Earthquake Risk Perception and Community Resilience in Peshawar

By

Myra Khan

00000273536

A thesis submitted in partial fulfillment of

the requirements for the degree of

Master of Science

in

Disaster Management

Military College of Engineering
National University of Sciences and Technology
Islamabad, Pakistan

(2022)

This is to certify that the

thesis titled

"Earthquake Risk Perception and Community Resilience in Peshawar"

Submitted by

Myra Khan

has been accepted towards the partial fulfillment

of the requirements for the degree

of

Master of Science in Disaster Management

Lt. Col Dr. Muhammad Jawed Iqbal

Assistant Professor

THESIS ACCEPTANCE CERTIFCATE

Certified that the final copy of MS thesis written by Myra khan (Registration No. 00000273536), of Military College of Engineering (MCE), Risalpur has been vetted by the undersigned, found complete in all respects as per NUST regulations, is free of plagiarism, errors and mistakes and is accepted as partial fulfillment for the award of MS degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the said thesis.

Supervisor: ________________________________

(Lt Col Dr. Muhammad Jawed Iqbal)
Assistant Professor

Member: ______________________________

(Lt. Col Dr. Muhammad Rizwan)
Assistant Professor

Member: _______________________________

(Dr. Arshad Ali)

Assistant professor

DECLARATION

I, Ms. Myra Khan hereby declare that I have presented my original work in this thesis.

The work has not been presented elsewhere for assessment. The material that has been used from other sources; it has been properly acknowledged / referred.

Signature of Student ______________________________

Myra Khan

00000273536

PLAGIARISM CERTIFICATE

It is certified that MS Thesis Titled **"Earthquake Risk Perception and Community Resilience in Peshawar** "by **Myra Khan** has been examined by us. I undertake the follows:

a. Thesis has significant new work/knowledge as compared already published or are under consideration to be published elsewhere. No sentence, equation, diagram, table, paragraph, or section has been copied verbatim from previous work unless it is placed under quotation marks and duly referenced.
b. The work presented is original and own work of the author (i.e., there is no plagiarism). No ideas, processes, results, or words of others have been presented as Author own work.
c. There is no fabrication of data or results which have been compiled/ analyzed.
d. There is no falsification by manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
e. The thesis has been checked using TURNITIN (copy of originality report attached) and found within limits as per HEC plagiarism policy and instructions issued from time to time.

Name & Signature of Student

Myra Khan

Signature:

____

Name & Signature of Supervisor with Stamp

Lt. Col Dr. Muhammad Jawed Iqbal

Signature:________________

COPYRIGHT STATEMENT

Copyright in text of this thesis rests with the student author. Copies (by any process) either in full, or of extracts, may be made only in accordance with instructions given by the author and lodged in the Library of NUST Military College of Engineering (MCE). Details may be obtained by the Librarian. This page must form part of any such copies made. Further copies (by any process) may not be made without the permission (in writing) of the author.

The ownership of any intellectual property rights which may be described in this thesis is vested in NUST Military College of Engineering, subject to any prior agreement to the contrary, and may not be made available for use by third parties without the written permission of the MCE, which will prescribe the terms and conditions of any such agreement.

Further information on the conditions under which disclosures and exploitation may take place is available from the Library of NUST, Military College of Engineering Risalpur.

CERTIFICATE OF ORIGINALITY

I hereby declare that the research paper titled **"Earthquake Risk Perception and Community Resilience in Peshawar"** is my own work and to the best of my knowledge. It contains no materials previously published or written by another person, no material which to a substantial extent has been accepted for the award of any degree or diploma at NUST or any other education institute, except where due acknowledgement, is made in the thesis. Any contribution made to the research by others, with whom I have worked at MCE/NUST or elsewhere, is explicitly acknowledged in the thesis.

I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project's design and conception or in style, presentation and linguistic is acknowledged. I also verified the originality of contents through plagiarism software.

Author Name: Myra Khan

Signature: ____________________

DEDICATION

My thesis is dedicated to my family and teachers – who have educated me and contributed positively for the attainment of this level.

Acknowledgement

In the name of Allah, the Most Gracious and the Most Merciful

With the humblest and sincerest of words, I thank Almighty Allah, who bequeathed onto me the potential and ability to complete my work, who taught me how to write by pen, whose gratefulness covers everywhere.

It is a source of pride to acknowledge the people whose contributions allowed this research study to come to fruition. In the first place, it gives me immense pleasure to extend my warmest indebtedness and thankfulness to my research supervisor, Lt.Col Dr. Muhammad Jawed Iqbal for his utmost and untiring supervision, advice, motivation, and guidance. His intuitive comments were influential in arriving at rational discussion of my results. I am grateful to him for enlightening me with research skills and taking out his precious time for this humble study.

I will be guilty of great omission if I fail to mention my thanks for parents, course mates, and family members who were always there to render help in every possible way to complete this study project by providing me the moral support and courage to keep abreast during these testing times.

Lastly, I once again thank Allah Almighty who made the difficult path easy and rewarded me with utmost magnanimity for my meager efforts to achieve the required outcome.

Table of Contents

LIST OF ABBREVIATIONS

Abbreviation	*Description*
EQ	Earthquake
RFI	Resilience Factor Index
CRFI	Composite Resilience Factor Index
ARFI	Aggregate Resilience Factor Index
ERP	Earthquake Risk Perception
ERI	Earthquake Resilience Index
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction

LIST OF TABLES

LIST OF FIGURES

Abstract

Introduction: Disasters around the world are increasing in number which are impacting human's lives in a negative way. Communities need to be made resilient to withstand the impacts of disasters. In order to work on resilience of communities against the harmful impacts of disasters, the level of resilience of a particular community and the risk perception of its people is crucial to find out. Risk perception of the people of a particular community directly tells us about how resilient they are. Peshawar holds a very important place in Khyber Pakhtunkhwa, being its capital. It is hit by many earthquakes in the past. It is likely to get hit by more earthquakes in the future.

Objective: This paper attempts to find out the earthquake risk perception of people of Peshawar in terms of earthquake hazard and thus the resilience of the city Peshawar to earthquake. In order to lessen the impacts of such earthquakes, this paper concludes the risk perception and resilience of its people.

Methods: this research is carried out using simple random sampling technique. Peshawar is divided into 4 towns, town 1, town 2, town 3, and town 4. In each town, surveys are made through semi structure questionnaires, which are composed of questions that are formulated, keeping in mind a few components that are social, economic, physical, and institutional. These components are further divided into indicators. These components are extracted from studying literature of past similar studies.

Results: The composite index revealed risk perception and resilience of people in all four towns. The difference between all towns was not significant nor were the results significant but town 1 and 3 had higher earthquake risk perception index and resilience index than town 2 and 4. The level of education of people, building type, age, income and similar indicators showed different results. For example, people with high education had greater risk perception. People with houses that are made using engineering methods were considered more resilient. None the less, risk perception and resilience cannot be calculated to 100% accuracy but this study enlightened us to a greater extent about Peshawar city.

Recommendations: Recommendations were made to increase risk perception and resilience of people through awareness campaigns, educating the people, income generating activities, using engineering techniques in building houses and structures etc.

Keywords: *Disaster, Risk perception, Indicators, Disaster resilience, Peshawar*

Chapter 1

INTRODUCTION

1.1 Background

Every year the number of disasters that are caused by natural hazards are increasing, not only frequency wise but also in terms of severity, losses to human lives in every aspect. They hinder communities in terms of development as well as economically. (Hyndman and Hyndman 2016) .Disasters are made when naturals hazards come in contact with a vulnerable population/community (Pelling and Uitto 2001). As disasters can be controlled to an extent but we cannot totally eradicate their occurrence that is why they are considered the main concern of development hindrance and problems to human lives in today's world. (Kõlves, Kõlves et al. 2013) Asia is the hotspot of many disasters that is why some scholars term it as the supermarket of disasters (Mavrodieva, Budiarti et al. 2019). According to a report, 37% disasters occurred in Asia only, in 2007. If preventive measures are not taken, the situation will worsen(Bilham and Hough 2006). Earthquakes have been observed to be one of the deadliest disaster around the world. Earthquakes of the same magnitude are recorded to have different impacts in different parts of the world. Its impacts have also increased in recent years. (Marano, Wald et al. 2010). The variation in impacts is primarily due to be the different topography, soil conditions, hazard level and different modes of construction adopted in the various parts of the worlds. Over the last decades earthquake events have caused great deal of destruction and losses to human lives and the entities associated to them such as structural, financial, social destruction. The Indo-Pak subcontinent has gone through significant losses because of earthquake disasters (Gupta and Gahalaut 2014). Pakistan is not an exception when it comes to losses from earthquake events. Both the urban and rural areas of Pakistan are at risk to earthquake hazard. There's doesn't does not exist a single area in Pakistan that is totally safe from earthquake hazard but some areas are more vulnerable than others because of different seismic demography and different level of capacities (Maqsood and Schwarz 2008). The losses in physical and economic sector in Pakistan as a result of earthquakes cannot be over emphasized. Geologically Pakistan is situated in seismic zone of high activity. Pakistan is prone to earthquakes, and has been hit by events in the past that have resulted in a loss of life and property. Seismically, Pakistan is one of the most active areas of Asia and has a high density of active faults being located at the intersection of three plate boundaries, namely Indian, Eurasian and Arabian(Mahmood, Kidwai et al. 2015). In the past Pakistan has witnessed some major earthquakes that caused great destruction to the country. One of them was Quetta earthquake in 1935 which caused great destruction in the country. The vibrations were recorded throughout the country. It was a 7.8 magnitude earthquake with the epicenter of 17km. It was a strong earthquake which lasted for 3 minutes and it also caused a volcanic eruption which in turn caused even more destruction. Quetta earthquake resulted in great loss of life, property, and infrastructure. People suffered in every way, be it loss of loved ones, injuries, finances, social disruption, emotional trauma etc. Another major earthquake that occurred on 28th November, 1945 originated from the Arabian Sea. Major cities of Baluchistan were badly affected. Karachi and Churi sustained great losses. It was an earthquake of magnitude 8.1 with the epicenter of 100km Karachi and 87 km churi. The strong vibrations lasted for 30 seconds reportedly. A tsunami was generated as a result of this earthquake which further enhanced the destruction caused by this earthquake. Reportedly, a volcanic eruption also took place after this earthquake which resulted in the formation of islands near Makran. Another destructive earthquake occurred in 2005 in Kahmir region on 8th October, 2005. It had a magnitude of 7.6 with an epicenter of

19km from Muzaffarabad and 105 km from Islamabad. This was a very destructive earthquake with about 122 aftershocks recorded the following day. A total of 1778 aftershocks were recorded till the end of 2005.being the most populated cities of Kashmir, were the most affected. A total of 87000 lives were lost. Reports say that the death toll could be greater than what is recorded. Other than that, greater damages were observed in terms of almost every aspect I.e. physical, financial, social, institutional aspects (Mahmood, Kidwai et al. 2015). Pakistan is located in one of the most earthquake prone region with many devastating earthquakes in the past and active tectonic shows that there might be more earthquakes in future. Hence it is crucial to perform earthquake hazard assessment across the country and subsequently develop and implement strategies for earthquake risk mitigation. Subsequent to facing extensive devastation by the 2005 Kashmir earthquake, the government has realized the importance of earthquake management and hence encouraged the scientific research aiming for earthquake hazard assessment and strategies for risk reduction. Moreover, organizations have been established mainly dedicated for natural disaster management. However, the magnitude of prevailing earthquake induced risk needs detailed earthquake hazard assessment, design earthquake resistant structures; implement the seismic building codes and public awareness to adopt for earthquake risk reduction.

Peshawar being the capital of Khyber Pakhtunkhwa is of particular importance when it comes to discussing earthquake hazards because it is located in the western Himalayan region, where there are high seismic risks as it lies near the active plate boundary between the Eurasian and Indian plates(Materna 2019). The fault systems on which the devastating Kashmir earthquake was generated, that is Main Boundary Thrust system, Main Mantle Thrust system and Main Karakorum Thrust System, if are ever active again in future, can cause devastating earthquake disaster in Peshawar. As Peshawar lies in zone 2. Zone 2 has peak ground acceleration between 0.16g to 0.24g with the return period of 475 years. Therefore, this research is being carried out to know that resilience of people in Peshawar as well as their risk perception in terms of earthquake hazard.

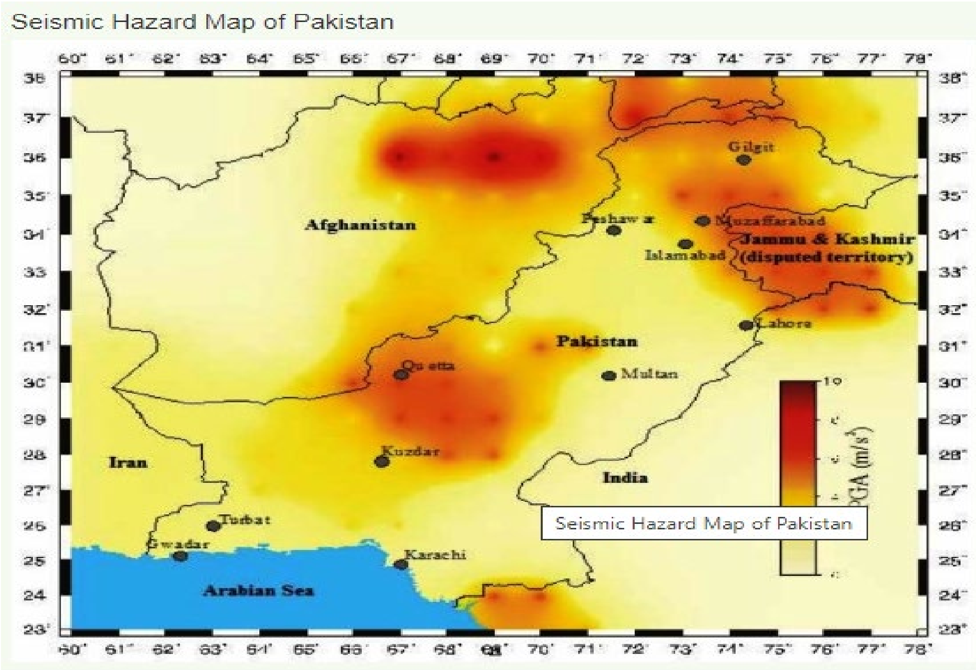


Figure 1. Seismic Hazard Map of Pakistan

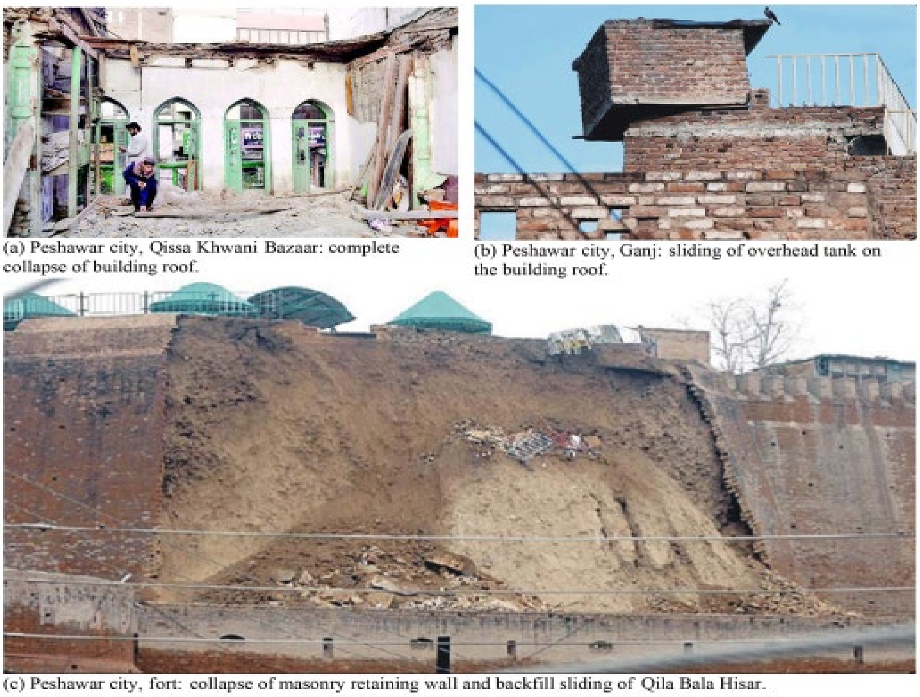


Figure 2. Damages observed in Qila bala hisar as a result of Hindukush earthquake 2015

1.2 Significance of the study

- Strengthening of infrastructure.
- Public awareness and education.
- Community resilience.

1.3 Aim of the study

- Public and housing safety.
- New laws and regulations.
- Disaster risk reduction.

1.4 Rationale of the study

- Earthquake vulnerability directly affects the development and growth of a country.
- If the root causes of vulnerability are not addressed, they will hinder the overall development of the area.
- In order to achieve the development goals, we ought to carry out this research to eliminate/reduce the potential causes of losses which result from earthquake disasters.

1.5 Objectives of the study

- To measure the resilience of Peshawar district in connection with earthquake hazard
- To analyze different aspects of community like socioeconomic, institutional and structural(housing) conditions in study area
- To suggest suitable measures to increase community resilience and to cope with earthquake hazards which can occur in the future

1.6 Organization of the thesis structure

1.6.1 Chapter 1: Introduction

This chapter describes the introduction of the thesis. The main emphasis of this chapter is on the purpose, objective and aim of the study.

1.6.2 Chapter 2: Literature Review

In this chapter the past studies similar to this research are being discussed with their proposed aim, objectives, proposed methodologies, results, discussions, conclusions and recommendations. Thus forming a basis and providing assistance for the researchers to conduct similar studies.

1.6.3 Chapter 3: Research Methodology

In this chapter the methodology through which this study is conducted is described. Data collection techniques, data formulation and data analysis etc. are discussed. The methodology adopted is described

1.6.4 Chapter 4: Results

The results concluded from the study are explained in detail in the chapter. The resilience factor index and composite factor index are calculated. The data analyzed is added to this chapter in the form of tables and graphs.

1.6.5 Chapter 5: Discussion

In this chapter, the whole process of what the research consisted of, is discussed. Results are elaborated.

1.6.6 Chapter 6: Conclusion and Recommendations

The objectives achieved through the study are concluded. Recommendations for improvement and further implementation are made. Limitations of the study are also discussed

Chapter 2

LITERTURE REVIEW

2.1 Background

The purpose of this chapter is to review the existing literature on earthquake risk perception and community resilience. We need to know about how the perception of people can affect a community in relation to earthquake hazard. We also need to know how different perceptions of the individuals of the community is related to resilience of the community, and that how the hazard itself is affecting them keeping in view their perception of earthquake hazard.

2.2 Definitions and concepts

2.2.1 Risk perception

Risk perception refers to the subjective judgement of individuals about the likelihood of negative occurrences like diseases, illnesses, injuries etc (Paek and Hove 2017)

2.2.2 Earthquake risk perception

This term refers to the perception of people who are living with earthquake risks. People's risks perception totally vary with income, age, house type and past experience of earthquakes(Qureshi, Khan et al. 2021)

2.2.3 Community resilience

The presence, engagement and development of resources by members of a particular community, to exist in the environmental atmosphere that is characterized by uncertainty and surprise (Berkes, Ross et al. 2013)

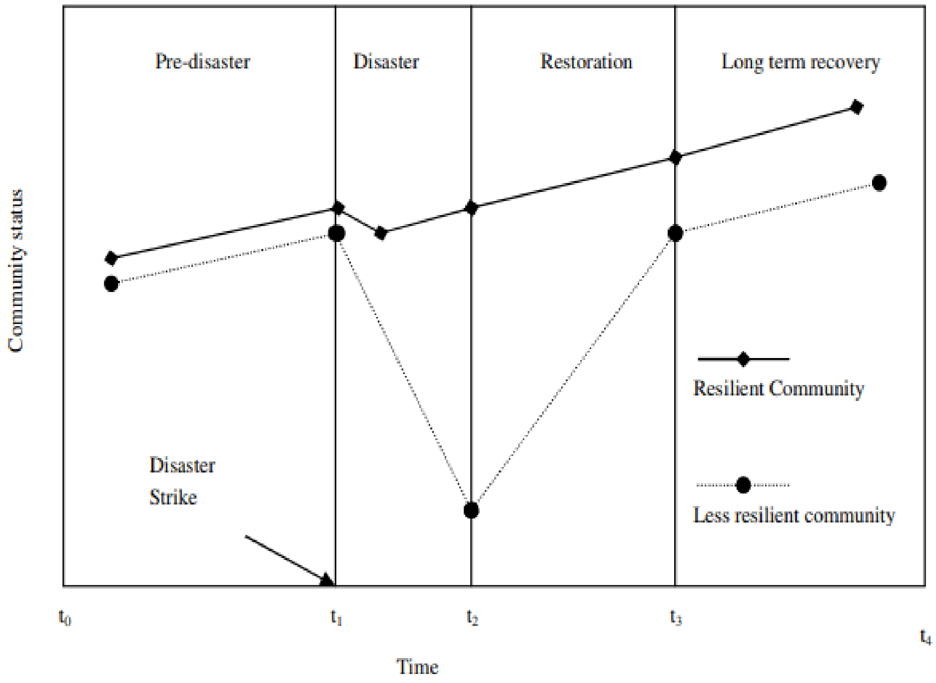


Figure 3 A hypothetical figure representing resilient and less resilient communities

2.3 Literature Review

As we know that Pakistan lies on the intersection of plate boundaries which have very high activity. Pakistan is one of Asia's most earthquake prone areas. The earthquake 1935 Quetta and 2005 Kashmir were one of the deadliest earthquakes in the history of Pakistan. Pakistan undergoes a constant threat of earthquake hazards even in the future. This threat may or may not be greater than the past earthquake events. Major population centres such as Islamabad, Quetta, Karachi, Muzaffarabad and Peshawar are located on or near to major faults; therefore, there is a strong need to develop and implement new building codes and also awareness should be raised with the public about the earthquake hazard. In addition, there is a strong need to identify active faults in Pakistan and their slip rates. A proper study should be carried out to identify the return period of these earthquakes (Mahmood, Kidwai et al. 2015)

A study carried out I Israel assessed the behaviors of the community members by observing the strategies they used in terms of coping with earthquakes. This study targeted a few factors that affected the risk of earthquake in Israel. Those factors in term affected the behavioral strategies of the community members which they adopted in times of earthquake; those factors were; age, income, gender, past experience and housing types. The results of the study indicated that those residents who had low socio economic status were the most vulnerable. Another finding showed that those who had followed engineering codes in building their houses were less vulnerable to earthquakes and thus had lower earthquake risk perception. Past experience directly affected the behavior of people in terms of earthquake. Earthquake preparedness plans were planned to be made by such assessments of all these indicators discussed above (Shapira, Aharonson-Daniel et al. 2018)

A study carried out in Christchurch, New Zealand and hitachi Japan demonstrated the comparison between how people of these two countries behaved when they were hit by earthquakes. Residents of both cities showed somewhat similar results in their emotional responses, behaviors, perception of risks and strategies that they adopted to cope with earthquakes. Both Christchurch and hitachi had quite similar physical/household and social characteristics but still people of hitachi showed greater emotional responses and risk perception than that of Christchurch. Both the cities had a higher response behavior that varied in terms of the strategy the adopted; for example; people of Hitachi would more likely evacuate the buildings in times of earthquake whereas people of Christchurch would drop to the ground and take cover. This study showed that although both the cities were quite similar in terms of demography, socio economic status and other physical characteristics and also showed they had similar patterns of emotional reactions, perceived risk, and immediate behavioral responses but it also demonstrated that there were also many significant differences that were measured (Lindell, Prater et al. 2016)

A study carried out in L'Aquila, Italy analyzed the causes of deaths as a result of a 6.3 magnitude earthquake on 6th April, 2009. The purpose of this study was to demonstrate the risk perception of people in terms of their behavior in order to reduce future risks from earthquakes. Age, gender, location and behavior of people directly affected the deaths, survival and casualties in the earthquake event of L'Aquila, Italy. The results showed that age directly affected the risks posed on people of L'Aquila. The elderly people had somehow low risk perception. As most of them were pensioners, their houses were mostly vulnerable to even the slightest tremors, so they were affected the most. Another finding showed that children and women were also the most affected as women stayed indoors most of the times and both women and had low risk perception. This implies that the results of mortality in L'Aquila earthquake varied gender wise as well. Location of houses and other physical characteristics also affected the mortality and survival rate significantly (Alexander and Magni 2013)

A study carried out in Bucharest, Romania identified the attitudes and risk perception of people regarding earthquake. Bucharest is a high risk seismic zone. This study was conducted to find out how different variables affected the perception of people in terms of earthquake, which in turn directly affected the resilience of the capital. The variables were age, gender, level of education, attachment to the area, socio economic status, awareness, risk exposure and degree of danger etc. findings showed that according to age group, the elderly were the most affected, as they deteriorated physically as well as financially. Another factor of the elderly being more affected was their attachment to the area. The love and attachment to the area over weighed their perception of seismic risk quite significantly. The study also demonstrated that education played a great role in risk perception of people of Bucharest. The educated folks had higher degree a awareness and thus higher risk perception as compared to the uneducated. The study also concluded that risk perception varied quite a lot on gender basis. Women had lower risk perception mostly because they were not as privileged as men. Their education level was also significantly low as compared to men. So, overall women were at a greater risk than men because of their attitude towards earthquake risk in Bucharest. The study also analyzed that socio economic status of people directly affected their vulnerability, exposure and risk perception in the area. People with better socio economic status had better build houses, larger capacities and higher risk perception(Armaş 2006)

A study was carried out in Taiwan to analyze the earthquake risk perception of people of Taiwan on the basis of gender and past experience. A comparison was made between group of people who had already experienced earthquake and those who had not experienced earthquake before. Two factors were analyzed while conducting the study. One was personal impact and the other was controllability factor. Controllability factor was the individual sense of protection one could have in times of earthquake; that how resilient they are to earthquake risk. Results showed that women had higher risk impact than men. Results also showed that people who had previous earthquake experience had higher impact factor than those who had no prior experience. In terms of the controllability factor, it was the same; gender wise and experience wise as well. findings showed that risk perception has various components and concludes that past experience (survivor status) and gender (female) affect the perception of risk(Kung and Chen 2012)

A research was conducted in Saudi Arabia to find out the risk perception of people regarding hazards like earthquakes, floods and epidemic etc. No existing literature was present. The research was mainly conducted in about thirteen areas of Saudi, using survey method. The results showed that that majority of people thought that disasters were sent to them as punishment from God. But still the majority was interested to learn the mechanism which could reduce the impacts of those disasters. The results showed that direct contact of people with the disaster also did not change their thinking about the nature and emergence of the disasters. so a few recommendations were made as a result of the study to capacitate the people of saudi arabia; that are, awareness rising, educating the people, special training,, availability of crucial services and resources, communication etc.(Alshehri, Rezgui et al. 2013)

A case study was conducted in Dhaka, Bangladesh to assess their earthquake awareness and risk perception. The purpose of it was to know the level of preparedness of the residents of Dhaka, to find out the resilience of the area in terms of earthquake. Comparison was made between different groups of people; i.e. gender based, education based, age based and awareness based. The results differed significantly for each group. Different groups had different risk perceptions. Findings showed that women had higher risk perception as compared to men. Results also showed that young people had higher risk perception. In the same way educated people had greater awareness and higher risk perception than the uneducated people. Findings concluded that groups of people with higher risk perception and awareness had greater preparedness and were more resilient to earthquakes than those with lower awareness and risk perception (Rahman 2019)

A research was conducted in Quetta city, Baluchistan. The main goal of it was finding the ERR of Quetta city. The study was based on two risk zones of Quetta, zone A and zone B. survey in these zones was carried out by resorting to simple random sampling technique of data collection to measure a few indicators, i.e physical, economic and social. The results show overall poor resilience in both zones but comparatively zone

A scored higher in resilience than zone B. however, it was concluded that improvement is needed in the targeted zones by bringing better social, economic, structural awareness in terms of the prevailing building codes requirements for coping the hazard efficiently in future (Ainuddin and Routray 2012)

Another research of the same nature was conducted in earthquake prone areas of district Malakand. The purpose of this research was to formulate effective risk reduction strategies for the earthquake prone areas of Malakand. For that, the risk perception of people about earthquake hazard was crucial to assess. A few variables were calculated in order to find the risk perception of people which were than used to formulate the risk reduction strategies. Those variables were socio economic, structural, and level of education, income, awareness, past experience and attitude towards earthquakes etc. 240 houses were surveyed using simple random sampling technique, through semi structured questionnaires. The risk reduction strategies that were suggested at the end comprised of awareness programs, education, introduction of engineering methods , building codes etc. (Qureshi, Khan et al. 2021)

2.4 Composite indices for community resilience and risk perception

The application of indices is not limited to a single discipline or area but it can be used in many different places and subjects such as deprivation, poverty, different aspects of life, human development, social capital, disaster risk reduction ,preparedness, resilience and vulnerability.(Ainuddin, Routray et al. 2015) . In order to find out the resilience of a community, the basic indicators on which their vulnerability and resilience depend, also needs to be determined. In that way experts can know how well a community will recover or respond from/to a hazardous event or what losses would occur, keeping an eye those indices.(Cutter, Burton et al. 2010). These indices are very easy and helpful tools because they can conclude the result of the entire analysis in one single value , which is called an index.(Cutter, Burton et al. 2010). Different indicators that are put together mathematically as one, to explain different aspects of a phenomenon is called an index. (Mazziotta and Pareto 2017). These indices are very helpful in carrying out performance measurement, as indices make conveying information and policy making easier(Ainuddin and Routray 2012). Worldwide several studies are carried out using the social vulnerability to climate change index, disaster risk index(UNDP2004) ,environmental sustainability index and human development index(Vincent 2004). The vulnerability which is caused by sea level rise and its impacts can also be determined through composite indices(Balica and Journal 2012). These indices are also used to determine the resilience on all levels country wide that is , on national level and on local level in the US.(Cutter, Burton et al. 2010).

Correlation between community resilience and risk perception

Community resilience and risk perception of people in a community are totally related. They have a direct relationship. If one goes up, the other goes in the same direction and vice versa. If people are well aware of a certain hazard, they know their plans, they understand the warning systems and impacts of a hazard, and they are already resilient because they have a high risk perception. On the other hand, people even living in good condition, do not have the knowledge or know how what to do before or in times of a hazard, are considered vulnerable**.** Because they are still at risk. in the same way, indicators like education, age, building type, location etc all contribute towards or away from risk perception and thus community resilience(Kung and Chen 2012)

CHAPTER 3

Research Methodology

Resilience and risk perception has too many dimensions/components when we go in depth in the field of research. Some of them are social, economic, institutional, physical, ecological etc (Cutter, Burton et al. 2010). In the same way we have set a few components of resilience and risk perception that we will use in this study, derived from studying the literature related to disasters and natural hazards. Those components are the following; social, physical, institutional and economic. These components are further broken down into sets of indicators. There is not a single method, nor one perfect method through which resilience and risk perception can be calculated. The method that we will use in this study is the one that is used by cutter et al in his study in 2010. All the data used was taken in percentages to avoid difficulty in carrying out calculations (Ainuddin and Routray 2012)

3.1 Components of community resilience:

The components selected for this study are the following;

- Social component
- Economic component
- Institutional component
- Physical component

Each component is further calculated through a number of sub components; that are the following.

3.1.1 Social component:

i. Level of education

ii. Age

iii. Income

iv. Social capital

v. Health insurance

3.1.2 Economic component:

i. Income sources

ii. House ownership

iii. Employment capital

iv. Income level

3.1.3 Institutional component:

i. Mitigation plans

ii. Awareness

iii. Municipal plans

3.1.4 Physical resilience

i. Location

ii. Building age

iii. Shelter capacity

3.2 Weighing and analysis of indicators:

In this research, the resilience of community Peshawar is derived through the already discussed four components, physical, economic, institutional and social. Each component is further calculated through a set of indicators discussed above. Each indicator has its own value which is expressed in percentage. Each indicator has given its own weight which makes it different than the other. For example, in social component; education and age are going to have different weights which make them important in their own way (Mayunga 2007). The weights of the indicators can be derived through two methods, as the literature. One is through empirical method that is done through testing and experimentation. The other is through subjective method, which is obtained through assessments.(Decancq and Lugo 2013) . The method used in this study is subjective assessment method this study is carried out on a small scale. According to literature all large scale studies were carried out using empirical method, while for small studies, subjective methods were used. A percentage scale was used for this study which had assigned values that ranged from 0 to 1. (Ainuddin and Routray 2012) . if higher is the value of the indicator, then higher will be its weight and thus higher will be the particular indicator's resilience and finally, higher will be the index value. The following equation sums it up below;

RFI of the ith indicator = % value of actual indicator / threshold value in % of ith indicator

The above equation is used to derive a single indicator. The values of the indicators derived as a result of using this equation are then used to calculate component resilience factor, using the below formula;

RFI of each component is calculated as the mean value of resilience index of all indicators under that component. Mathematically, it is expressed as:

$$\text{CRI} = \sum_{i=1}^{n} \text{RFI}/\text{n}$$

Where n is the number of indicators of that component.

Similarly, the aggregate resilience index is calculated as the mean value of all components. It is expressed as:

$$\text{ARI for towns} = \sum_{i=1}^{4} \text{CRI}/\text{N}$$

N = Total no of components.

Values of indicators close to 0 shows less resilience and thus indicates low index of resilience. Values closer to 1 shows greater resilience index.

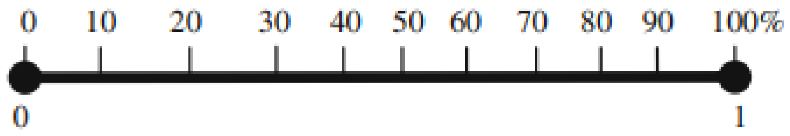


Figure 4 Percentage resilience scale

Indicator	Weights scale	Justification
Social resilience		
Percentage of people with high school and above education	0 10 20 30 40 50 **60** 70 80 90 100% 0 … 1	Education at high school levels is seen a useful in first step toward community preparedness (Dufty 2009; Johnston et al. 2010). Further, more people equipped with high education and knowledge can really disseminate the safety behaviors (Knight 2007) and emergency response practices. Therefore, education at both levels may help the community in preparedness, interpreting the warning and evacuation during an earthquake. More the community is educated, better will be their preparedness and coping. The percent of high school and above education in Japan is 77.7 % (MECSST 2007) and 60 % in California (United States Census Bureau 2010), and 31 % in Pakistan (Pakistan Census Organization 1998). Based on the above references, we consider that if 60 % of the population has high school and above education, they may cope better with earthquake hazards
Percentage of people above 60 years of age	0 10 **15** 20 30 40 50 60 70 80 90 100% 1 … 0	In disaster-prone countries, population should not be in the extremes of the age spectrum (Cutter et al. 2000) because it affects their movement during emergency. In case of children, it will be the loss of time and money for parents to take care of old and children together when the day care facilities are affected by disaster. This will also increase the burden during emergency evacuation (Cutter et al. 2003, 2010). The percent of people >60 in Japan is 20 (Japan Census Data 2010) and 14 % in California (United States Census Bureau 2010), and 5 % in Pakistan (Pakistan Census Organization 1998). Therefore, we assume that if 15 % people >60 years of age can be managed and have considered community as resilient
Percentage of people below 15 years of age	0 10 **20** 30 40 50 60 70 80 90 100% 1 … 0	Furthermore, the population below >15 in Japan is 13 % (Japan Census Data 2010), 22 % (United States Census Bureau 2010) in California, and 43 % in Pakistan. Thus, we consider that 20 % of the population should be below 15 years of age to cope well with earthquake hazards
Percentage of people with health insurance coverage.	0 10 20 30 40 **50** 60 70 80 90 100% 0 … 1	The provision of healthcare insurance in Japan is 88 % (Statistical year book 2005) and in California 81 % (United States Census Bureau 2010). Apart from that, people during disasters should be provided with basic healthcare facilities, because healthcare provisions such as physicians, nursing homes, and hospitals play vital role in post earthquake disaster. The lack of these medical services will prolong the immediate relief and long-term recovery from earthquake hazards (Cutter et al. 2003, 2010; Heinz 2002). Therefore, 50 % people should be provided with healthcare insurance, so that they can better cope with hazards
Percentage of people without any physical and mental disability	0 10 20 30 40 50 60 70 **75** 80 90 100% 0 … 1	For the community resilience, the population should not suffer from any physical or mental disability, because those with disabilities or homeless are always disproportionally affected during disasters. And because of their invisibility in the communities, most of them are ignored during earthquake relief and recovery process (Morrow 1999; Cutter et al. 2003, 2010). According to ESCAP (2010), Japan has 95 % population without disability and California has 81 % people without disability (United States Census Bureau 2010), and it is 96 % in Pakistan (Pakistan Census Organization 1998). It is considered that if 88 % of community is without any kind of disability, that community may be able to bounce back and cope with earthquake impacts and recover quickly from hazard impacts
Percentage of people connected with social networks and tried up with community trust during disaster	0 10 20 30 40 **50** 60 70 80 90 100% 0 … 1	A community with 50 % of the social capital and community trust can better handle the disaster situation and recovery process. Since social capital proves to be the strongest and most robust predictor of population recovery after earthquake (Aldrich 2010). Within the community, the trust of civic and religious organizations with the community can play a positive role in the recovery process (Cutter et al. 2010; Morrow 2008) after the catastrophe

Figure 5(a). Social Component weighing indicators.

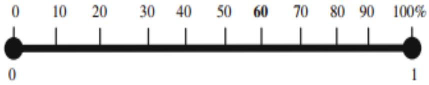
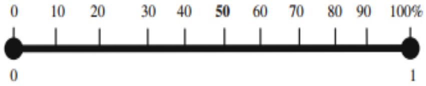
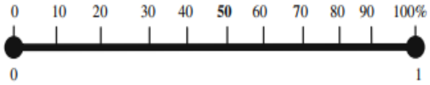
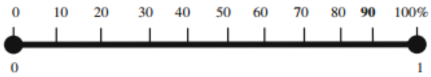
Indicator	Weights scale	Justification
Economic resilience		
Percentage of house ownership		House ownership plays an important role in areas prone to earthquake hazards. It is because of two reasons. In the absence of house ownership, the quality and maintenance of the house become poor, hence increases the vulnerability, and second people suffer most after earthquake and they often lack access to information about financial aid during recovery (Morrow 1999; Cutter et al. 2003). In Japan, the house ownership is 61 % and California with 57 % (Nevin 2006), and in Pakistan 81 % (Pakistan Census Organization 1998). Therefore, it is assumed that if the community has house ownership at the cost of 60 % which would probably enhance resilience within the community
Percentage of people employed		According to Census Bureau (2010), Japan has 62.6 % employment and California has 55 % (United States Census Bureau 2010), and Pakistan with 31 % (Pakistan Census Organization 1998). Employment plays a vital role and sometimes after the disaster, many people lose the employment that exacerbates the number of unemployed people in the community. This contributes to the slower recovery from disaster (Cutter et al. 2010). Thus, community with 5 % employment can well absorb the impacts and recover quickly from earthquake hazards.
Percentage of households with multiple source of income		For a resilient community, multiple sources of income can play a vital role related to earthquake rehabilitation and reconstruction. If 50 % of the community has multiple income sources, they may recover quickly from the earthquake impacts. A single source of income or sector may increase economic inequality that may undermine the community resilience, while a diversification of income sources and increasing income levels may be beneficial for community resilience (Adger et al. 2002)
Percentage of population above urban poverty line		Household income is crucial and works in different ways, for example it increases the capacity of community and individuals to absorb disaster impacts and speed up the recovery process (Cutter et al. 2000; Blaikie et al. 1994; Cutter et al. 2010). It can also be used directly to reduce vulnerability such as buying insurance and retrofitting homes (Mayunga 2007). In Japan, 92 % people are above urban poverty line and 89 % of population in California is above poverty line, and 60 % of population in Pakistan lives above poverty line (Pakistan Census Organization 1998). Thus, it is assumed that if 90 % of the population lives above poverty line, the community may recover faster from the earthquake impacts and will improve their economic situation and reduce the vulnerability

Figure 5(b). Economic Component weighing indicators.

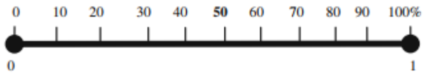
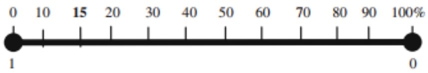
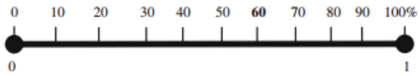
Indicator	Weights scale	Justification
Institutional resilience		
Percentage of population covered by hazard mitigation plan		Hazard mitigation encompasses a range of advance measures taken to reduce and eliminate long-term risks (FEMA 2000). Hazard mitigation planning protects people, property, and environment from the destructive impacts of hazards (Godschalk 2003). Hazard mitigation planning includes identifying hazards and vulnerability, carrying out smart growth and hazard mitigation plans before disaster occurs and redirect the new developments away from hazardous locations (Godschalk 2003). Therefore, 50 % of the population may be needed to cover by hazard mitigation planning to achieve community resilience
Percent of municipal expenditure for fire and emergency management systems		Local government officials legally and politically are responsible for the maintenance and monitoring of municipal expenditure for fire, police, and emergency management systems. Japan's municipal expenditure is 14 % (Japan Census Data 2010) and California 12 % (United States Census Bureau 2010). Therefore, officials involve in the process to identify steps that can be taken to mitigate the impacts through spending and formulation budgets for these municipal services can reduce the disaster effects. This preparedness can serve the community during large-scale earthquake disasters. Based on the above, at least 15 % of the municipal budget allocation for the services can make the community adoptive to the hazards impacts
Percent of people with earthquake preparedness education (mok drills, programs on TV etc.)		Pragmatic approach is required to shift from disaster response to preparedness (Churiwala and Churiwala 2007) and the key to achieve this requires active involvement of training and disaster education programs initiated at the local levels. The school Safety Initiatives project in Asia demonstrates the concept of community resilience by promoting communities through earthquake education and awareness to better understand the risk reduction strategies (Shaw and Kobayashi 2001). Furthermore, community education regarding earthquakes plays the most vital role for decision and actions (Shaw et al. 2004). Based on the above, at least 60 % of the population may be provided with the knowledge of earthquake preparedness activities including programs, mok drills, and seminar and workshops

Figure 5(c).Institutional Component weighing indicators.

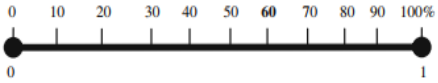
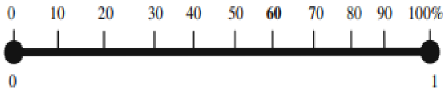
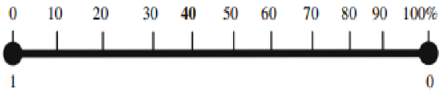
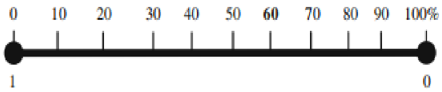
Physical resilience		
Percent of houses with wood (as construction material)		The earthquake resistance of buildings plays a vital role in the earthquake protection, where majority of deaths, injuries, economic loss, and social disruption caused by earthquake is equally attributed to the failure of buildings and man-made structures (Coburn and Spence 1992). Apart from that, the recent seismic events around the world provide new insights into the way that structures perform when subjected to earthquake and ground motion. These events have focused the attention of government agencies, scientific community, and the general public on safety hazards and potential losses associated with the failure of structures that perform poorly during earthquakes; therefore, the severity of seismic hazards has been realized, leading to a significant increase in the applications of new technologies-related earthquake-resistant houses (Nakashima and Chusilp 2003). Japan has 58 % houses with wood construction (United States Census Bureau 2010) and California has 98 % houses with wood construction (Pakistan Census Organization 1998). Pakistan has 58 % houses with stone and bricks, 34 % earth bound bricks, and 5.4 % wood (Census 1998). Therefore, it is assumed that if 60 % of the houses are made of wood or reinforced steel frames, it may reduce the loss of structures and human lives
Percentage of housing units following the building rules of 1935		Most of the buildings and houses throughout Baluchistan are constructed with poor engineering considerations, low quality materials, and improper design (Maqsood and Schwarz 2010). However, it is considered that those houses and buildings made after the reconstruction of 1935 earthquake may be resilient as compared to those constructed earlier. Therefore, it is assumed that if 40 % of the buildings are constructed after 1935 would be viable for community resilience
Percentage of housing units located in core of the city		Due to the density of population and high concentration of houses and commercial activities in the core of the city, there are higher chances of economic as well as human loss, which would create long-term recovery issues within the community (Cutter et al. 2003). Therefore, it is assumed that if 40 % of the houses are located outside the core area of city, it indicates that community will suffer less from the earthquake impacts
Percentage of rental vacant houses/ public places such as schools, community halls, and masques		Japan has 13 % rental vacant houses (Japan Census Data 2010) and California has 26 % (United States Census Bureau 2010). Vacant rental housing helps in the aftermath of earthquake where victims can take shelter facility during emergency (Cutter et al. 2003, 2010); therefore, it is considered that if 20 % rental vacant houses are available, that would minimize the cost of providing shelters to the affected people after an earthquake

Figure 5(d). Physical Component weighing indicators.

Figure 5.Indicators weighing scale with resilience threshold (Ainuddin and Routray 2012)

3.3 Study Design:

The study was carried out in the following design manner; semi structures questionnaires were formulated which consisted of social, economic, physical and institutional components and their indicator, derived from the study of past literature. The questionnaires were filled by respondents through physical surveys. Descriptive analysis was done for risk perception purposes at the end. Both quantitative and quantitative methods were used.

3.4 Study Population:

Students, engineers, random residents of Peshawar from all four towns.

3.5 Study Setting

Normal/non contrived

3.6 Study Site

Peshawar city comprising of the following towns:

- Town 1
- Town 2
- Town 3
- Town 4

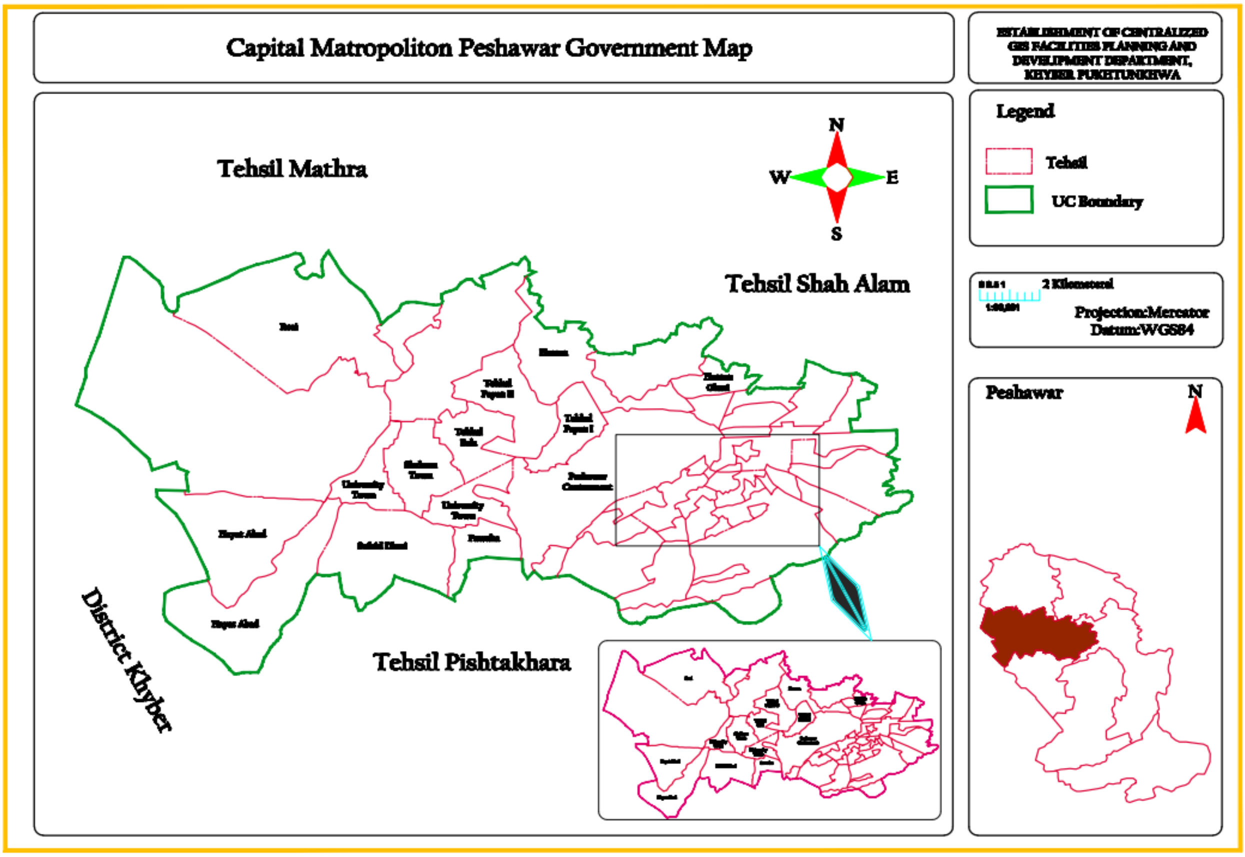


Figure 6 Capital metropolitan Peshawar government map

Table 1. Demographics of Peshawar District

Demographics of Peshawar District	
Area	**1257Sq.Kms.**
Population-2007	**4,267,198**
• Male	2,198,005
• Female	2,068,568
• Transgender	625
Age Groups	
• 0-14 years	1,814,775
• 15-64 years	2,335,894
• 65+ years	116,529
Population Density	**3395 per Sq.km**
• Urban Population	1,969,823
• Rural Population	2,297,375
Average Household Size	**8.6**
Literacy Ratio (10+)	**0.55**
• Yes	1,646,178
• No	1,344,836
Average Annual Growth Rate (1998-2007)	**0.0399**
Total Housing Units	**489843**
• Housing Units having electricity	443,215
• Housing Units Having Piped Water	234,567
• Housing Unit using Gas for cooking	115,647
Administrative Units	
• Tehsils	1
• Number of Village Councils	227
• Number of Neighborhood Councils	130
• Town Committees	4
• Cantt.	1

3.7 Sampling Technique

Simple random sampling technique was used

3.8 Date Collection Tool

Semi structured questionnaires/Surveys

3.9 Statistical Analysis

The data generated through questionnaires was analyzed through MS excel. Tables and graphs were made later on.

3.10 Study Duration

It took 18 months after the synopsis was approved.

Chapter 4

RESULTS

This study was conducted to find out the community resilience and risk perception of people of Peshawar city in terms of EQ hazard in order to suggest suitable risk reduction and preparedness measures to overcome damages in future. All four towns were surveyed. The component resilience index consisted of 4 components which comprised of the mean index value of each component. Four sets of data are achieved which portrayed the condition of risk perception and resilience of all town. These overall composite indices of each town were 0.59, 0.48, 0.55, and 0.40. The composite index of towns higher than other show that they are more resilient than the others. In the same way, each component has its own value which contribute to the mean resilience of town. Here, town 1 and town 3 has greater resilience and thus greater perception of risk as compared to town 2 and town 4 but the difference is very small.

All the data of the components and indicators was obtained through questionnaires. Which was then analyzed through Microsoft excel. The final results were obtained after the data was calculated through these formulae.

The tables and graphs computed are below:

Table 2. Results of Community Resilience of Town 1

No component indicator	Total surveys	No Above Threshold	No. Below Threshold	Actual Value (%)	Resilience Value (percent)	Resilience F. Index(RFI)
Social						
% of people with high school, above education	75	35	40	47%	60%	0.78
% of People > 60 years of age	75	15	60	20%	15%	0.75
% of population < 15 years of age	75	11	64	15%	20%	0.73
% of people with health insurance	75	9	66	12%	50%	0.24
% of people with no physical, mental disability	75	2	73	3%	12%	0.22
Community trust during disaster	75	15	60	20%	50%	0.40
CRFI(average)						**0.52**
Economic						
% of house ownership	75	45	30	60%	60%	1.00
% of people employed	75	16	59	21%	30%	0.71
% of households having multiple sources/income	75	18	57	24%	50%	0.48
% of population above poverty line	75	50	25	67%	80%	0.83
CRFI(average)						**0.76**
Institutional						
% of people having disaster/hazard mitigation plans	75	19	56	25%	50%	0.51
% of municipal expenditure for emergency management	75	12	63	16%	30%	0.53
% of people with earthquake preparedness knowledge/ education	75	20	55	27%	60%	0.44
CRFI(average)						**0.49**
Physical						
% of houses constructed in slumps	75	3	72	4%	15%	0.27
% of housing units following the BCP 2007	75	29	46	39%	40%	0.97
% of houses located in core of the city	75	20	55	27%	50%	0.53
Component resilience factor index(average)						**0.59**
Aggregate Resilience Index/ Component Index						**0.59**

Table 3. Results of Community Resilience of Town 2

No component indicator	Total surveys	No Above Threshold	No. Below Threshold	Actual Value (%)	Resilience Value (percent)	Resilience F. Index(RFI)
Social						
% of people having high school, above education	75	23	52	31%	60%	0.51
% of People > 60 years of age	75	16	59	21%	15%	0.70
% of population < 15 years of age	75	14	61	19%	20%	0.93
% of people having health insurance	75	7	68	9%	50%	0.19
% of people with no physical, mental disability	75	4	71	5%	12%	0.44
Community trust during disaster	75	16	59	21%	50%	0.43
CRFI(average)						**0.53**
Economic						
% of house ownership	75	42	33	56%	60%	0.93
% of people employed	75	14	61	19%	30%	0.62
% of households having multiple sources	75	26	49	35%	50%	0.69
% of population above poverty line	75	48	27	64%	80%	0.80
CRFI(average)						**0.76**
Institutional						
% of people having disaster/ hazard mitigation plan	75	7	68	9%	50%	0.19
% of municipal expenditure for emergency management	75	6	69	8%	30%	0.27
% of people having earthquake preparedness knowledge/education	75	6	69	8%	60%	0.13
CRFI(average)						**0.20**
Physical						
% of houses constructed in slumps	75	6	69	8%	15%	0.53
% of housing units following the BCP 2007	75	8	67	11%	40%	0.27
% of houses located in core of the city	75	20	55	27%	50%	0.53
CRFI(average)						**0.44**
Aggregate Resilience Index/ Component Index						**0.48**

Table 4. Results of Community Resilience of Town 3

No component indicator	Total surveys	No Above Threshold	No. Below Threshold	Actual Value (%)	Resilience Value (percent)	Resilience F. Index(RFI)
Social						
Percent of people with high school and above education	75	28	47	37%	60%	0.62
Percent of People > 60 years of age	75	17	58	23%	15%	0.66
Percent of population < 15 years of age	75	11	64	15%	20%	0.73
Percent of people with health insurance	75	8	67	11%	50%	0.21
Percent of people without any physical and mental disability	75	6	69	8%	12%	0.67
Community trust during disaster	75	14	61	19%	50%	0.37
CRFI(average)						**0.55**
Economic						
Percent of house ownership	75	37	38	49%	60%	0.82
Percent of people employed	75	16	59	21%	30%	0.71
Percent of households with multiple source of income	75	15	60	20%	50%	0.40
Percent of population above poverty line	75	59	16	79%	80%	0.98
CRFI(average)						**0.73**
Institutional						
Percentage of population covered by hazard mitigation plan	75	16	59	21%	50%	0.43
Percent of municipal expenditure for fire and emergency management	75	15	60	20%	30%	0.67
Percent of people with earthquake preparedness education (mok drills)	75	16	59	21%	60%	0.36
CRFI(average)						**0.48**
Physical						
Percent of houses constructed in slumps	75	2	73	3%	15%	0.18
Percent of housing units following the BCP 2007	75	5	70	7%	40%	0.17
Percent of houses located in core of the city	75	35	40	47%	50%	0.93
CRFI(average)						**0.43**
Aggregate Resilience Index/ Component Index						**0.55**

Table 5. Results of Community Resilience of Town 4

No component indicator	Total surveys	No Above Threshold	No. Below Threshold	Actual Value (%)	Resilience Value (percent)	Resilience F. Index(RFI)
Social						
% of people having high school, above education	75	10	65	13%	60%	0.22
% of People > 60 years of age	75	16	59	21%	15%	0.70
% of population < 15 years of age	75	13	62	17%	20%	0.87
% of people having health insurance	75	8	67	11%	50%	0.21
% of people with no physical, mental disability	75	4	71	5%	12%	0.44
Community trust during disaster	75	20	55	27%	50%	0.53
CRFI(average)						**0.50**
Economic						
% of house ownership	75	32	43	43%	60%	0.71
% of people employed	75	18	57	24%	30%	0.80
% of households having multiple sources	75	14	61	19%	50%	0.37
% of population above poverty line	75	16	59	21%	80%	0.27
CRFI(average)						**0.54**
Institutional						
% of population having disaster/hazard mitigation plan	75	7	68	9%	50%	0.19
% of municipal expenditure for emergency management	75	2	73	3%	30%	0.09
% of people with earthquake preparedness knowledge, education	75	5	70	7%	60%	0.11
CRFI(average)						**0.13**
Physical						
% of houses constructed in slumps	75	7	68	9%	15%	0.62
% of housing units following the BCP 2007	75	6	69	8%	40%	0.20
% of houses located in core of the city	75	19	56	25%	50%	0.51
CRFI(average)						**0.44**
Aggregate Resilience Index/ Component Index						**0.40**

Table 6. Community Resilience comparison of all four towns of Peshawar

No component indicator	Town 1		Town 2		Town 3		Town 4	
	Percent Value	RFI	Percent Value	RFI	Percent Value	RFI	Percent Value	RFI
Social								
% of people having high school, above education	60%	0.78	60%	0.51	60%	0.62	60%	0.22
% of People > 60 years of age	15%	0.75	15%	0.70	15%	0.66	15%	0.70
% of population < 15 years of age	20%	0.73	20%	0.93	20%	0.73	20%	0.87
% of people having health insurance	50%	0.24	50%	0.19	50%	0.21	50%	0.21
% of people with no physical,mental disability	12%	0.22	12%	0.44	12%	0.67	12%	0.44
Community trust during disaster	50%	0.40	50%	0.43	50%	0.37	50%	0.53
Component resilience factor index (average)		**0.52**		**0.53**		**0.55**		**0.50**
Economic								
% of house ownership	60%	1.00	60%	0.93	60%	0.82	60%	0.71
% of people employed	30%	0.71	30%	0.62	30%	0.71	30%	0.80
% of households having multiple sources	50%	0.48	50%	0.69	50%	0.40	50%	0.37
% of population above poverty line	80%	0.83	80%	0.80	80%	0.98	80%	0.27
Component resilience factor index (average)		**0.76**		**0.76**		**0.73**		**0.54**
Institutional								
% of population having disaster/ hazard mitigation plan	50%	0.51	50%	0.19	50%	0.43	50%	0.19
% of municipal expenditure for emergency management	30%	0.53	30%	0.27	30%	0.67	30%	0.09
% of people having earthquake preparedness knowledge, education	60%	0.44	60%	0.13	60%	0.36	60%	0.11
Component resilience factor index (average)		**0.49**		**0.20**		**0.48**		**0.13**
Physical								
% of houses constructed in slumps	15%	0.27	15%	0.53	15%	0.18	15%	0.62
% of housing units following the BCP 2007	40%	0.97	40%	0.27	40%	0.17	40%	0.20
% of houses located in core of the city	50%	0.53	50%	0.53	50%	0.93	50%	0.51
Component resilience factor index (average)		**0.59**		**0.44**		**0.43**		**0.44**
Aggregate Resilience Index/ Component Index		**0.59**		**0.48**		**0.55**		**0.40**

4.1 Social resilience

4.1.1.1

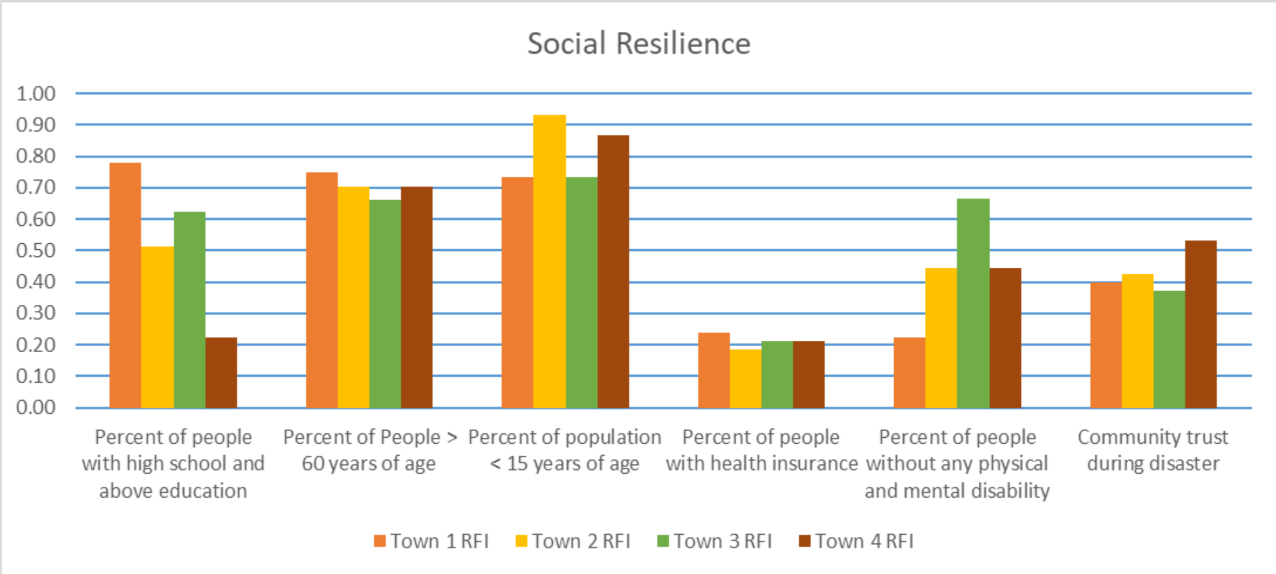


Figure 7. Social Resilience Comparison of all the four towns in District Peshawar.

Social component is very important in calculating the ERP and ERI of Peshawar. For example, higher the education level, awareness, higher is the risk perception and resilience. The social component shows different results in all for town. Some indicators have significant difference in some towns while others have very little difference. For example, town 2 and 3 has higher index value for education as compared to town 3 and 4. Town 4 has the lowest index value for education which means low ERP and ER. The index of old age people is almost the same in all towns. The index of very small children is almost the same in town 1 and 3 which is less than town 2 and 4. That indicates that town 2 and 4 are more vulnerable because of having more people aged less than 15. Index of people with health insurance is not too high in all town, town 1 stands at the higher level but still the different is not significant. Which shows low resilience and low perception of risk. Index of disability is low in all towns which means all towns are more resilient. Trust in the community, social ties, care and empathy is significant in all towns.

Lastly, town 2 and 3 are concluded to be more resilient, having greater risk perception than town 2 and 4 comparatively, in the context of social index. Numerically town one has social index of 0.52. 0.53, 0.55, 0.50.

4.2 Economic resilience

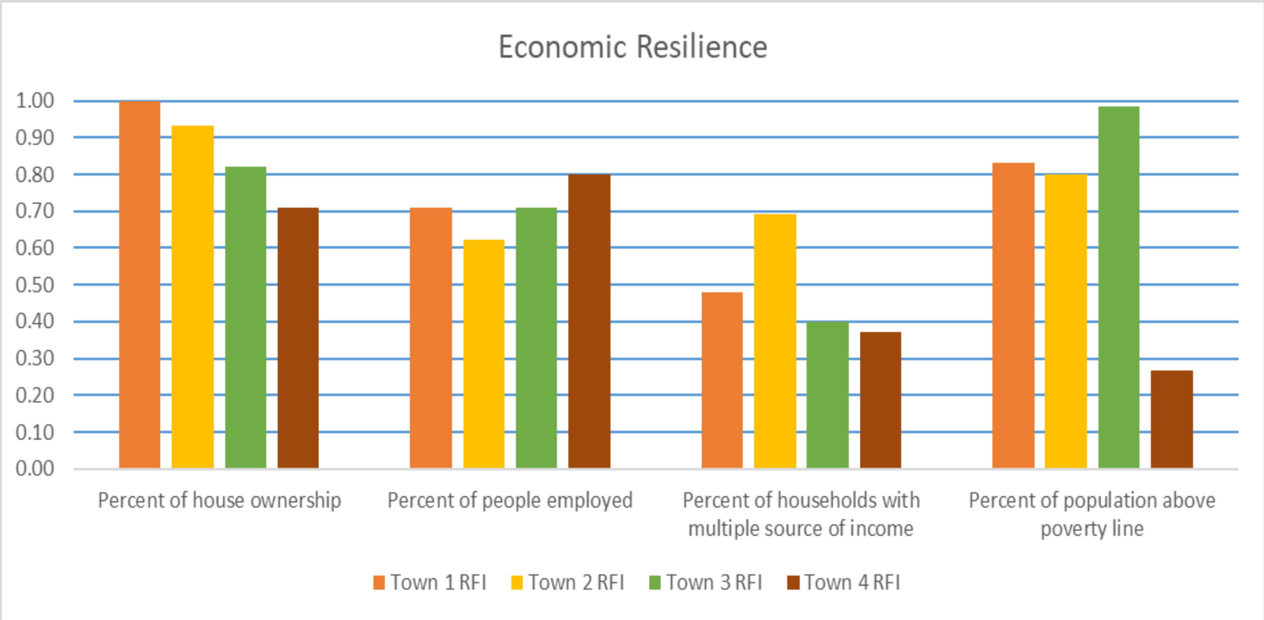


Figure 8. Economic Resilience Comparison of all the four towns in District Peshawar.

Economic resilience plays a very crucial part in building resilience of communities. Indicators like house ownership, number of people employed, sources of income, population above poverty line are evaluated to calculate the economic index. Greater the value of these indicators, higher is the resilience for example if people are living above poverty, they are more resilient and more capacitated thus less vulnerable. Another example is that if people are having their own houses, they have a higher risk perception. Statistical results show that town 1 and town 2 has the same economic resilience/perception index, while town 3 and 4 has lesser index. Town 4 has the lowest. That is; 0.76, 0.76, 0.73 and 0.54

4.3 Institutional resilience

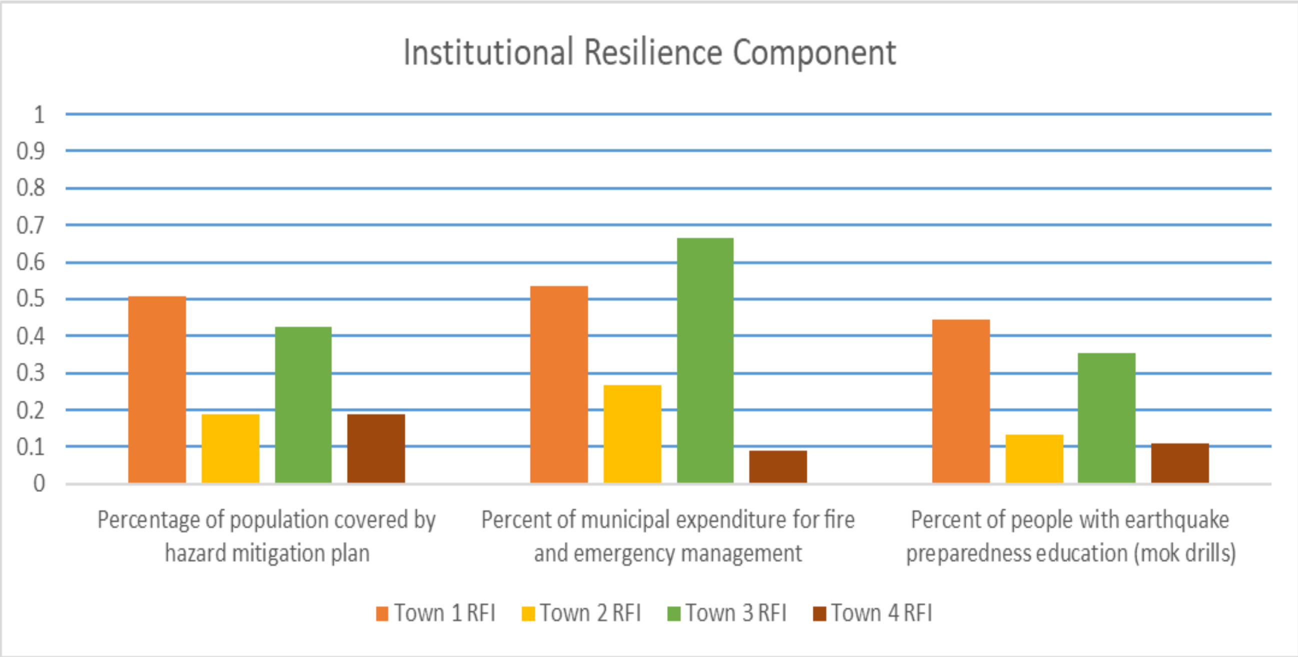


Figure 9. Institutional Resilience Comparison of all the four towns in District Peshawar.

If a community has greater institutional index value that means it has a higher risk perception and thus higher resilience. Indicators like the presence of mitigation plans, emergency management strategies and EQ preparedness awareness and education play very crucial role in the perception and resilience of a community. In terms of economic resilience, town one has the greatest index of all indicators. Town 3 also has a considerable index value for all components, while town 2 and 4 have lesser values thus having lesser resilience and risk perception. Statistically the index values of all towns are the following; 0.49, 0.20, 0.48, 0.13

4.4 Physical resilience

Physical component is the most important of all components. Better conditions of housing and physical structures, having been built by engineering techniques and building codes etc, located in good resilient areas is considered to be the most resilient. Here again, town 1 stands at greater value than town2, 3 and 4 which are almost the same. Statistically, values are; 0.59, 0.44, 0.43, 0.44

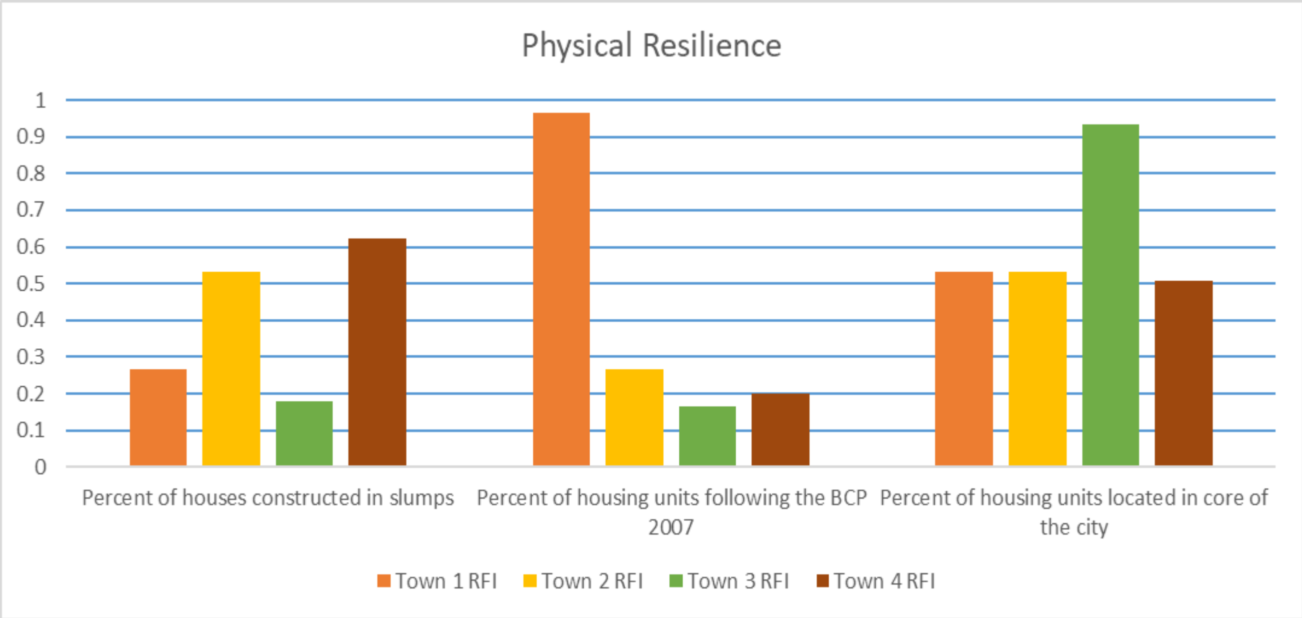


Figure 10. Physical Resilience Comparison of all the four towns in District Peshawar.

4.5 Aggregate resilience index (ARI)

The overall aggregate resilience index is higher in town 1 and town 3 as compared to town 2 and town 4. Though the difference between all towns is not significant. Numerically the values of all towns are 0.59, 0.48, 0.55, and 0.43

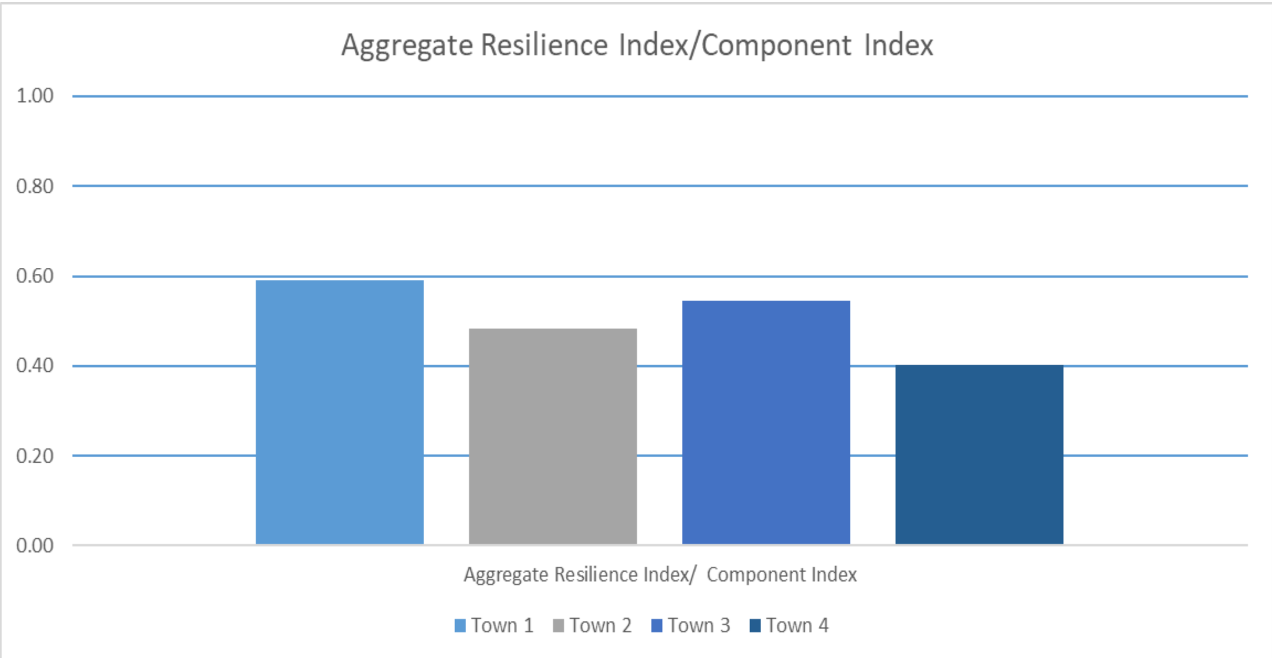


Figure 11. Aggregate Resilience index/Component index comparison of all the four towns in District Peshawar.

Chapter 5

Discussion

Earthquakes hazards can be devastating if they hit a vulnerable area. Peshawar is formerly hit by major EQ events with great losses of life, infrastructure and economic damages. In order to make Peshawar city resilient in future, to withstand the effects of EQ, this paper attempted to calculate the resilience index of Peshawar and the risk perception of people. The purpose of finding resilience is to recommend risk reduction measures, preparedness plan, earthquakes mitigation plans and strategies. The methodology was adopted from past literature using indices for calculation of resilience index.

5.1 Components used

This study was conducted using four components. The same components threw light on both resilience and perception of people. The components were; social, economic, institutional and physical.

5.2 Indicators

The components of this study were further split into sets of indicators that were part of the questionnaires used. For example; social component had indicators like education, age, health, trust etc. Economic component was divided into income, employment, number of income sources etc. institutional component had the components like mitigation plans, municipal services, house age etc. Physical component was divided into house, location, shelter etc.

5.3 Formula used for the resilience factor index

The following formula was used to find out the level of each indicator:

RFI of the ith indicator = % value of actual indicator / threshold value in % of ith indicator

Formula for calculating component resilience factor which computes all the indicators of single component

CRI = $\sum_{i=1}^{n} \mathrm{RFI}/\mathrm{n}$

The resilience factor of each indicator is found, the mean is then calculated of each component of each town. The values of each town are compared. The results show that all four towns have very little difference in CRFI. Comparatively town 1 and 3 have greater CFI than town 2 and 4.

Risk perception was qualitatively assessed from the surveys that took place during the study. The same RFI indicators were used to assess and describe risk perception of people. The general rule was used in assessing risk perception, greater the vulnerability, lower is the perception of risk. All components affected risk perception to some point.

5.4 Social component and risk perception

- Education affects the level of perception of an individual. They have a direct relationship. Higher the level of education, higher is the perception of risk. As we know that the more educated an individual is, the higher is the level of understand about a particular risk, how to cope with it and prepare for it. That's why our statistical results showed that higher the level of education, higher is the resilience.
- Very young aged individuals have little understanding about earthquake risks and how to prepare for it e.g very young children aging less than 15 years. The results also indicated that the more number of people aging than 15 in a community, the less resilient it is.
- On the other hand, people who are above 60 have also showed results having lower risk perception and resilience e.g because of fatalistic behavior, being

used to such events all their lives, less mobility because of old age, stubbornness in terms of participating and believing in risk reductions programs etc.

- People with health insurance have higher risk perception and thus are more resilient. Because they know they can recover from the disaster easily
- People who have trust in their existing plans and strategies have a higher risk perception. This behavior lessens undue panic and negative attitude which increases the chances of survival.

5.5 Economic resilience and risk perception

- People having their own houses have different attitudes when it comes to risk of earthquakes. On one hand they feel secure that they have a place to live which they know can withstand such disasters. Thus their attitudes and risk perception becomes very low. On the other hand their perception becomes higher because they have spent their finances, time and energy in building their own houses, they do not want to withstand any damages, thus becomes more cautious.
- People who do not own houses have usually a greater risk perception because they are in panic, where to go if their houses are destroyed during earthquakes.
- Employment plays a great role in risk perception. Those who are employed have lower risk perception than those unemployed. And those who have multiple sources of income have even lower perception of risk.
- People above poverty line has lower risk perception because they know they are resilient enough to withstand the effects of EQ

5.6 Institutional component and risk perception

- People with higher risk education have higher risk perception

- Those who have EQ plans in place have higher sometimes lower risk perception. Because some become relaxed that the government will take care of everything, while others become more aware and participate in drills etc
- Those with greater awareness have greater risk perception

5.7 Physical component and risk perception

- People who have made their houses using building codes have lower risk perception
- People living in the slumps sometimes exhibit lower, sometimes higher risk perception. Higher perception is because they know their surrounding are very prone to EQs, no proper mitigation plans etc. And lower because of low awareness and education etc.
- People living in well built houses can have lower or higher risk perception, in the sense that they have higher risk perception that is why they built their houses to withstand EQs using engineering methods. On the other hand, such strong infrastructure can make the perception of people low as they sometimes can sometimes lower the perception of people as they know they will not be affected much

Chapter 6

Conclusion and Recommendations

6.1 Conclusions

This research is carried out to conclude the concepts of earthquake resilience and earthquake risk perception. The study focuses on the resilience and risk perception of people of Peshawar. The purpose of finding out the resilience and risk perception is to suggest affective risk reduction measures, fill the gap where there is lack of earthquake reduction plans, policies and capacities, raise awareness, risk knowledge, coping mechanisms etc. as we know that Peshawar city has four towns. The study is carried out including all four towns. A scale ranging from 0-1 is used to calculate resilience and risk perception of people. Values closer to 0 indicated less resilience and EQ risk perception, while values closer to 1 indicated higher resilience and risk perception. All towns had somewhat similar results but town 1 and 3 were closer to 1 while town 2 and 4 were closer to which means town 1 and town 3 were more resilient and had greater EQ risk perception while town 2 and town 4 had lower comparatively. Statistically the difference was very insignificant, that is, town 1 (0.59), town 2 (0.48), town 3 (0.55), town 4 (0.40). The overall results indicated that there is a great need for EQ disaster education, awareness, preparedness, mitigation plans and risk reduction measure to increase people's general EQ risk perception as well as practical measures and their implementation to avoid damages from EQs in the future.

6.2 Recommendations

- Awareness programs, mock drills and educational programs need to be included in preparedness plans
- All preparedness and mitigation plans need to be implemented effectively

- Disaster risk management (DRM) and Disaster risk reduction (DRR) need to be effective so that people feel safe and develop trust in their organizations
- Buildings and infrastructure need to be built by using building codes and other engineering methods to lessen the impacts of EQ
- Building houses and building in vulnerable areas need to be totally avoided. There needs to be a check on these regulations
- Generating income sources/activities to strengthen the community economically to withstand such disasters in the future
- All parts of the community need to be included in EQ preparedness and mitigation programs so that not a single individual is left vulnerable.

6.3 Limitations of the study

- People were reluctant to participate
- Gender was a great issue, men were in majority among the respondents.
- Incomplete responses from respondents
- The results are not 100% but only gives an idea about resilience and perception of people
- The selection of methodology was a crucial step as there is not a single method that can be used, also, to choose which one is the best and more reliable
- As the approach of resilience is still new, studying the literature was a tiresome task.

References

Ainuddin, S. and J. K. Routray (2012). "Earthquake hazards and community resilience in Baluchistan." Natural hazards **63**(2): 909-937.

Ainuddin, S., et al. (2015). "Operational indicators for assessing vulnerability and resilience in the context of natural hazards and disasters." **18**(1): 66-88.

Ainuddin, S. and J. K. J. N. h. Routray (2012). "Earthquake hazards and community resilience in Baluchistan." **63**(2): 909-937.

Alexander, D. and M. J. P. c. Magni (2013). "Mortality in the L'Aquila (central Italy) earthquake of 6 April 2009." **5**.

Alshehri, S. A., et al. (2013). "Public perception of the risk of disasters in a developing economy: the case of Saudi Arabia." **65**(3): 1813-1830.

Armaş, I. J. R. A. (2006). "Earthquake risk perception in Bucharest, Romania." **26**(5): 1223-1234.

Balica, S. J. E. E. and M. Journal (2012). "Approaches of understanding developments of vulnerability indices for natural disasters." **11**(5): 963-974.

Berkes, F., et al. (2013). "Community resilience: toward an integrated approach." **26**(1): 5-20.

Bilham, R. and S. J. S. A. J. Hough (2006). "Future earthquakes on the Indian subcontinent: inevitable hazard, preventable risk." **12**(5): 1-9.

Cutter, S. L., et al. (2010). "Disaster resilience indicators for benchmarking baseline conditions." Journal of homeland security and emergency management **7**(1).

Cutter, S. L., et al. (2010). "Disaster resilience indicators for benchmarking baseline conditions." **7**(1).

Decancq, K. and M. A. Lugo (2013). "Weights in multidimensional indices of wellbeing: An overview." Econometric Reviews **32**(1): 7-34.

Gupta, H. and V. J. G. r. Gahalaut (2014). "Seismotectonics and large earthquake generation in the Himalayan region." **25**(1): 204-213.

Hyndman, D. and D. Hyndman (2016). Natural hazards and disasters, Cengage Learning.

Kõlves, K., et al. (2013). "Natural disasters and suicidal behaviours: a systematic literature review." **146**(1): 1-14.

Kung, Y. W. and S. H. J. R. A. A. I. J. Chen (2012). "Perception of earthquake risk in Taiwan: Effects of gender and past earthquake experience." **32**(9): 1535-1546.

Lindell, M. K., et al. (2016). "Immediate behavioural responses to earthquakes in Christchurch, New Zealand, and Hitachi, Japan." **40**(1): 85-111.

Mahmood, I., et al. (2015). "Revisiting major earthquakes in Pakistan." **31**(1): 33-38.

Maqsood, S. and J. Schwarz (2008). Seismic vulnerability of existing building stock in Pakistan. Proceedings of the 14th World Conference on Earthquake Engineering.

Marano, K. D., et al. (2010). "Global earthquake casualties due to secondary effects: a quantitative analysis for improving rapid loss analyses." **52**(2): 319-328.

Materna, K. Z. (2019). Geodetic and Seismological Investigations of Earthquake Cycle Deformation and Fault Zone Properties, University of California, Berkeley.

Mavrodieva, A. V., et al. (2019). "Governmental incentivization for SMEs' engagement in disaster resilience in Southeast Asia." **1**(1): 32-50.

Mayunga, J. S. (2007). "Understanding and applying the concept of community disaster resilience: a capital-based approach." Summer academy for social vulnerability and resilience building **1**(1): 1-16.

Mazziotta, M. and A. Pareto (2017). Synthesis of indicators: The composite indicators approach. Complexity in society: From indicators construction to their synthesis, Springer**:** 159-191.

Paek, H.-J. and T. Hove (2017). Risk perceptions and risk characteristics. Oxford research encyclopedia of communication.

Pelling, M. and J. I. J. G. E. C. P. B. E. H. Uitto (2001). "Small island developing states: natural disaster vulnerability and global change." **3**(2): 49-62.

Qureshi, M. I., et al. (2021). "Determinants of people's seismic risk perception: A case study of Malakand, Pakistan." **55**: 102078.

Rahman, M. L. J. I. j. o. d. r. i. t. b. e. (2019). "Risk perception and awareness of earthquake: the case of Dhaka."

Shapira, S., et al. (2018). "Anticipated behavioral response patterns to an earthquake: The role of personal and household characteristics, risk perception, previous experience and preparedness." **31**: 1-8.

Vincent, K. J. T. C. f. C. C. R. W. P. (2004). "Creating an index of social vulnerability to climate change for Africa." **56**(41): 1-50.