobs, and people doing daily wage occupations (Adger 2006). Institutional vulnerability describes the communities vulnerabilities related to disaster management activities like people awareness, mitigation measures, and disaster planning, etc. Institutional vulnerability indicators include implementation of building codes by government authorities, awareness, and preparedness programs initiated by relevant stockholders i.e. PDMA, NDMA, or DDMA, coordination among institutions, and participation of people in emergency response (Taubenböck et al. 2008). Physical vulnerability identifies vulnerabilities related to physical infrastructure, house location, building age, the material used in the building construction, building height, land use planning, open spaces, roads, overflies, etc (Cutter, Mitchell, and Scott 2000).

2. Study Area and Methods

Quetta the capital city of Balochistan is selected as a study area. Quetta is surrounded by district Pishin in the north; district Mastoong in the southwest and District Ziarat in the east. Quetta is situated in the first and highly seismic zone of Pakistan. The well-known

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and 850-kilometer-long Chaman fault is located near Quetta. The climate of Quetta District is dry, arid: hot in summers and mild to extreme cold in winter, with a snow season from December through February. Quetta does not experience sustained and heavy rainfall as it lies outside of monsoon conditions (Development, Department, and UNICEF 2009).The current study evaluated the causing factors of earthquake vulnerability using qualitative and quantitative methods techniques. Primary data was collected from 400 sample respondents using stratified random sampling to achieve the objectives of the study. Key informants' interviews were scheduled with all four PDMAs to understand the overall institutional mechanism of disaster management in Pakistan.

Figure 1: Study area Map

3. Results and Discussion

3.1 Physical, Economic and Social Vulnerability of the Study Area

The results related to house location revealed that almost 50% of houses in the study area are located in the outer core and 33% of houses are located in the inner core of the city. Similarly, 12 % & 6 % of houses are located in the periphery and outer periphery respectively. Houses located in inner and outer core areas of the city are highly congested with population and face all those problems which an overcrowded area can be faced. So it's concluded that houses located in the core areas are more vulnerable than the periphery and outer periphery. House types, Materials used in house construction, and house age are the significant factors to determine the structural Vulnerability of any locality. In this context numbers of questions were asked from respondents. Initially, age of the house is categorized into three categories as mentioned in Table 1. The majority

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of the houses in the study area were below 20 years of age and 29% of the houses were more than 40 years old. It is concluded that houses aged more than 40 years are less resilient in the context of the earthquake, because such houses may not be withstood potential earthquake shock in the future. House type is categorized into four categories: 1) single/bungalow 2) row house 3) double story and 4) flat. The vulnerability level increases from the single houses to flats. Flats are most vulnerable in earthquake-prone areas due to their height and congested nature. The majority of the houses in the study area were row houses 36% followed by single bungalows 33% and the rest 34 % of houses were double stories and flats. The inner and outer core areas were found less resilient in terms of double stories and flats. Materials used in house construction are categorized into four categories as given in Table 1. In the study area, almost 40% of the houses were made of concrete. Similarly, 39% & 16% of houses were made of Bricks, Stones, and unbaked Bricks/earthbound respectively. We can conclude that houses made of Bricks, Stones, and unbaked Bricks/earthbound are comparatively less resistant as compared to concrete and steel houses. Within the social component, illiteracy is found most contributing factor to earthquake vulnerability. Similarly, aged people 9% and children below 15 years of age with 26 % are enhancing social vulnerability during earthquake evocation and emergency response. Within the economic component, the unemployment occupation with 36% and daily wage occupation with 23% have found most contributing factors to economic vulnerability.

Table 1: Physical Environment and Housing Location

Variables	Categories	Percentage
Location of the House	Inner Core	33
	Outer Core	49
	Periphery	12
	Outer Periphery	06
Age of House	Less than 20 Years	38
	21-40 Years	33
	Above 40 Years	29
House Type	Single/Bungalow	32
	Row House	36
	Double Story	17
	Flat	10
	Others	05
Materials Used in Construction	Steel	04
	Concrete	40
	Bricks and Stones	39
	Unbaked Bricks/Earthbound	17
Social Dimensions	Illiteracy rate	42
	Disabled population	02

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	Aged people	09
	Children below 15 years of age	26
	Women	48
Economic Component	Unemployment	36
	Daily wage occupation	23
	Diversified source of income	14
	Government employers	21

(Source: Primary Data)

3.2 Public Perception about Earthquake Vulnerability

Questions were asked from the respondents about seven factors which are shown in figure 2.

Low resistance and improper building infrastructure is the main factor contributing to earthquake vulnerability, as (26%) of the sample respondents highlighted that, thelack of earthquake-resistant buildings is the highest factor that exceeds the vulnerability of the overall community during a disaster. Physical location, poor land-use planning, and lack of awareness and preparedness are more or less the same contributing factors to vulnerability as shown in figure 2. The low response of public perception about the building codes shows the complete failure of the institutions, it means the low attention of the people towards the implementation of the building code is due to poor policy and low level of awareness.

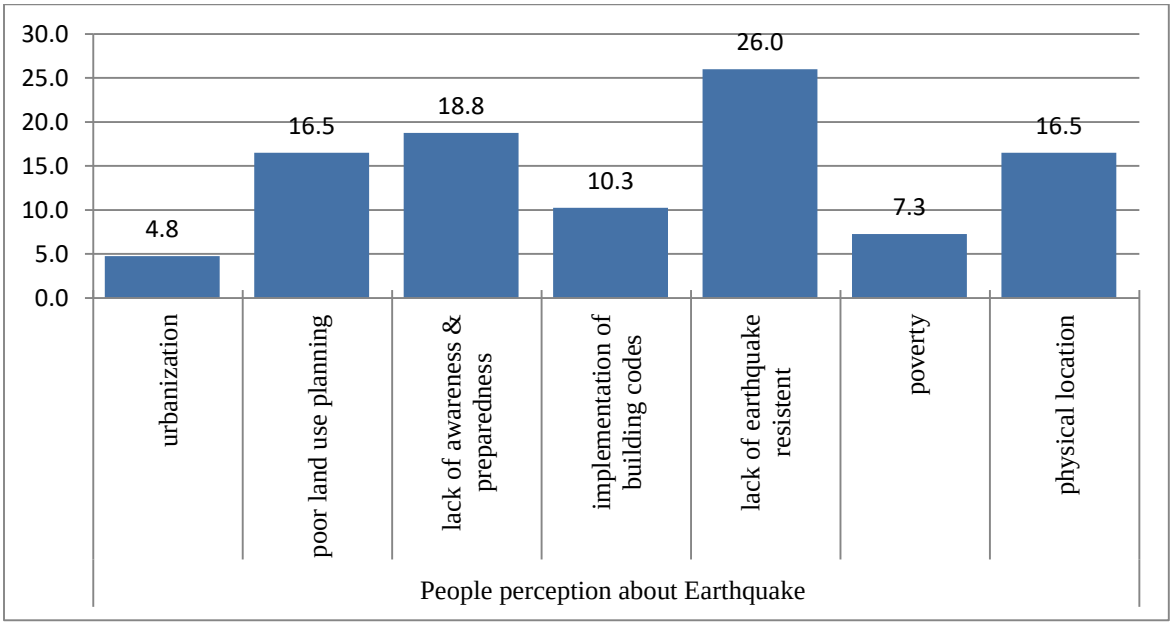

Figure 2: Factors contributing Vulnerability (Source: Primary Data)

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3.3 Public Perception about Earthquake Awareness and Preparedness

During data collection in the field, a number of questions were asked from respondents about earthquake awareness and preparedness. Respondents were asked whether they know about the occurrence of an earthquake in the future or if they know about the hazard-prone areas. Did they know about land-use planning, and whether communities cooperate with each other during disasters? Results revealed that almost (85%) of the respondents in the study area were aware that earthquakes will occur in the future but still appropriate mitigation measures were not taken into consideration. Similarly with the same ratio respondents were known that they live in hazard-prone areas. Only 10% of the households were having preparedness plans for earthquake emergencies in the study area. Cooperation among communities during a disaster is a positive sign and is found better indicator comparatively rest of the indicators. Still, there is a big debate about religious norms and values in the literature, as shown in Table 2, almost 34% of the sampled respondents said that the occurrence of an earthquake is due to punishment by GOD. It shows the strong belief in the religion of the people, and also shows the low level of awareness in the community.

Table 2: Public perception about earthquake Preparedness and Awareness

Variables	Categories	Percentage
Do you think that the earthquake occur in the future?	Yes	85.3%
	No	14.7%
Do you know that you live in hazard prone area?	Yes	82.7%
	No	17.3%
Do you think the earthquake risk is increasing in Quetta?	Yes	89.9%
	No	10.1%
Does your community have preparedness plan for earthquake emergency?	Yes	9.6%
	No	90.4%
Do you have community based organization?	Yes	17.3%
	No	82.7%
Does your community work for common interest?	Yes	43.6%
	No	56.4%
Do they help each other during disaster?	Yes	56.4%
	No	43.6%
	Yes	76.9%

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Is there any cooperation among communities during disaster?	No	23.1%
Do you know land use planning?	Yes	29.2%
	No	70.8%
Earthquake occurs because off	Punishment by GOD	33.6%
	Geological process	39.7%
	Don't know	26.9%

(Source: Primary Data)

4. Institutional Vulnerability of the Overall Disaster Management system in Pakistan

The key informant interviews were scheduled with all the four PDMAs and visits were paid to understand the overall development of each PDMA regarding disaster management strategies, preparedness, and steps taken by the respective PDMA for risk reduction. The results are not encouraging because these institutions or agencies are established back in 2007. These authorities have an acute shortage of skilled human resources in the field who know the technical aspects of disaster management. On other hands most of the employees in these authorities are brought in the deputation from other department which slows down the development of these authorities themselves. Some authorities over employment have observed. In all the four authorities including NDMA, irrelevant employees from other departments are serving that is why after the establishment in 2007, they are still struggling and have not been able to streamline the authorities and take mitigation steps to avoid disaster in their jurisdiction and human resource development has not taken place since its inception.

Apart from that in most of the PDMAs except KPK, Disaster institutions are not implemented at the local levels such as DDMA, and Union council, which are the key institutions for awareness, preparedness, and disaster management activities, involving local people in policy, implementation and monitoring, and evaluation. Unless we establish these institutions, talking about risk reduction and climate change adaptation would be merely a dream for the national authority to combat the disastrous effects of natural and man-made events in the country. This would exacerbate the vulnerability and reduce the power of resilience to withstand and cope with disasters at local levels. That is why NDMA is always involved in the handling disasters at the local levels.

In all the four PDMAs, The PDMA of KPK has improved much compared to other provincial authorities. The reason behind this could be the frequency of both natural and man-mad disasters in the province for a long time. Apart from that, KPK has evolved and developed its disaster policy in line with the national framework. Further, the province has also made great development in the implementation of the sub-authorities at the district and union council level, which has a great development for awareness, and preparedness

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at a local level, which is one of the goals of the Sendai framework. Indeed without public involvement, risk reduction is not possible.

Though, the country agreed with the international commitments made regarding disaster risk reduction like Hugo Framework for action (2005-15) and Sandi Framework (2015-30). But has failed in implementing at all levels, particularly, the country has not done the risk assessment, and has not established the local institutions at district and union council levels. Which are the key players in reducing disaster effects at all levels? Additionally, the country is facing huge structural issues involved in disaster governance and institutions. Therefore it is extremely important to take serious steps to revitalize these authorities with the following recommendations.

1. The authorities should be given in dependent mandate to appoint fresh and permanent technical human resource in the field.
2. The authorities should train the human resources through certification/Degrees in the specific disciplines under the umbrella of disaster management.
3. In the provinces the authorities should not be dependent on Ministries and should work directly under NDMA independently.
4. The deputation should be discouraged by these authorities.
5. Some authorities and departments like GSP, ERRA PMD, and SUPARRCO should work under the NDMA to have one window operation.

5. Conclusion

A Hazard only transforms into a disaster when it affects the vulnerable and exposed human population and their infrastructures. A developing country like Pakistan is more expected to be exposed to a higher risk of hazards due to disaster management activities with a reactive approach. The main objective of the current study was to identify factors contributing to earthquake vulnerability in Quetta city. A sample size of 400 was selected for the said study. The results of the study reveal that Quetta is highly vulnerable to earthquake in the future; its geology coupled with the human dimension indicates a more disastrous future in the next event. The study reveals a very poor index of physical, social, and institutional which is shown in figure 2. Apart from that, disaster preparedness at both the community and institutional levels is not encouraging. People in the study area are vulnerable both structurally and institutionally in the context of earthquake preparedness and awareness. Building code implementation is a major issue that needs political commitment; the results show poor policy implementation in the quarter concerned. And need to establish an authority that would be responsible for the monitoring of building code in the future.

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