Assessment of Monsoon Flood Risks in Lahore Metropolitan

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A thesis submitted in partial fulfillment of the requirements for the degree of MS Urban & Regional Planning

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THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of the thesis titled "Assessment of Monsoon Flood Risks in Lahore Metropolitan" written by Ms. Azka Zia (Registration No. 00000203482), of Urban and Regional Planning (NIT-SCEE) has been vetted by the undersigned, found complete in all respects as per NUST Statutes/Regulations, is free of Plagiarism, errors, and mistakes and is accepted as partial fulfilment 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.

Signature: _____

Name of Supervisor: Dr. Irfan Ahmad Rana

Date: _____

Signature (HOD): _____

Date: _____

Signature (Dean/HOD): _____

Date: _____

DEDICATION

This thesis is dedicated to my beloved friend Rida Lodhi for helping me out during my thesis work and boosting my morale for working hard, and my sister for always being an unending source of love and encouragement.

ACKNOWLEDGEMENTS

All praises to the Allah Almighty, the merciful and the most beneficent who showers his blessings upon us every day. He beholds all the knowledge of the universe and beyond.

I would like to thank my supervisor, Dr. Irfan Ahmad Rana, for the help, guidance, inspiration, and support throughout the research project. His assistance and valuable feedback enabled me to achieve a solution-oriented research experience. Intellectual input and assistance at every stage enabled me to gain valuable knowledge and a better solution to the problems faced during the research phase.

Azka Zia

ABSTRACT

Climate Change has affected humanity and its habitat disastrously. One of the destructing effects of climate change is the seasonal variation resulting in increased and heavy monsoon rainfall. Heavy rainfall is becoming the cause of urban flooding in the cities and disrupting human life completely by damaging their houses, properties, amenities (water, gas, electricity, etc.). Lahore is the second biggest city in Pakistan, also faces heavy rainfall events in the monsoon resulting in urban flooding. The objective of the study is to evaluate different strategies for managing the urban floods in the city during monsoon seasons. Using Slovin's sampling method, a total data of 370 samples were collected, from which 310 samples were used for analysis purposes. Descriptive and comparative analysis along with a Chi-square test was run in order to analyses the public opinion. Houses and household properties are the most affected by monsoon flooding. The collapse of the ceiling, seepage in the basement, and foundation of houses are the most reported problems. Despite facing these problems, people still do not prepare themselves according to flood guidelines. The reason for this careless behavior is the lack of education, i.e., less than 50% of the population is graduated and considers that awareness training programs regarding floods are just a waste of time.

Key Words: Climate Change, Flash flooding, Developing countries

Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

1.1 Background:

The periodicity of disasters is increasing around the globe due to rapid climatic change. Out of all the natural catastrophes, flooding is the most regular catastrophic event. In the Asian areas, the image is more severe instead in the developed nations. South-Asian floods are determined by the extraordinary hydro-meteorological and monsoonal impacts in the area. Two monsoonal seasons are prevailed in the Southern Asia: monsoon rains during summers are the southwestern one and winter rains are called northeast monsoon. About 70-80% rainfall of the South Asian region is due to the southwest monsoonal window during the months of June to September. Also as a result of climate change, melting of glaciers in Himalayan-Hindu Kush mountains has increased the risk of floods. From the recent World Risk Report 2011 it is inferred that Pakistan, India, Bangladesh, Nepal and few more Asian countries are vulnerable to floods because of their lacking capacity in terms of adaption.

Floods in cities are caused due to coastal or river floods, flash floods, but there are urban floods also. Due to the lack of drainage capacity in the cities, urban floods may be appear very often. As there is minimal open soil that can be utilized for water storage, almost all the precipitation should be transport to surface water or the sewer system. When city's drain canals and sewer pipes exceeds the designed amount of rain due to heavy

rainfall it results in flooding. At some point of sewerage system water enters and it might get deposited other part of the city like streets, roads etc.

Urban floods are an incredible disturbance to day-by-day life in a densely populated area. Roads get blocked, water slowly rises on the low spots such as basements, underpasses, and underground parking garages, people cannot go to their workplace. The intensity of economic loss is very high though the number of causalities is low. In short, sometimes the damage caused by floods is enormous and countless.

Flood damage estimation is a basic component, mostly with the goal of flood mitigation benefits evaluation. Regularly, flood mitigation structures were designed so as to control up to a certain, predefined design flood, for example, the return time of the rainfall. In recent years, this structural flood control approach has been changed to a newly developed concept called "flood risk management." In flood risk management, where flood hazard is given more consideration, the risk is characterized as the harm that happens or would be surpassed with a certain likelihood in a specific period. Thus, damage aspects are significant also and should be very much considered in flood risk management.

1.2 Problem Statement:

Lahore is covered with housing development, but it houses different institutions, commercial hubs, and even industries on its outskirts. Due to increased migration, the city provides employment opportunities, and unplanned and lousy settlements are being developed with poor critical infrastructure. Extreme monsoon rainfall triggers urban

floods, resulting in a traffic jam that affects the movement of rescue vehicles, tripping of feeders, and sometimes water and sanitation contamination. Therefore, a thorough study needs to be done to develop strategies in urban flood risk management.

Also, with the growth of cities, there is an increased demand for water supply. But unfortunately, the water table in urban areas is low. On the other hand, due to climate change, rainfall intensity is expected to increase in the near future. In this scenario, the urban flooding challenge can be turned into an opportunity by solving decreased water supply and water table issues.

1.3 Aims and Objectives:

The objective of the study is to evaluate different strategies for managing the urban floods in the city during monsoon seasons. In order to achieve the goal following objectives along with questions are formulated:

1. To determine the socio-economic losses, vulnerabilities, and adaptation strategies of exposed communities during monsoon.
2. To understand infrastructural and institutional stresses/challenges during monsoon season.
3. To assess urban development policies of various institutions mitigating monsoon flood risk.
4. To suggest appropriate policy and practical measures for effective monsoon flood risk reduction.

1.4 Scope of the study:

This study will be helpful to study the direct and indirect losses from which people suffer during the monsoon seasons. How their livelihoods, access to basic necessities of life, and traveling to various destinations are affected, and the alternatives adopted by the people during monsoon will be part of this research. The study will further focus on the programs and policies that local governing bodies are presently implementing in their action plans to mitigate urban floods and to what extent the policies favor people. Finally, data collected from above all research will help suggest new practical measures to help mitigate urban floods and develop a "Build Back Better" community.

Chapter 2

LITERATURE REVIEW

2.1 Climate Change:

Climate change is causing a consequential danger to the cities putting its urban development on a serious risk. Globally the rate of natural disasters has increased four time in last 30 years, resulting in a rapid increase of economic and human loss (UNISDR, 2012). Owing to the facts regarding the magnitude and frequency of disasters, if no beneficial adaptive measure will be adopted, Climate change will increase the vulnerability factor of the cities (IPCC, 2007). Verifiably, urban communities have been regularly and are still seen as giving shelter from fiascos and support against climate change. Today, however, they are better described as risk and disaster hotspots (UNISDR, 2012). Natural changes, humankind faces are profoundly entwined with complex urbanization measures and occur at formerly inconspicuous rate and intensity. Therefore as a result it should be accepted scientifically that majority of the impacts of climate change are bound to happen and hence cannot be avoided (IPCC, 2007)(Holt, 2012).

2.2 Climate Change a Concern for Cities:

According to the studies conducted by many organizations, areas that experience a greater extent of the climatic disaster and are most at risk to the hazards are "Urban." Cities are alarmed as more risk-prone areas because they houses many costly land

properties, urban structures and a very dense population which are vulnerable to hazards (Romero-Lankao & Dodman, 2011). Due to the high land price in the downtown of the cities, most of the cities are developed along the coasts, as the settlements are planned by the development authorities along the shore. The development of settlements in the coastal areas exposes many population and economic assets to risks of sea-level rise. The prevalence of urban poor's who generally involve minor terrains inside such unsound areas where risk proliferate highlights the significance of attention on urban communities (Hunt & Watkiss, 2011).

2.3 Impacts of Climate Change on the Cities:

According to the researchers frequency of occurrence and magnitude of climatic events will be amplified due to climate change. Its effect on urban areas will be adverse because the vast majority of the development today seldom thinks about potential changes to the climate. Therefore the impacts of the disaster will more on the settlements situated in flood-prone areas and muddy hills. The aftermaths faced by many cities as a result of climate change are sea-level rise, health problems, unavailability of water, infrastructure damage and flooding (Hunt & Watkiss, 2011).

2.4 Environmental impacts:

2.4.1 Sea-Level Rise:

Climate change will considerably cause a one-meter rise in sea levels throughout the present century. Sea level rise may prompt broad "disintegration of shorelines and bluffs, expand flooding, inundation of low-lying territories, salt intrusion into springs and

surface waters, and higher water tables. The coastal urban areas of developing nations will be most affected because high population and economic assets reside in low-lying zones less protected against the sea. Similarly, as with numerous poor urban areas of the developing world, it is the deprived and underestimated communities (regularly slums), having the least access to shared resources and basic decision-making processes, that will face the greatest effects (Hunt & Watkiss, 2011).

2.4.2 Extreme flooding and coastline changes:

Flooding caused by climate change is a great threat to coastal front urban communities where it will prompt to interrupt the livelihood, including the loss of lives and properties. Increase in precipitation pattern and environmental changes have been recently the cause of flooding. However the extent and magnitude of floods is calculated by the factors such terrain of the area, forest cover and increased development of urban areas (Douglas et al., 2008; few, 2003:44). Most of the urban communities are hit by the floods due to the poor maintenance of critical infrastructure and building's drainage and sewer system. The recurrence and extremity of climate change-incited flooding may overpower the limit of many city planners to manage the extent of the issue (Hunt & Watkiss, 2011).

2.4.3 Changes in soil organic carbon:

Organic components present in the soil enhances the nutrient supply and water to the plants and boost the release of greenhouse gases. All parts of soil are viewed as in danger from environmental change, lessening the capacity of biological system to work. Climate Change has also increased the amount of carbon dioxide in the atmosphere

resulting in the increased productivity of plants but it has increased the temperature too globally, resulting in dry summer span and wet winter seasons causing increase soil erosion (Hunt & Watkiss, 2011).

2.4.4 Water Availability and Resources:

IPCC (2007) has predicted a distinct transformation in water availability by 2050, anticipating a decrease in mid-latitude areas and dry tropics and increasing high-latitude regions and wet tropics. Unfortunately, these predictions will affect billions of people, putting them at risk of water deprivation, with the risk being more severe for countries already facing water stress. Houghton (2004) puts water stress and the ever-increasing population in the same bracket; more population bringing higher water demand with it. He advocates that climate change will adversely affect water availability and management, especially in areas already facing water shortages. Developing countries with increasing populations and desire for higher living standards are most likely to suffer from climate change creating problems of water availability.

A decrease in water supply because of environmental change joined with an expansion sought after for agrarian water system will affect the capacity of oceanic environments to keep up with and recharge. Flow of low water can increase the risk of pollution water and nutrients. The potential evaporating of conduits likewise has suggestions from more extensive scene convenience (Hunt & Watkiss, 2011).

2.4.5 Changes in Species Migration Patterns:

Many birds are migratory birds and in winter season these birds migrate towards the warmer regions. Migration patterns are therefore greatly affected due to the climate change. Perceptions recommend that patterns are changing, as far as terrain and timing, conduct which itself may be viewed as a variation to environmental change. However, the researchers are still concerned about the impacts imposed on the breeding pattern and succession of their species.

2.5 Economic Impacts:

Most of the areas are development where natural resources are easily available and so local economy can easily be supported. Climate change will not only put these resources at risk but also affect the livelihoods and jobs depending on these resources. For example climate change will impact the tourist and recreational spots of a city, it will put farming communities at risk and affect the transportation system.

2.5.1 Tourism:

Environmental change impose a visible in the recreational activities. Increasing hot temperature and rainfall will reduce the number of days when people can enjoy activities like skiing. Due to the sea level rise and ocean storms, beaches are facing soil erosion. Changes are observed in the migration pattern of animals which has greatly affect the hunting activity. Communities whose economy is solely dependent of tourism have started to make backlash (Hunt & Watkiss, 2011).

2.5.2 Energy and the Built Environment:

According to UN-HABITAT literature on global warming, climate change will increase the temperature within the cities. This temperature will continue to increase due to the material used in buildings whose heat-energy absorption capacity is high during the day and slowly and eventually releases heat at night. Furthermore, the process of evapotranspiration is less; therefore, the surface temperature is bound to rise. The temperature in summers is increasing compared to the past and so do the humidity, which has pushed people on the use of air conditioning system resulting in the increased demand of energy supply. Even with climate change, high energy demands will probably build stress on city planners, particularly in urban areas that depend unequivocally on their energy supply on such climate-sensitive power supplies as hydropower and biomass. Any decline in the energy supply will adversely affect the urban livelihood and raise the demand for commercial energy (Hunt & Watkiss, 2011).

2.5.3 Transportation:

Extreme climate conditions will no doubt contrarily sway the states of being the existing framework that can require the months and long time to fix and expand generally speaking support cost. Increased temperature will diminish the existence of asphalt, add pressure to extension joints for spans and interstates, cause asphalt and railroads to clasp and influence airplane execution. Flooding will weaken structural supports for bridges, promote deterioration of soil that supports roadways, tunnels, and bridges, shorten pavement life expectancy, and increase sedimentation in waterway channels.

These physical damages will result in the disruption of transportation network, goods and people. During a weather event and after damages are being assessed and repaired, transportation systems can become entirely unusable due to flooding, debris, or damage. Floods can lead to disrupted transport network which in return cut off the supplies needed for home use or businesses.

2.6 Health Impacts:

The most notable impacts of climate change are extreme weather events, warming of temperature, and change in precipitation patterns. These impacts threaten human health as they affect the air, water, and food that humans consume (Kovats & Akhtar, 2008).

2.6.1 Temperature-Related Impacts:

As the temperature of Earth is becoming warmer it has led to hotter days and people are more likely to be struck by heat wave Death rate due to heat waves has also been increased. Stroke, cardiac and respiratory are few serious diseases experienced by human when their body is exposed to heat waves for a long period of time. People like students, outdoor workers, athletes and homeless people are more vulnerable to these disease as they spend most time of the day outside and are exposed to heat (Kovats & Akhtar, 2008).

2.6.2 Air Quality Impacts:

Climate change has also affected the air, we humans breathe. Change in weather patterns has greatly affected the quality of air and led to many diseases like asthma, respiratory infections and cardiovascular diseases. Due to climate change the rate of wildfires is

increasing, and releases smoke and carbon dioxide in the air. Airborne allergens like pollen are also affected due to the rise in carbon dioxide and increasing temperature (Kovats & Akhtar, 2008).

2.6.3 Vector-borne Diseases:

Vector-borne diseases are transmitted through insects like mosquitoes, flea and tick. These insects carry harmful and deadly viruses and bacteria's from animals to humans. Changes in weather pattern increases the time period of diseases which means a disease can spread earlier in a year (Kovats & Akhtar, 2008).

2.6.4 Mental Health:

Any change around person's surrounding or built environment can affect his/her mental health also. For example any change in a weather patter can cause stress or any other metal problem to a human body, especially when someone has lost any of its home member. People who takes medicines for treating their mental diseases are more at risk as it is difficult for their body to regulate temperature (Kovats & Akhtar, 2008).

2.7 Climate Change Mitigation and Adaptation:

When dealing with climate change, two different approaches are come across. First one is to stop the warming of temperature for future (mitigation of climate change) and second is to find remedies to live with the current situation (adaptation to climate change).

Adaptation is also defined (Ahuja 2007) as "the change in regular or human frameworks in light of real or anticipated climatic improvements or their belongings, which conservatives mischief or adventures valuable freedoms" (Yulandhika & Nugrahanti, 2014).

Mitigation is defined by Ahuja (2007) in the report for IPCC as "an anthropogenic mediation to lessen the anthropogenic constraining of the environment framework, it incorporate procedures to decrease ozone depleting substance sources and outflows and to improve ozone harming substance sinks"(Yulandhika & Nugrahanti, 2014)

2.8 Disaster Risk Reduction

The concept of DRR emerged from the concepts of emergency management and disaster management. Initially, emergency management and disaster management were the key concepts to reduce risk and vulnerabilities. However, due to the limitations of the disaster management concept in dealing with increasingly frequent and complex disasters, international frameworks began to replace disaster management with the concept of disaster reduction and later disaster risk reduction. Thus, UNISDR defines DRR as "The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events"(Dias et al., 2018).

Rapid urbanization and climate change are amongst the most significant phenomena of the 21st century. In 2010, for the first time in human history, the number of global urban inhabitants outnumbered the rural inhabitants. Besides the social and economic opportunities provided to the communities and states, urbanization is a risk to many people. In a more accurate term, urban sprawl and unplanned urbanization as consequences of improper development accumulate extensive risks that threaten the lives, property, and dignity of millions of people worldwide.

Every day, more than 100,000 people move to slums in the developing world that is one person every second. Nearly 1.5 billion people currently live-in informal settlements and slums without adequate healthcare, clean water, and sanitation. Many are at risk of hurricanes, cyclones, flooding, earthquake, epidemics, crime, fires, and industrial accidents. Developed countries are not safe and immune against the urban disasters' risks. Some of the most destructive urban disasters occurred in highly developed countries in recent years. In the rapidly growing urban risk environment, everyone from development sectors to humanitarian actors takes urban disaster risk reduction and management as a serious concern and priority for action (Singh Rai, 2017).

2.9 Global efforts toward Urban Disaster Risk Reduction:

2.9.1 UNISDR resilient cities campaign

The Making Cities Resilient: 'My City is getting ready!' campaign, launched in May 2010, addresses local governance and urban risk issues. 1468 cities have signed up for the campaign with its ten essentials for making cities resilient.

2.9.2 World Urban Forum 6 in 2012:

1. Highlighted the need for "guidance and tools to assist urban and local governments in ensuring resilience in the face of disasters."
2. Highlighted the fact that "cities are increasingly being exposed to disasters associated with climate change, which threatens economies, public health, quality of life and stability."
3. The disturbance and erosion of social cohesion by pervasive violence in neighborhoods expose youth to increased risks."

2.9.3 Urban DRR/DM Projects

Several National Societies are engaged in various types of DRR and DM projects in urban areas with the support of Participating National Societies. These projects range from urban risk assessment initiatives such as risk mapping to delivering health, water, and sanitation services to the people in slums and informal settlements.

2.10 Concept Urban Resilience:

The etymological roots of resilience stem from the Latin word resilio, meaning "to bounce back"(Meerow et al., 2016). Urban resilience refers to the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity (Meerow et al., 2016).

Cities are vulnerable to shocks and stresses that can erode and compromise their structures and, in turn, their resilience. Shocks refer to acute and sudden events of high impact on a city's structures like earthquakes, fires, or flooding. Stresses refer to continuous processes that erode the capacity of a city's community and structures to recover properly. A resilient city has the capacities in place to shift into a different state in the aftermath of a shock or disaster while restoring its functions and services. An 'unresilient city' has limited or restricted capacity to recover and "has high poverty and crime rates and devastating natural environment, or 'a ghost town'(Meerow et al., 2016).

2.11 Vulnerability:

The characteristics and circumstances of a community, system, or asset make it susceptible to the damaging effects of a hazard.

Vulnerability is used in the field of risk, hazard, and disaster management, as well as in the areas of global change and environment and development studies. Within the last years, especially urban vulnerability and the vulnerability of megacities became a focal point. By vulnerability, we mean the condition of a given area to hazard, exposure, and preparedness, prevention, and response characteristics to cope with specific natural hazards. It is a measure of the capability of this set of elements to withstand events of a certain physical character (Weichselgartner, 2001).

The vulnerability relates to a number of factors, including: Physical factors, e.g., poor design and construction of buildings, unregulated land use planning, etc. Economic factors, e.g., the uninsured informal sector, vulnerable rural livelihoods, dependence on

single industries, globalization of business and supply chains, etc. Social factors, e.g., poverty and inequality, marginalization, social exclusion and discrimination by gender, social status, disability and age (amongst other factors), psychological factors, etc. Environmental factors, e.g., poor environmental management, overconsumption of natural resources, a decline of risk regulating ecosystem services, climate change, etc.(Weichselgartner, 2001).

2.12 Urbanization:

"Urbanization refers to the population shift from rural to urban residency, the gradual increase in the proportion of people living in urban areas, and how each society adapts to this change". It is predominantly the process by which towns and cities are formed and become larger as more people begin living and working in central areas. Although the two concepts are sometimes used interchangeably, urbanization should be distinguished from urban growth: urbanization is "the proportion of the total national population living in areas classed as urban," while urban growth refers to "the absolute number of people living in areas classed as urban". It can also be termed as the progressive increase of the number of people living in towns and cities. It is highly influenced by the notion that cities and towns have achieved better economic, political, and social mileages compared to the rural areas (Shrestha & Raj, 2019).

2.13 Impacts of Urbanization on Various Components of Environment:

Most of the major environmental problems in the coming century will probably result from the continuation and sharpening of existing problems that currently do not receive

enough political attention. The problems are not necessarily noticed in many countries, or nothing is done even though the situation has been detected. The most emerging issues are climate changes, freshwater scarcity, deforestation, and freshwater pollution, and population growth. These problems are very complex, and their interactions are hard to define. It is very important to examine problems through the social - economic- cultural system (Uttara et al., 2012).

2.13.1 The creation of heat island:

Materials like concrete, asphalt, bricks, etc., absorb and reflect energy differently than vegetation and soil. Cities remain warm at night when the countryside has already cooled (Uttara et al., 2012).

2.13.2 Changes in Patterns of Precipitation

Cities often receive more rain than the surrounding countryside since dust can provoke the condensation of water vapor into rain droplets. Increased condensation will result in more storms but also contribute to drying over some land areas. As a result, storm-affected areas are likely to experience increased precipitation and an increased risk of flooding (Uttara et al., 2012).

2.13.3 Flow of Water into Streams:

Natural vegetation and undisturbed soil are replaced with concrete, asphalt, brick, and other impervious surfaces. This means that when it rains, water is less likely to be absorbed into the ground instead of flowing directly into river channels resulting in urban flooding (Uttara et al., 2012).

2.13.4 Flow of Water through Streams:

Higher, faster peak lows change stream channels that have evolved over centuries under natural conditions. Flooding can be a major problem as cities grow and stream channels attempt to keep up with these changes (Uttara et al., 2012).

2.14 Urban Flooding:

Urban flooding is an overflowing or irruption of a great body of water over land in a built-up area that is not usually submerged. Thus, flooding in urban areas is caused by intense and/or prolonged rainfall, which overwhelms the capacity of the drainage system. Our cities are densely populated, and an urban flood affects a large number of people in a very small area. In addition, an urban flood results in inundation and damage to vital infrastructure, and disruption to roads and services, thereby affecting all walks of life. It often leads to major economic losses, which have both local and global implications. An outbreak of diseases is yet another hazard after a major urban flood. Urban flooding is a dangerous hazard that is increasingly causing more severe damage to metropolitan areas around the world (Shrestha & Raj, 2019).

2.15 Monsoon Flooding:

Monsoon floods can be defined as flooding that happens due to the result of wind that brings a lot of rain. Monsoon floods happen in certain seasons. This season can be divided into two, which are northeast monsoon flood and southwest monsoon flood. North-east monsoon floods occur from October to February, while South-west monsoon floods occur from July to September.

When monsoon flood disasters hit certain areas, they will destroy houses and other facilities. Due to this, local residents will build the house higher from the ground surface, which is the house with having pillars. Basically, these types of houses are built without cement and are referred to as house boards (Hua, 2015).

2.16 Flash Flooding:

Flashfloods are often caused by heavy or excessive rainfall over a short period of time, distinguished from a regular fluvial flood by a timescale of less than 6 h (NWS, 2009). In the UK flash, floods are regarded as having time to peak of less than 3 h within catchments of 5e10 km2, whereas in the USA times to peak of up to 6 h for catchments of 400 km2 are regarded as potential flashflood catchments. Flash floods are usually characterized by raging torrents after heavy rainfall flows over river beds, through urban streets, or mountain canyons in low-lying geomorphic areas and almost sweeps through everything. They can occur within minutes, or a few hours, after excessive rainfall and can also occur even if no rain has fallen, for instance, after a levee or dam has failed or breached, or after a sudden release of water by debris or ice jam. Due to their rapid occurrence, flashfloods usually result in a very limited opportunity for warnings to be prepared and issued. Therefore, they are extremely dangerous events, often leading to catastrophic consequences and particularly in the form of loss of human life and property. Urban areas are notably susceptible to flash floods because a high percentage of their surfaces are impervious streets, roofs, and car parking areas where runoff occurs rapidly. Flash floods can be particularly dangerous because they occur suddenly and are difficult, if not impossible, to forecast. They typically affect a more localized area than

other floods. However, They can still cause serious damage as the water may be travelling at high speed and carrying large amounts of debris, including rocks, trees, and cars (Xia et al., 2011).

2.16.1 Impacts of Flash Floods:

Table 2.1 Impact of Flash Floods

Economic impacts	Social impacts	Environmental impacts
Infrastructure losses • Transportation networks • Communications network • Water supply and sewage systems	Human injury (physical, emotional, psychological)	Destruction of flora
Residential losses • Property • Furnishings	Loss of life	Destruction of fauna
Government facilities losses	Displacement of people	Damage to habitats, food chains, species diversity, and stability.
Public facilities losses (schools, Hospitals, etc.)	Health hazards • Polluted water • Communicable diseases • Food supplies • Exposure to cold, rain, etc. due to lack of shelter	Damage to natural recreational resources
Employing businesses losses • Structural damages • Inventory losses • Sales losses	Emotional and psychological trauma associated with loss of personal property and memorabilia, homes, communities	Damage to scenic resources
Job losses: income losses	Disruption of educational programs	Damage to archaeological and historical resources.
Increase in fuel costs and lost time due to traffic delays and use of alternative transportation routes.	Disruption of cultural programs (sports events, church programs, etc.)	
Costs of emergency measures	Disruption of law enforcement programs.	
Increased taxes to cover costs of replacement, repair, and rehabilitation of infrastructure and public facilities		

2.17 Case Studies:

Title: An Impact of Floods on the Socio-Economic Livelihoods of People: A Case Study of Sikaunzwe Community in Kazungula District of Zambia.

Author: Yande P. Mwape

Year of publishing: August, 2009

Problems:

- People's income was reduced as their maize crop was destroyed which was there staple food and resulted in food insecurity.
- Due to disruption of transportation network access to basic health units was affected.
- Diseases like malaria and cough widely spread at household level. People also suffered from diarrhea due to drinking contaminated water and poor sanitation facilities (MWAPE, 2009).

Adaptation Strategies:

- People shifted their homes to a high terrain and built canals to fight flood.
- Construction of houses on the pillars to raise the floor level to avoid rain water entering the homes.
- Construction of mezzanine floors in homes for placing electrical appliances (MWAPE, 2009).

Title: Rain go away; our cities can't keep the water at bay.

Author: Ravleen Kaur

Year of Publishing: 2013-06-17

Introduction:

Every year Mumbai is hit by urban floods. A 37 inches of rain fall within five hours of a day. Due to flood one-third part of the city is affect and all rail and transport networks are shut down (Ravleen Kaur, 2013).

Problems:

- Mobility of middle class families is affected as their mode of transportation I metro, which is shut down due to flood.
- During heavy rainfall, drains cannot drain storm water secondary and primary channels; instead, water is drained back to settlements resulting in the water clogging in houses.
- Leaking of house roofs or seepage on the walls.
- Damage to the home accessories and appliances (Ravleen Kaur, 2013).

Adaptation Strategies by the people:

- Use of personal cars for going to the office.
- Some people keep umbrellas and extra pairs of shoes in their cars during monsoon season.
- Use of raincoats and rain shoes by the people travelling on bikes. Even some people cover their shoes with plastic bags (shoppers) while riding bikes.
- To avoid leaking of roofs, the use of tarpaal on the roofs is very common. Some people place buckets under the dripping ceilings.
- Use of wooden paneling or wall papers in homes for hiding detrimental effects water seepage in walls.
- Trend of using tiled floor instead of carpets.

- Placing of cloth pieces in windowpanes and under the doors to avoid rainwater from entering the house.
- People use shoe wrapping papers for guests at the entrance and wire rugs for cleaning the shoes instead of entering the house with dirty feet.
- Packing of important documents and papers in the plastic bags to avoid them from getting wet (Ravleen Kaur, 2013).

Recommendation by the Author:

Water harvesting:

- It is a very contemporary solution, time-tested and need of the hour, to mitigate floods and fulfill water requirements locally (Ravleen Kaur, 2013).

Title: Problems Faced by Delhi during Monsoon

Author: Skymet Weather Team

Year of Publishing: July 10, 2015

Introduction:

The southwest monsoon reaches Delhi by the end month (June). During heavy precipitation the city faces monsoon flooding. The incapability of drainage system and choked sewer system results in heavy floods.

Problems:

- Every year during the monsoon, vegetables get stupendously expensive. During rain not only the supply need of vegetables is delayed, also their prices are escalated by 20-30%.
- Water is a good conductor of electricity. In the rainy season, open plugs and switches become much more dangerous.

- Moist water often leads to wet clothes or clothes are not dries properly after washing.

Adaptation Strategies:

- For stagnant water, check if there is any water caught up in pots or any other container near or around your home. Even in small quantity stagnant water is dangerous and an active breeding ground for mosquitoes. Empty them as soon as possible.
- The rainy season is not a good season to enjoy street food. Because the bacteria are causing it, insects might be sitting on it. Houseflies and other bacteria-causing insects might be sitting on street food if it is left uncovered. It can cause series of diseases if people consume such food.
- Never use exposed, frayed, cracked, or faulty wires. The power points must be switched off before plugging and unplugging devices. If an electrical appliance breaks down, do no try to open and mend it on your own.
- Indoor cloth stands should be used for drying clothes.

2.18 Emergency Preparedness Guidelines for Floods:

Preparedness is defined as the ‘‘education, ability and actions taken by government, social organizations and people themselves to recuperate from the life threatening and destructing impacts and risks of hazards’’. To make a community resilient to any disaster preparedness is considered an important factor.

Globally the most common hazard is floods. Especially the flash floods which gives no warming sign and can develop in a matter of minutes (Robert N. Harewood, 2011).

What to do Before Flood?

1. Evacuation is the basic education principle in the time of flood. People should be aware of their community evacuation routes.
2. Extra supply of food and clean water should be stored for the rainy day. The storage of food and water should be enough to at least survive three in the time of flood.
3. Properly shut down gas, electricity and water valves as a mere leakage of gas or short circuiting of electricity can put house on fire.
4. Purchase flood insurances, so that flood damages should be covered after the disaster.
5. Some options to consider protecting your property:

a) Make a photographic record of documents, property papers and policy papers and to keep them safe pack them in plastic bags or sheets.

b) Do not build home in a flood-prone zone unless it is completely reinforced.

c) The floor level of water heaters and electric panels should be elevated to avoid any hazard from flood (Robert N. Harewood, 2011).

What to do During a Flood

1. Be aware of flash floods. In any case of a flash flood, instantly move to a higher place or a safe spot.
2. Keep yourself updated through radio or television information.

3. I case of any warning issued by the authorities, prepare yourself for the evacuation:

- Make your home safe and sound. Move outdoor furniture and equipment inside the home. Place your electrical appliances on a higher or safe level to avoid water getting into the appliance.
- Switch off all the utilities valves and detach all electrical machines.
- Save containers of clean water for drinking in case the water supply disconnects.

1. Try not to stroll through moving water. Even six inch of water can injury your feet. Utilize a stick to check the immovability of the ground before you walk.
2. Try not to crash in over flowed region. A water level of six inch will arrive at a lower part of most vehicles, causing loss of control and conceivably slowing down. A water level of two feet will wash away practically all vehicles. (Robert N. Harewood, 2011).

What to do After a Flood

1. Try to stay away from flood water because it will contaminated by oil, gas or sewer waste. It may have electrical charges.
2. Make complain to Power Company if any high tension wires are fallen and stay away from them.
3. Do not walk in moving water as it will injure your feet badly.
4. Do not drove in the areas where roads are weaken by flood water as there is a high risk that vehicles may collapse.

5. Do not go to the disaster area unless asked by the authorities for any volunteer work.
6. Before returning home make sure the authorities have declared the area safe and check if there is any damage to your house or building before residing again (Robert N. Harewood, 2011).

2.19 Risk perception:

Risk is often defined as "the probability that an individual will encounter the impact of risk." (Svahn, 2013).

Today risk perception is a very important concept as it helps to study human behavior and how people react in a hazardous situation. It is observed by the experts that human reactions are affected by both emotional and cognitive factors (Svahn, 2013).

"Risk perception alludes to the instinctive danger decisions of people with regards to restricted and dubious data. These decisions vary from a person to person because of various degree of data and vulnerability, and also because of various instinctive conduct and explicit force groupings and place of interest. As individual's opinion regarding flood risk varies, politicians, government officials, and employees of disaster management may look this issue from a different perspective" (Messner and Mayer 2006,p.154) (Svahn, 2013).

2.20 Paradigm Regarding Risk Perception:

2.20.1 The psychometric paradigm:

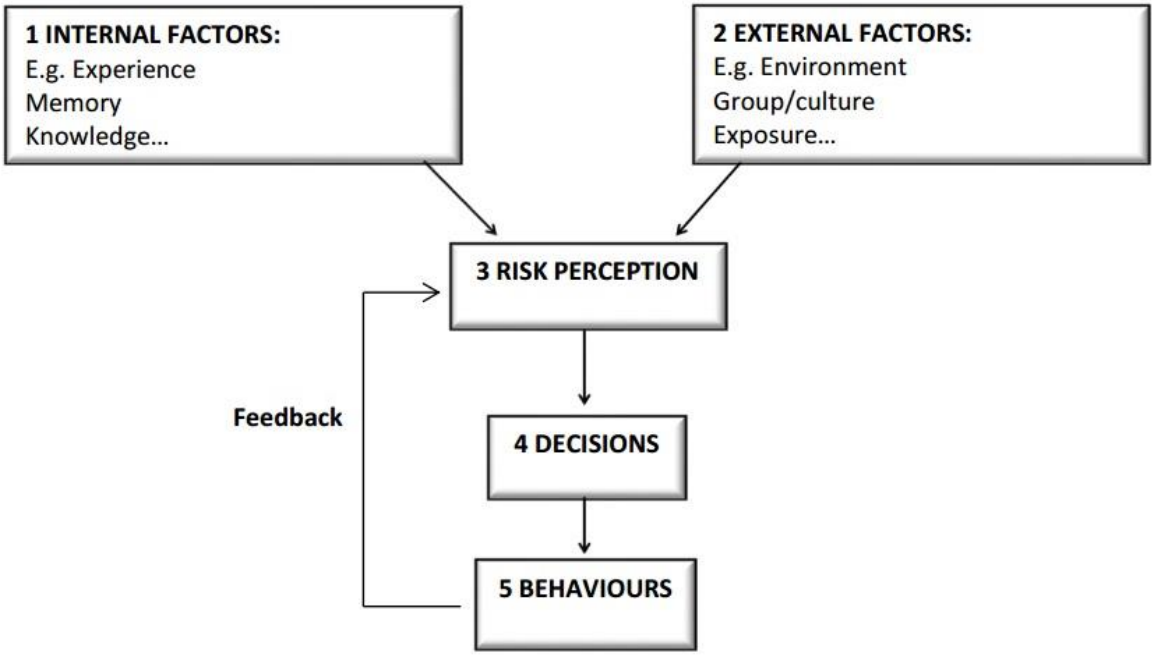
According to the psychometric paradigm, "Risk is completely developed by the individual own self however psychological, cultural and social factors do affect a person's perception." According to psychometric paradigm factors influencing person's conception towards risk can be evaluated (Sjöberg, Moen, and Rundmo 2004).

2.20.2 The cultural theory paradigm:

The cultural theory paradigm starts from sociological exploration and "targets clarifying how individual see and follow up there general surroundings. All the more explicitly, the hypothesis asserts that social viewpoints and social adherence to a great extent decide this." It is additionally expressed that:

"Risk perception is not represented by character qualities, necessities, inclination, or the properties of the danger objects. The phenomena is completely social and cultural. That is seen as hazardous and how much danger to acknowledge, is a component of one social adherence and social learning" (Douglas 1978 in Oltedal et al. 2004, p.16) (Svahn, 2013).

2.21 Risk Perception Model:



2.22 Protection Motivation Theory (PMT):

The protection motivation idea includes any danger for which there is a powerful suggested reaction that can be done by the person. Protection Motivation Theory, based on the authors Grothmann & Reusswig (2006), is discussed in the following part.

The first component is 'threat appraisal' (also known as risk perception) which explains that without any change in behavior, a person estimate the likelihood of damage to his or her property or valued items.

The second one is 'coping appraisal' which describes that a person estimate his or her coping capacity to combat a hazard. This includes cost of damages and threats imposed (Svahn, 2013).

2.23 Summary:

Climate Change is becoming a threat to the human community as it has imparted negative impacts on the urban areas and is disrupting the socio-economic lives of humans. Increased urbanization by humans has not only risked their lives but has exposed them to many disasters. Monsoon flooding is one of them. With the advancement and more awareness in disaster sciences, people are learning to adapt to floods by perceiving the risks of the disasters and following emergency preparedness guidelines. Pakistan being a developing country, lacks educational and institutional training to cope with the monsoon flooding. Every year people face a severe economic loss due to monsoon floods due to unawareness of adaptation strategies and emergency preparedness guidelines. The reason being is people do not perceive monsoon floods as a risk and are not motivated to take any precautionary measures due to lack of finances.

Chapter 3

METHODOLOGY

3.1 Research Design:

The research is divided into two phases. The first one focuses on finding out how people perceive monsoon flood risks, their adaption strategies in the monsoon seasons, and whether they follow emergency preparedness guidelines for floods adopted internationally. The second phase of the study aims to find out which institutions deal with monsoon floods, what challenges they face in implementing flood policies, and how these policies help cope with floods.

3.2 Study Area:

Lahore is covered with housing development and houses different institutions, commercial hubs, and even industries on its outskirts. Due to increased migration, the city provides employment opportunities, and unplanned and lousy settlements are being developed with poor critical infrastructure. Extreme monsoon rainfall triggers urban floods, the flow of traffic is also disrupted due to the accumulation of rainwater on the roads. It is common to see people pushing their cars as they came to a halt due to excessive inlets of water into the mechanical parts.

In the absence of a functional sewerage system, water entered the homes and shops of citizens, who spent the day pushing it out of their homes. On top of this, power outages are reported across multiple areas of the city, which added to the miseries of the people.

Iqbal Town, Samnabad, Shadman, Mozang, Waris Road, Ichra, and Lakshmi Chowk are among the most affected areas.

3.3 Data Collection:

The data will be collected through a questionnaire survey. They will be aimed at investigating preparedness for flood disasters and risk perception in the Iqbal Town and Samnabad Town areas, which were severely affected in the monsoon season. Disaster preparedness will be assessed through a set of questions designed to identify the type and number of protective behaviors adopted by individuals to cope with a possible flood disaster.

The questionnaire will be divided into the following sections:

1. Risk Perception: the perception of risk will be categorized by one.
2. Economic impacts of floods measure the physical risk.
3. Household preparedness and adaptation strategies will be based on closed-ended questions for preparedness and open-ended questions for adaptation strategies.

3.4 Designing Survey Sample:

A large sample size generally increases precision when estimating unknown parameters. Still, it would be too expensive and a waste of time and effort, where a smaller sample size would save time and effort over accuracy. Therefore, between these two extremes lies the most efficient sample size for the given study objective.

By using Slovin's formula, the sample size was calculated (Slovin, 1960).

Slovin's formula

$$n = \frac{N}{1+Ne^2}$$

where,

n = sample size

N: = size of the population

E = error margin

According to the census of 2017, the total population of Androon Lahor was 144,834, and Samnabaad Town was 128,717. With a 95% confidence level, the Slovin's formula gave the sample size of 400.

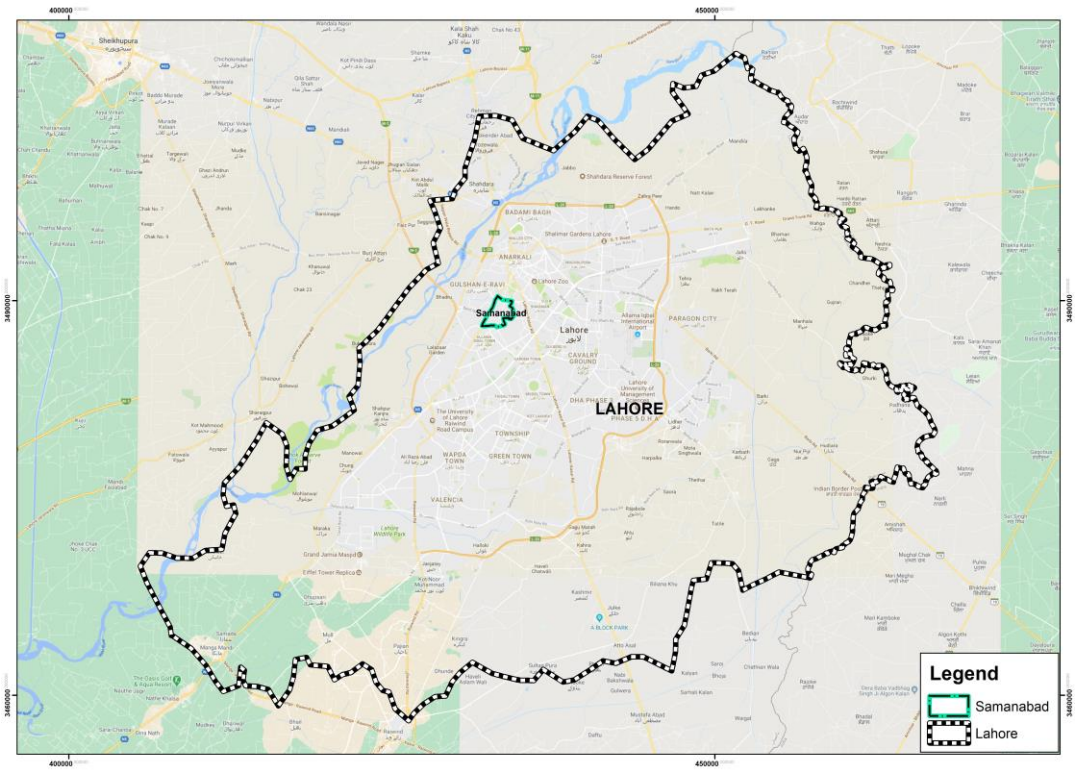


Figure 3.1 Map of Lahore

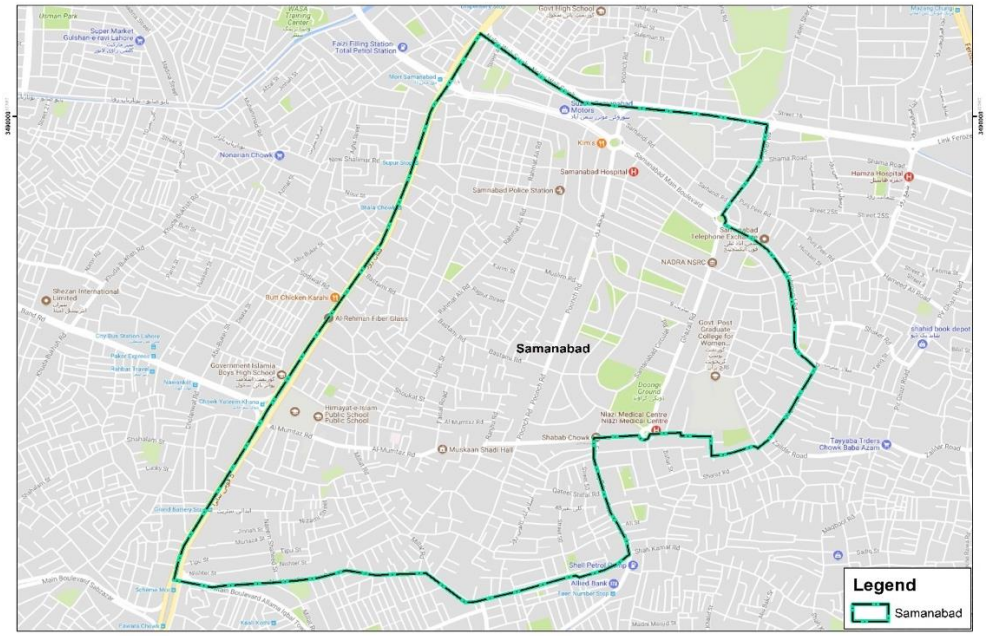


Figure 3.2 Map of Samanabad

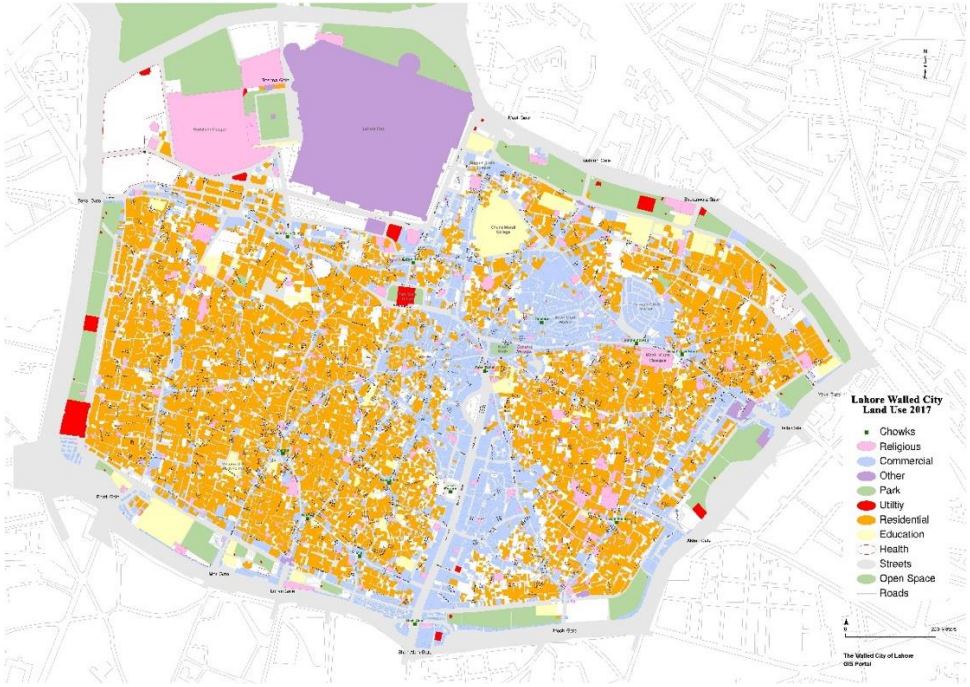


Figure 3.3 Map of Walled City

3.5 List of Indicators:

Sr No	Indicators	Unit	Reference
Risk Perception (Situational)			
1	Physical Location		Lechowska, E., 2018
2	Extent of Effect	• Direct & Indirect Impacts	Lechowska, E., 2018
3	Socio-economic and demographic factors of the population	• Gender • Age • Education • Income • Number of children	Lechowska, E., 2018
4	Residence characteristics	• Owning a house • Type of a building • Presence of a ground floor	Lechowska, E., 2018
5	Group of people influenced	• Individuals • Their families	Lechowska, E., 2018
Physical Risks			
6	Damaged area	• Houses • Parks • Shops • Schools • Other parts of Community	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
7	Number of deceased	• Numbers	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
8	Number of injured	• Numbers	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
9	Ruptures in water mains	• Numbers	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
10	Rupture in gas network	• Numbers	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
11	Fallen lengths on HT power lines	• Meters	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.

12	Telephone exchanges affected		Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
13	Electricity substations affected	• Numbers	Carreño, M.L., Cardona, O.D. and Barbat, A.H., 2007.
Preparedness Resource Availability			
14	Keep emergency food and water	-	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
15	Keep mosquito net	-	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
16	Save enough money for emergency	• Rupees	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
17	Keep torch lights and candles available	-	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
18	Keep a list of emergency phone numbers in case of a flood Emergency	-	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
19	Keep first aid kit ready	-	Miceli, R., Sotgiu, I. and Settanni, M., 2008.
Preparedness Knowledege			
20	Read material on flood preparedness	• Newspapers • Electronic media	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
21	Listen to messages on flood preparedness on radio or television	-	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
22	Attend meetings for the purpose of flood preparedness	No. of community meetings held	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
23	No. of attended first aid training	Numbers	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
Preparedness Response mechanism			
24	Groups available who help during a flood	-	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
25	Household member help another member of the community	-	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017

26	Government help during a flood	• Maintenance of Infrastructure • Supply of food • Provision of first aid	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
27	NGO help during a flood	• Maintenance of Infrastructure • Supply of food • Provision of first aid	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
28	Households contacted through TV	• Advertisements	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
29	Household contacted through newspaper	Advertisements	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
30	Household member relocate during floods	-	Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
31	Have a plan for a safe place during a flood		Atreya, A., Czajkowski, J., Botzen, W., Bustamante, G., Campbell, K., Collier, B., Ianni, F., Kunreuther, H., Michel-Kerjan, E. and Montgomery, M., 2017
Preparedness **Education and training**			
32	Attend training held by school/NGO/Government for flood preparedness purpose	Yes/No	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
33	Teach member of the household what to do in case of a flood	Yes/No	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
34	Attend first aid training	Yes/No	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.
35	Participated in mock drills or rehearsal for the purpose of flood preparedness	Yes/No	Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G. and Mulwafu, W., 2018.

Chapter 4

PROFILE OF RESPONDENTS

In Respondents' profile, unvaried facts and figures are collected through surveys conducted. It is highly significant for it provides the basic information regarding the respondents' age, gender, income, education, household size, etc. Moreover, it helps contextualize the study, so almost 370 people were surveyed and studied for this research. The results are as follows:

4.1 Age:

Table 4.1 Age of Respondents

Age Group	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
<26	33	19.6	27	19	
26-45	103	61.3	77	54.2	X2= 2.888
46-65	23	13.7	29	20.4	Sig= 0.409
>65	9	5.4	9	6.3	
Mean	37.77		39.06		
Std dev.	14.193		14.876		

In research methodology, the age of respondents' plays an important part in the analysis of the sociology of people. The age group makes it easy to categorize people for their views. The table shows the age survey of people living in two areas of Lahore: Walled City and Samnabad. It is very clear that the majority of people belong to middle age (from 26 to 45) in both areas, 61.3% in Walled City and 54.2% in Samnabad. The second

significant number of people belong to young people, with 19.6% and 19% in Walled City and Samnabad. Also, the significant value is greater than 0.05. It is 0.409 which means that there is no significant difference exists in both areas.

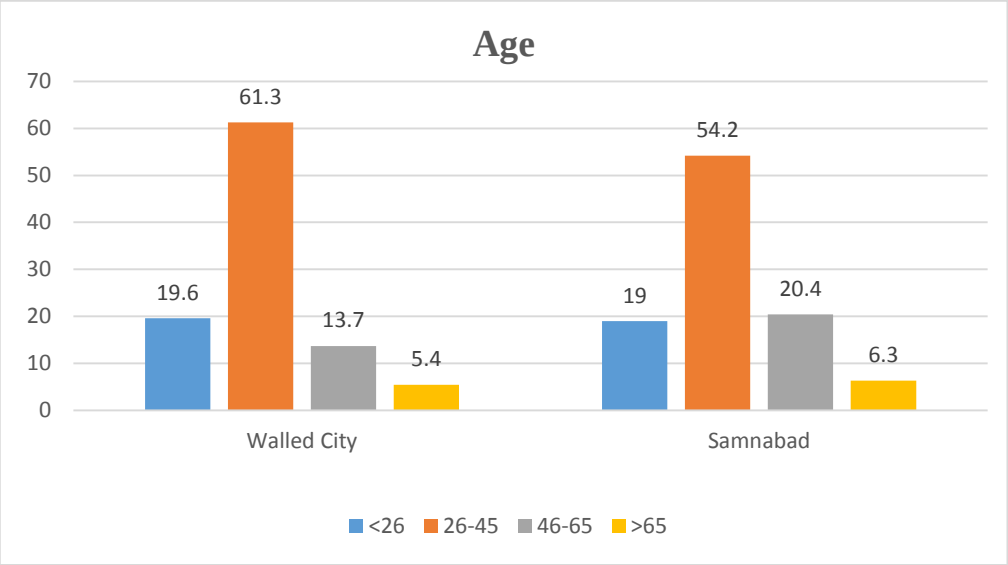


Figure 4.1 Age of Respondents

4.2 Gender:

Table 4.2 Gender of Respondents

Gender	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Male	150	89.3	123	86.6	X2= 0.520 Sig= 0.471
Female	18	10.7	19	134	
Mean	1.11		1.13		
Std dev.	0.310		0.342		

In social sciences, the gender of a person plays a vital role in understanding the views and standing of a person in their household. In a thesis, where we assess the outcomes

of monsoon flooding, this part of respondents' profile becomes particularly critical because both males and females play different roles in combating the issues that follow these disastrous situations. It is apparent from the table that the male category dominated the survey in both areas. A total of 89.3% and 86.6% percent consisted of males in Walled City and Samnabad, respectively. The females that participated in this survey were bare 10.7% and 13.4 % in both areas.Also, the significant value is less than 0.05. It is 0.471, which means that there is no significant difference in both areas.

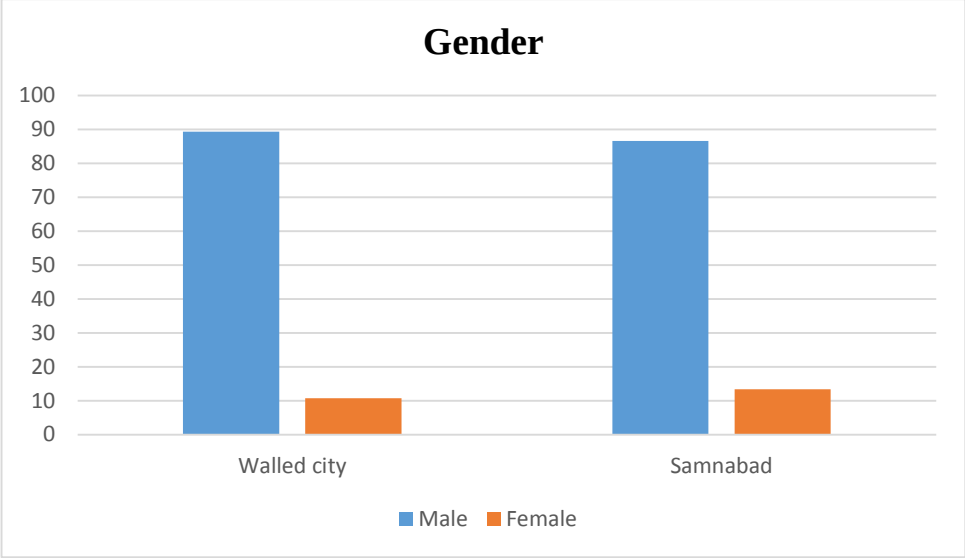


Figure 4.2 Gender of Respondents

4.3 Income:

The household income is directly related to the economic conditioning of any family. Financial status plays a crucial role in how people deal with the day-to-day affair and crises. So, here we have collected the following data as an important factor in the lives of respondents.

Table 4.3 Income of Respondents

Income	**Walled City**		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
2500	0	0	1	0.7	
2501-52500	78	46.4	29	20.4	
52501-102500	67	39.4	53	37.3	X2= 40.986
102501-152500	7	4.2	22	15.5	Sig= 0.000
152501-202500	12	7.1	20	14.1	
202501+	4	2.4	17	12.0	
Mean	72419.64		130017.61		
Std dev.	54379.442		119284.873		

It is evident from the table, the responses of people regarding their monetary conditions are variable in both Walled City and Samnabad. In Walled City, the majority of people, about 46.4%, lie in the bracket of 2501-52500. The second highest, about 39.4%, is the category of people having a household income of 52501-102500. Collectively, the mean income is approximately 72000. In Samnabad, the highest category of income, belonging to 37.3% of people, is 52501-102500. Subsequently, the next category has almost 2501-52500 earning, for almost 20.4% of respondents' population. So, the mean household income in this area is about 130000. Moreover, the Chi-Square Test shows a major difference in both areas because the value of the test is 0.000.

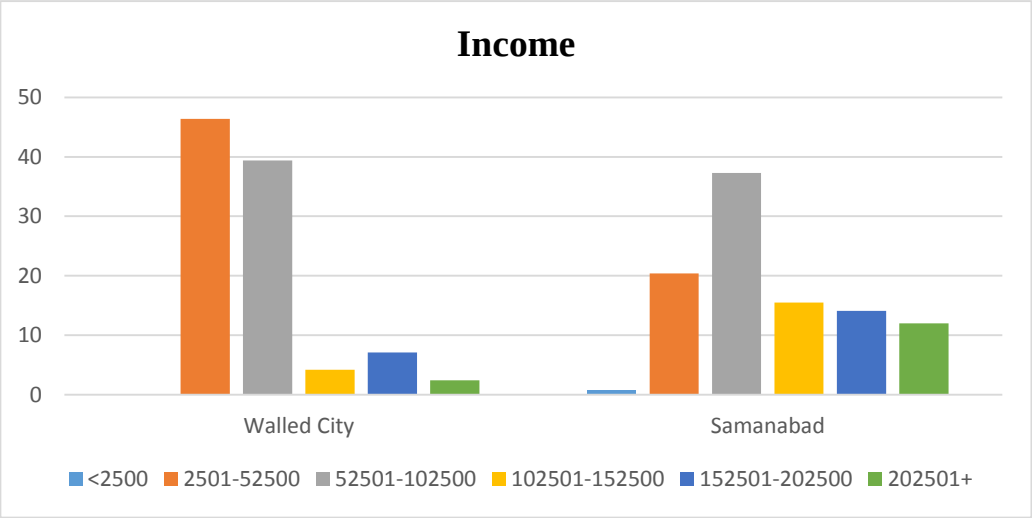


Figure 4.3 Income of Respondents

4.4 Household Size:

When conducting research, the household size greatly influences the social conditioning of a family. It plays an important role in the distribution of economic assets and other resources, which are pivotal to family life as a whole and on the individual level.

Table 4.4 Household Size

Household Size	**Walled City**		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
2	0	0	2	1.4	
3-6	98	8.3	83	58.3	
7-10	53	31.5	42	29.6	X2= 2.537
11-14	13	7.7	12	8.5	Sig= 0.638
15-18	4	2.4	3	2.1	
Mean	6.79		6.68		
Std dev.	2.807		2.854		

The table above shows that almost one-third (31.5%) of the respondents in the area of the walled city have 7-10 people in their family. With 8.3% and 7.7% having 3-6 and 11-14 people in their households, respectively. Only 2.4% of people have a household size of 15-18 people. While more than half (58.3%) of the respondents in the area, Samnabad has 3-6 people in their households. With a significant percentage of 29.6, having a family size of 7-10. With the least percentage of about 2.1% and 1.4% of people having a family of 15-18 people and 2 people respectively. Also, the significant value of the Chi-Square Test is more than 0.05. It is 0.638, which means that there does not exist a significant difference in both areas.

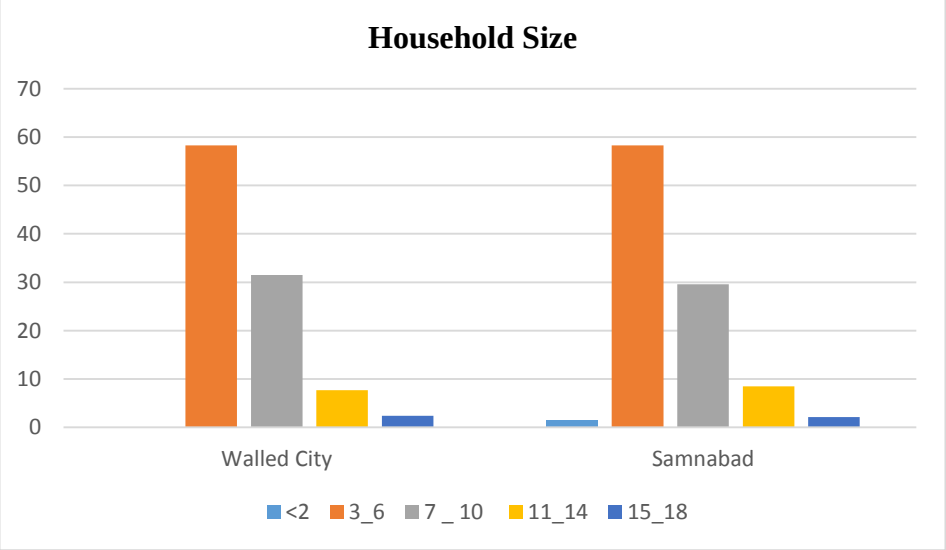


Figure 4.4 Household Size

4.5 Education:

Education is a pivotal aspect that shows the level of awareness and consciousness individuals have. Their decision-making regarding normal and crisis situations can be guessed through their education level.

Table 4.5 Education of Respondents

Education	**Walled City**		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Matric	38	22.6	11	7.7	
Intermediate	37	22.0	31	21.8	
Graduation	62	36.9	69	48.6	X2= 13.697
Post-Grad.	31	18.5	31	21.8	Sig= 0.003
Mean	2.51		2.85		
Std dev.	1.038		0.853		

Table 4.5 shows that a major portion of people has graduate-level education in Walled, which is about roughly 36.9%. It is followed by Matric and Intermediate at 22.6% and 22.0%, respectively. Lastly, only 18.5% of people have had a degree of postgraduate level. Now, if we analyze the data of Samnabad, almost half, which is 48.6% of the populace, has graduation-level education. It is followed by Post Graduation and Intermediate, both at a percentage of 21.8. Here, the least number of people are attributed to the matric level education that is 7.7%. Moreover, the Chi-Square Test shows a major difference in both areas because the value of the test is 0.003 only.

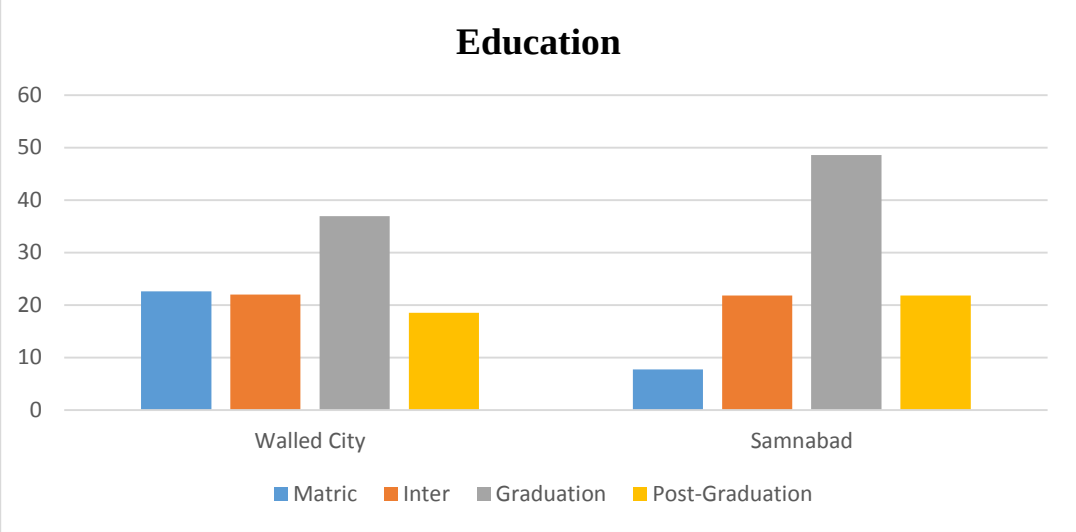


Figure 4.5 Education of Respondents

4.6 Family System:

The type of Family life and system that one belongs to reflects heavily in their life choices and attitudes. A person's opinions and belief system are conducive to their impression of the family system and outlook of life. Majorly, in research work of social science, the element of the family system plays a critical role in study and analysis.

Table 4.6 Family System

Family System	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Nuclear	114	67.9	109	76.8	X2= 3.808 Sig= 0.149
Joint	54	32.1	33	23.2	
Mean	1.65		1.49		
Std dev.	0.935		0.857		

If we observe the statistics of Walled City, about 67.9% of the population has a nuclear family system while 32.1% of the population has a joint family system. In Samnabad,

almost 76.8% of people live in a nuclear and 23.2% of people live in the joint family system. In addition to this, the Chi-Square Test shows no difference in both areas because the significant value of the test is only 0.149, which is greater than 0.05.

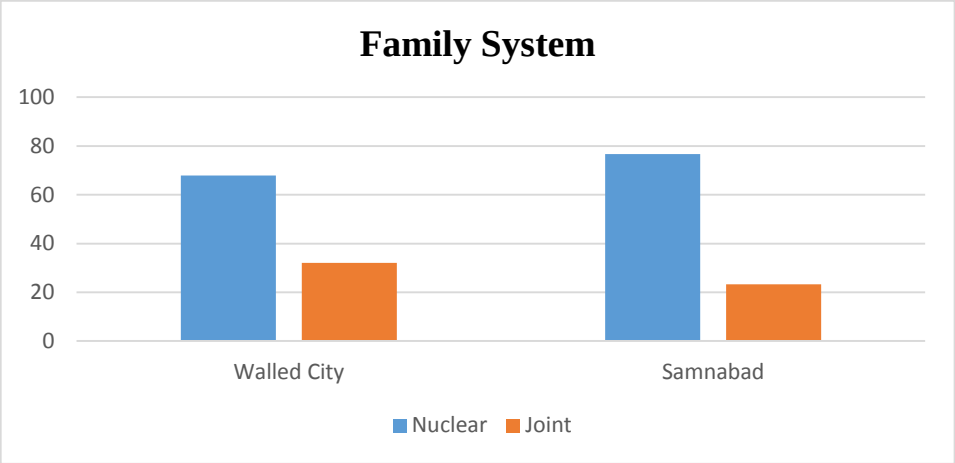


Figure 4.6 Family System

4.7 House Ownership:

When dealing with disasters such as monsoon flooding, house ownership matters in a research study because it can indicate the level of commitment that people will show in precautionary measures, also, the house ownership shows the ratio of investment families will have in maintaining their houses.

Table 4.7 Household Ownership

Ownership	**Walled City**		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Owned	149	88.7	128	90.1	X2= 0.170 Sig= 0.680
Rented	19	11.3	14	9.9	
Mean	1.11		1.10		
Std dev.	0.318		0.299		

The figures above show that in the walled city of Lahore, about 88.7% of people own the house while 11.3% are living in rented houses. Moreover, in Samnabad, about 90.1% of people are living in self-owned houses, and only 9.9% of these people taking part in the responses live in rented houses. Also, the significant value of the Chi-Square Test is more than 0.05. It is 0.680, which means that there does not exist a significant difference in both areas.

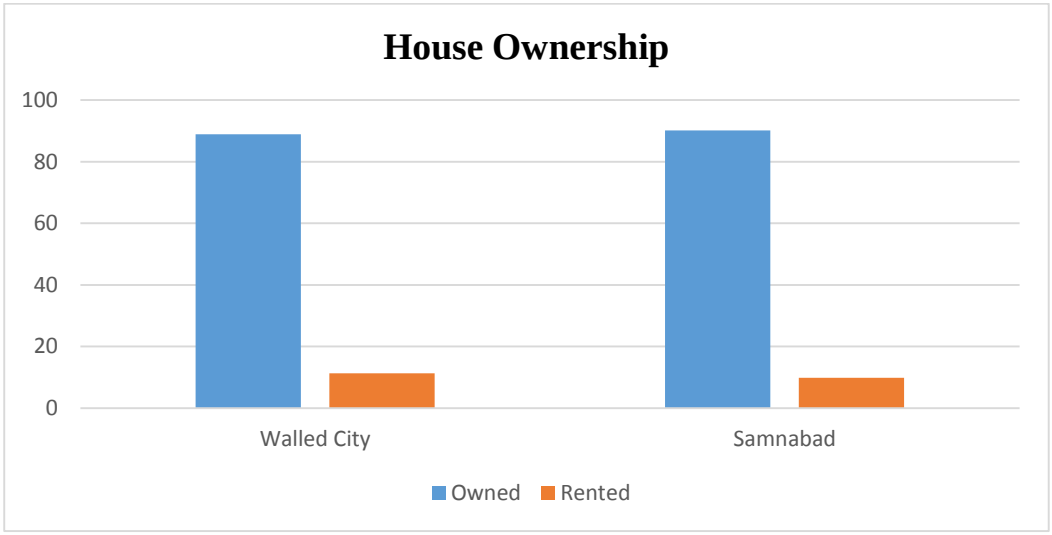


Figure 4.7 Household Ownership

4.8 Flood Dynamics:

In research methodology, the flood dynamics deal with the different aspects of the monsoon rainwater affecting the lives of people through heavy or life flooding. This helps us understand how urban flooding can disrupt day to day life of people living in metropolitan areas.

4.9 No. of times flood water entered the house:

The no. of times flood water entered the house can elaborate the severity of the situation with risks of disturbance to people. This information tells us as too often; the water enters people's houses in high monsoon season.

Table 4.8 Number of times flood water entered the house

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
0	67	39.9	86	60.6	
1-5	76	45.2	47	33.1	
6-10	17	10.1	4	2.8	
11-15	1	0.6	1	0.7	X2= 16.043 Sig= 0.007
16-20	3	1.8	2	1.4	
21+	4	2.4	2	1.4	
Mean	1.86		1.54		
Std dev.	1.026		0.897		

According to the table, in Walled City Area, the water entered 1-5 times in 45.2% of houses. More so, in 39.9% of houses, there is no instance of water entering the houses. Followed by 6-10 times of water entrance in 10.1% of houses. However, only 2.4% of people faced situations where the flood water entered their house more than 21 times. Now, in Samnabad. The major population never faced flood water issues entering their house, which is about 60.6%—followed by 33.1% of people whose houses the floodwater entered 1-5 times. But a significantly scant percentage of people face the excessive entrance of water in their houses of 16-20 times and more than 21 times which

is only 1.4% in both cases. Moreover, the Chi-Square Test shows a major and heavy difference in both areas of Lahore because the value of the test is 0.007 only. This significant value is less than 0.05.

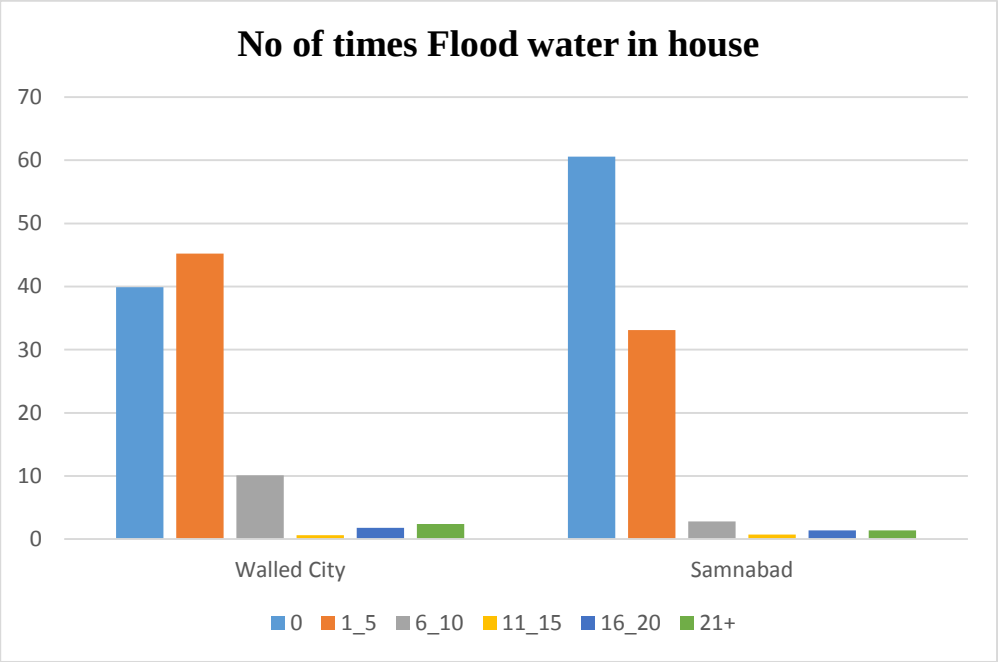


Figure 4.8 Number of times flood water in house

4.10 How long it stayed in the house:

This is how long the water stayed in the houses after monsoon rains and urban flooding. It is a key factor, but it can help us evaluate the significant damage it could have caused to home appliances, furniture, etc.

Table 4.9 Duration of water stayed in the house

Hours	**Walled City**		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
0	66	39.3	86	60.6	
1-20	55	32.	41	28.9	
21-40	18	10.7	9	6.3	X2= 21.488
41-60	12	7.1	4	2.8	Sig= 0.001
61-80	8	4.8	1	0.7	
81+	9	5.4	1	0.7	
Mean	2.21		1.56		
Std dev.	1.427		0.879		

Table no. 4.9 evidently shows that in the area of Walled City, around 39.3% of people faced no issue because the water stayed for zero hours or none at all. Afterward, we a have a significant percentage of 32% of households where the water stayed for 1-20 hours. With 10.7% of those households where the waters stayed for 21-40 hours. However, the most problematic is the situation of that 5.4% of households where the water stayed for more than 81 hours. Also, in the table are the figures of Samnabad where 60.6% of people faced no issue because the water did not stay in the house. Afterward, a significant percentage of 28.9% of households where the water stayed for 1-20 hours. With 6.3% of these households having floodwater in their houses for 21-40 hours. However, the most problematic is that 0.7% of families with water stay in their homes for 61-80 and more than 81 hours after the rain. Furthermore, the Chi-Square Test shows a major contrast in the statistical analysis of both areas, i.e., Walled City and Samnabad, because the value of the test is less than 0.05, i.e., 0.001 only.

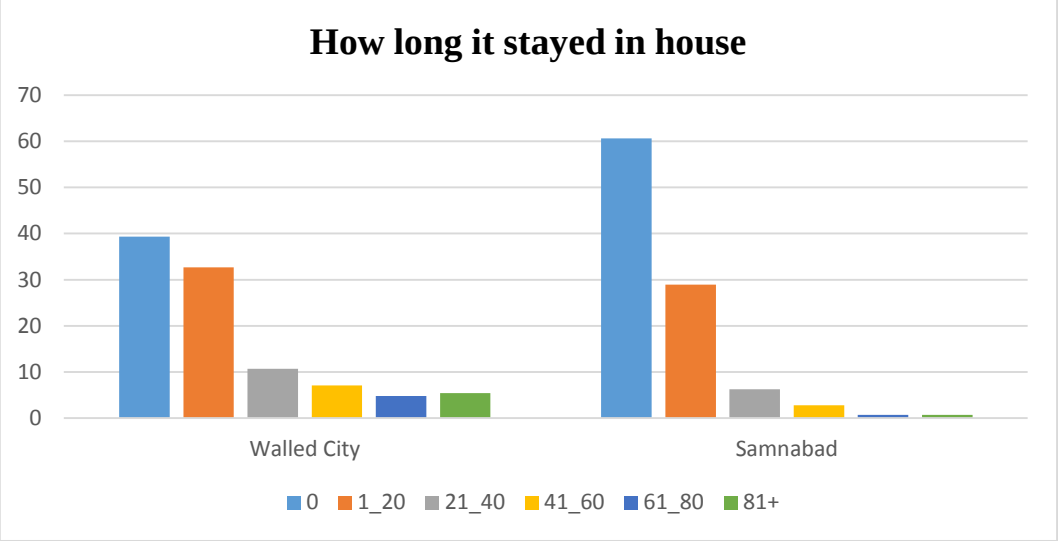


Figure 4.9 Duration of water stayed in house

4.11 Height of flood:

In disaster management and risk awareness situations, it is important to know the data about the height of a flood. It shows the water level, further making it easier to guess whether low-level or high-level appliances are affected in the houses.

Table 4.10 Height of water

Meters	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
0	66	39.3	87	61.3	
1	80	47.6	43	30.3	X2= 14.880
2	19	11.3	10	7.0	Sig=
3	2	1.2	2	1.4	0.002
Mean	1.74		1.49		
Std dev.	0.703		0.692		

It is shown above that the height of the water was zero meters in 39.3% of houses in the walled city, whereas 47.6% of houses had water up to almost 1 meter. Additionally, 11.3% and 1.2% of houses showed higher water levels of 2 and 3 meters respectively. It is also evident that the height of the water was zero meters in 61.3% of houses in Samnabad, whereas 30.3% of houses had water up to almost 1 meter. Furthermore, 7.0% and 1.4% of households showed higher water levels of 2 and 3 meters, respectively. Also, the Chi-Square Test shows a significant difference in the data of both areas of Metropolitan Lahore because the value of the test is less than 0.5, i.e., 0.002 only.

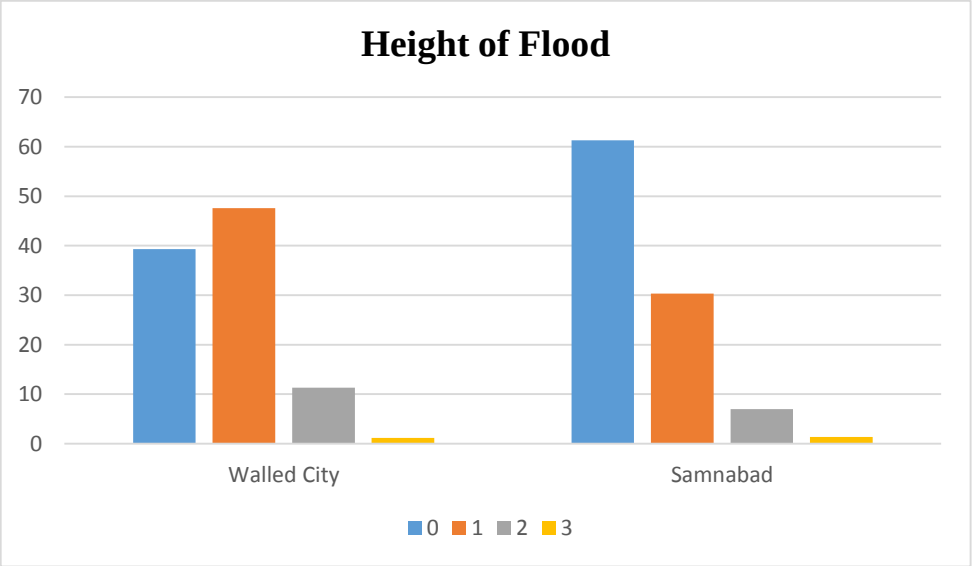


Figure 4.10 Height of flood

4.12 Access Road submerged:

One key element of study in flood dynamics is access to the road. The level of water there and the amount and the likelihood of submerging show issues such as travel problems, sewerage issues, ensuing of diseases through stagnant water, and much more.

Table 4.11 Access road Submerged

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	124	74.8	117	82.4	X2= 4.231 Sig= 0.121
No	44	26.2	25	17.6	
Mean	1.27		1.18		
Std dev.	0.460		0.382		

The aforementioned data points towards the fact that a total of 74.8% percent of houses in Walled City faced the issue that their access road is submerged by rainwater, whereas 26.2% percent of households were saved from this hassle. Also, it clearly shows that almost 82.4% of households faced this problem in Samnabad, with the exception of 17.6% of households that did not face this issue. Adding on, the significant value in the Chi-Square Test shows no difference in both areas because the value of the test is greater than 0.05, i.e., 0.121.

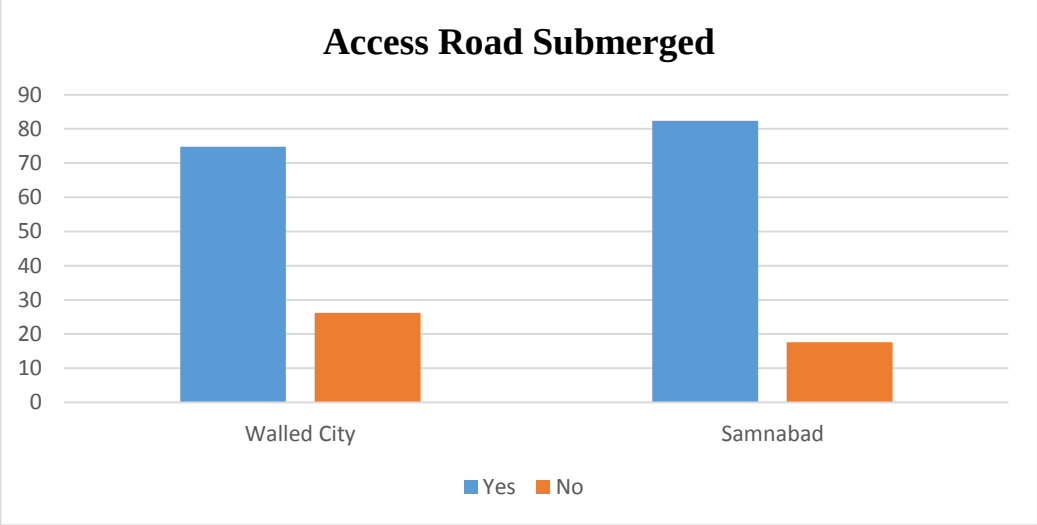


Figure 4.11 Access road submerged

4.13 Height of Flood Water on Access Road:

In the end, we must cater to the problem of the height of Flood Water on Access Road because it can result in cars being struck, sewerage system failing, electric shortcuts and other problems.

Table 4.12 Height of flood water on access road

Meters	**Walled City**		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
0	43	25.6	24	16.9	
1	49	29.2	34	23.9	
2	52	31.0	64	45.1	X2= 9.896
3	19	11.3	19	13.4	Sig= 0.042
4	5	3.0	1	0.7	
Mean	2.37		2.57		
Std dev.	1.075		0.94		

The stats elaborated show that 29.2% of households have about a level of 1-meter water on their access road in the Walled City while 25.6% did not face any such problem. Moreover, 31% of families confronted the challenge of 2 meters, 11.3% of 3 meters, and 3% of 4 meters of height of floodwater on the access road. The statistics of the table also show that in Samnabad, 23.9% of households have about a water level of 1 meter on their access road while 16.9% did not face any such problem. Moreover, 45.1% of families confronted the water level of 2 meters, 13.4% of 3 meters, and merely 0.7% of 4 meters of height of floodwater on an access road. Furthermore, the Chi-Square Test

shows contrast in the statistical analysis of both areas, i.e., Walled City and Samnabad, because the value of the test is less than 0.05, i.e., 0.042 only.

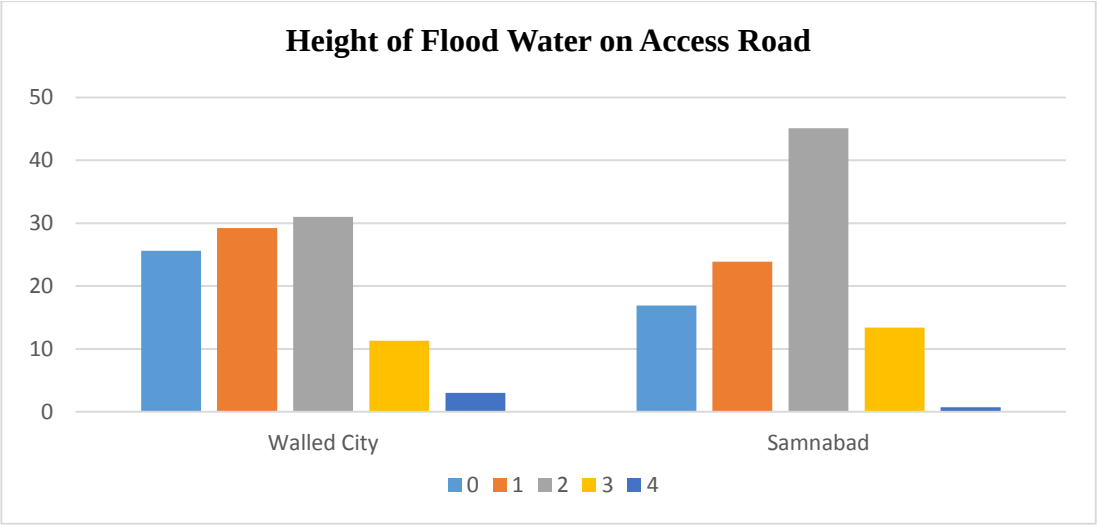


Figure 4.12 Height of flood water on access roads

4.14 Summary of the Chapter:

Descriptive analysis of the survey sample showed more male respondents (87.95%) compared to the female one (12.05%). Most of the respondents answered the questionnaire from the middle age group, i.e., 26-45 (57.7%). The household size in a walled city consists of nuclear families of 7-10 persons with an average income of 72000. Similarly, for Samnabad majority of the families live in the nuclear family system. 3-6 people living together with an average household income of 130000. Comparing the flood dynamics of the two areas, water entered in the houses of walled city has a value of 45%, whereas 60% of the houses in Samnabad has no such problem. On average, the water stayed in homes for the walled city is 1-20 hours with a percentage of 32%, while for Samnabad, the value 28.9%. An average height of the flood, 1m, is observed for the respective areas, while 2m is observed for the access road.

Chapter 5

SOCIO-ECONOMIC IMPACTS OF MONSOON FLOODING

The thesis studies of social sciences primarily focus on the relationship of social and economic factors in any survey. It analyses how the economic factors are shaped by social processes, in turn affecting society holistically. In this particular chapter, the Socio-Economic Impacts of Monsoon Flooding in Walled City and Samanabad are discussed. Approximately 300 were questioned, and their responses are as follows.

5.1 Fear of Monsoon Rain:

The second part of the questionnaire dealt with Likert Scale Evaluation. A Likert scale is a psychometric scale that is widely used in questionnaire-based studies. While there are other forms of rating scales, it is the most commonly used approach to evaluating responses in survey research, to the point where the word (or more fully the Likert-type scale) is mostly used synonymously with the rating scale.

In this particular case, the question was about qualitative analysis of how much people fear the Monsoon Rains resulting in Monsoon Flooding. This preliminary question sets a precedent for other questions to come.

Table 5.1 Fear of Monsoon Rain

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 1.148
Very High	48	28.6	38	26.8	Sig= 0.887
High	21	12.5	23	16.2	
Moderate	47	28.0	36	25.4	
Low	34	20.2	28	19.7	
Very Low	18	10.7	17	12.0	
Mean	2.72		2.74		
Std dev.	1.3		1.361		

As mentioned above, the table shows a point Likert scale data, where it ranges from very high to very low. In Walled City, about 28.6%, i.e., 48 people are afraid of Monsoon Flooding at a very high level, followed by 12.5%, i.e., 21 people fear it at a high level. In addition to this, 28%, i.e., 47 people, fear it at a moderate occurrence. Lastly, 20.2% (34) and 10.7% (18) fear these alarming situations in low and very low emotional analyses, respectively. The second area catered in this study is Samanabad, where 26.8% (38) are afraid of flash flooding at a very high level compared to about 12%, i.e., 17 people who fear this situation at very low levels. People fear flash flooding in high, moderate, and low levels by 16.2%, 25.4%, and 19.7% of the population, respectively. Also, the significant value of the Chi-Square Test is more than 0.05. It is 0.887, which means that there does not exist a significant difference in both areas.

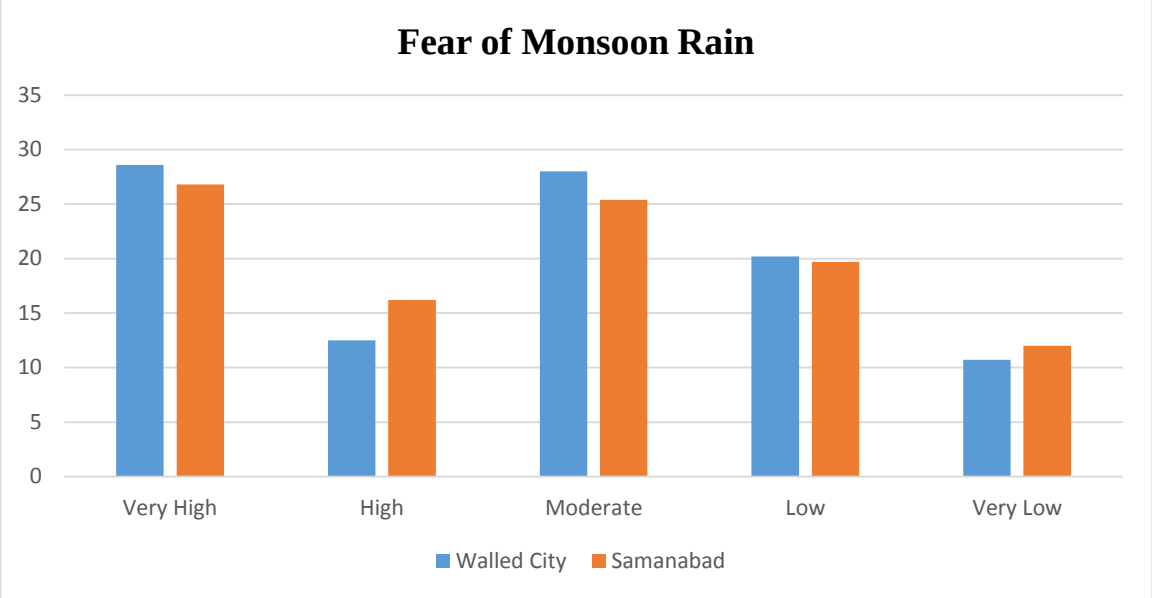


Figure 5.1 Fear of Monsoon Rain

5.2 Perceived occurrence of Flooding:

A critical question is about "how much do you think these monsoon floods can occur in the future?" It is important to know the expected frequency on behalf of the general public because they plan their lives accordingly in the Monsoon season.

Table 5.2 Perceived occurrence of flooding

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 3.701
Very High	36	21.4	24	16.9	Sig= 0.448
High	45	26.8	34	23.9	
Moderate	38	22.6	43	30.3	
Low	44	26.2	34	23.9	
Very Low	05	03	07	4.9	
Mean	2.63		2.76		
Std dev.	1.172		1.142		

The Walled City area being one of the oldest neighborhoods of Lahore, for the most part, faces those situations where urban flooding occurs during Monsoon rains. About 36 people, which makes 21.4%, expect that there will be a very high level of flash flooding in the Monsoon season, and 45 people that make 26.8% expect this at a high level. Next, almost 38 people making 22.6 percent expect this situation at a moderate level. In the end, about 44 people make 26.2%, and 05 people who make 03% expect that flash flooding will occur in the future at low and very low levels, respectively.

As the study moves on to analyze the Monsoon Flooding of the area of Samanabad, about 24 people make 16.9% predict that there will be a very high level of these flooding cases occurring in the future 34 people that makes 23.9% expects them at a high level. Next, almost 43 people making 30.3 predicts this situation at a moderate level. So now, in the end, about 34 people that make 23.9% and 07 people that makes 4.9% predicts at low and very low level respectively that floods will occur in the future.

Also, the Chi-Square Test shows a significant difference in both areas because the value of the test is 0.448, which is less than 0.5.

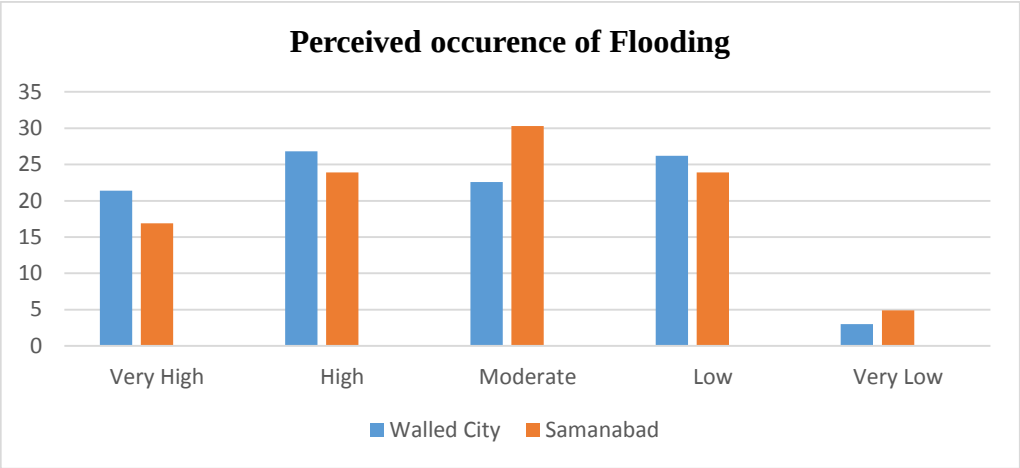


Figure 5.2 Perceived occurrence of flooding

5.3 Frequency of Occurrence:

This particular area of the questionnaire deals with the mental and emotional toll of urban and flash flooding during the Monsoon Rains. One important element is the fear that strikes people when they contemplate the idea of an increased number of Monsoon floods. Following are the answers in this section, which are qualitative because it comprises of Likert test.

Table 5.3 Frequency of occurrence

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 3.331
Very High	60	35.7	39	27.5	Sig= 0.504
High	52	31.0	49	34.5	
Moderate	41	24.4	35	24.6	
Low	11	6.5	14	9.9	
Very Low	04	2.4	05	3.5	
Mean	2.09		2.27		
Std dev.	1.037		1.079		

The table above shows a Point Likert Scale data, ranging from very high to very low. In Walled City, about 35.7%, i.e., 60 people are afraid at a very high level that these floods may happen more often, followed by 31.0%, i.e., 52 people who fear it at a high level. In addition to this, 24.4%, i.e., 41 people, are afraid at a moderate occurrence. Lastly, 6.5%, i.e., 11 people and 2.4%, i.e., 04 people, are afraid of the increased number of flooding at low and very low circumstances, respectively.

The second area catered in this study is Samanabad, where 27.5%, i.e., 39 people, fear that these floods might happen more often while 3.5%, i.e., 05 people, fear its very low levels of flash flooding. The middle levels like high, moderate, and low are feared by 34.5%, 24.6%, and 9.9% of the population, respectively. Also, the significant value of the Chi-Square Test is more than 0.05. It is 0.504, which means that there does not exist a significant difference in both areas.

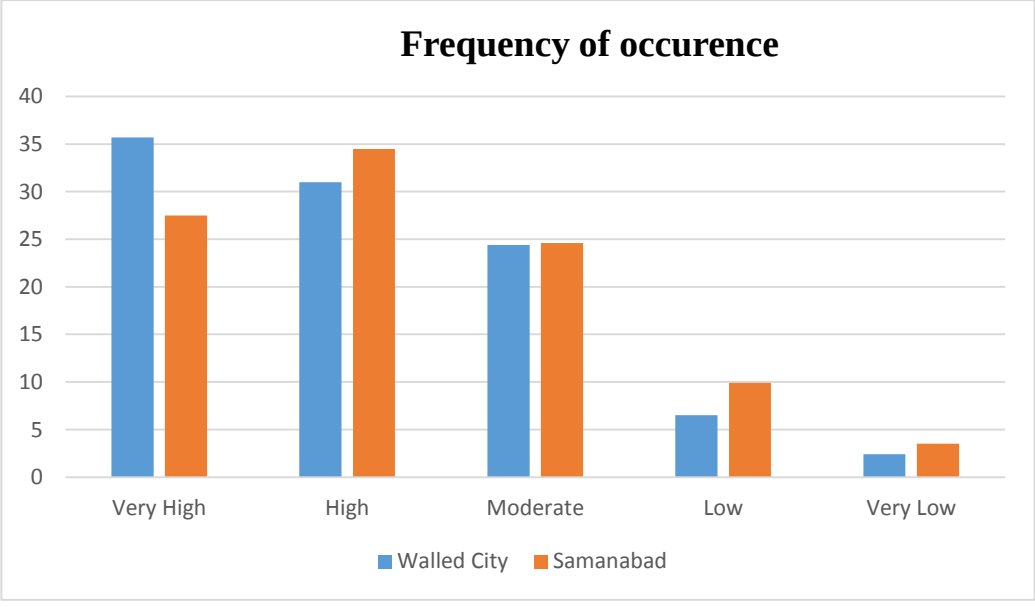


Figure 5.3 Frequency of occurrence

5.4 Loss of Lives:

Moving on with the survey, we qualitatively question people about what they think will be the chances of losing lives in floods. Urban flooding can cause various diseases if the residual water is not catered to, electricity shortcuts, the collapse of infrastructure, and much more. So, it is necessary to know what the general public thinks about this issue.

Table 5.4 Loss of lives

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 5.441
Very High	31	18.5	22	15.5	Sig= 0.245
High	52	31.0	41	28.9	
Moderate	49	29.2	41	28.9	
Low	27	16.1	20	14.1	
Very Low	9	5.4	18	12.7	
Mean	2.59		2.80		
Std dev.	1.123		1.235		

The Walled City area being one of the oldest neighborhoods of Lahore, for the most part, faces situations where unprecedented circumstances can cause loss of lives because of Monsoon rains. About 31 people, who make 18.5% believe that these incidents can happen at a very high level, and 52 people that make 31.0% agree with the situation at a high level. Next, almost 49 people making 29.2 percent believe that people lose their lives in Monsoon floods at a moderate level. Now, in the end, about 27 people that make 16.1% and 09 people, which makes 5.4%, have an idea that almost low and very low level (respectively) of people lose their lives. Furthermore, the Monsoon Flooding of

the area of Samanabad shows about 22 people that makes 15.5% believe that these types of incidents can happen at a very high level, and 41 people that make 28.9% at a high level, resulting in the death of people. Next, again 41 people making up 28.9, the loss of lives in such situations happens at a moderate level. About 20 people make 14.1%, and 18 people make 12.7% agree that people can die because of Monsoon floods low and very low level, respectively. In the end, the Chi-Square Test shows no significant difference in both areas because the value of the test is 0.245, which is more than 0.05.

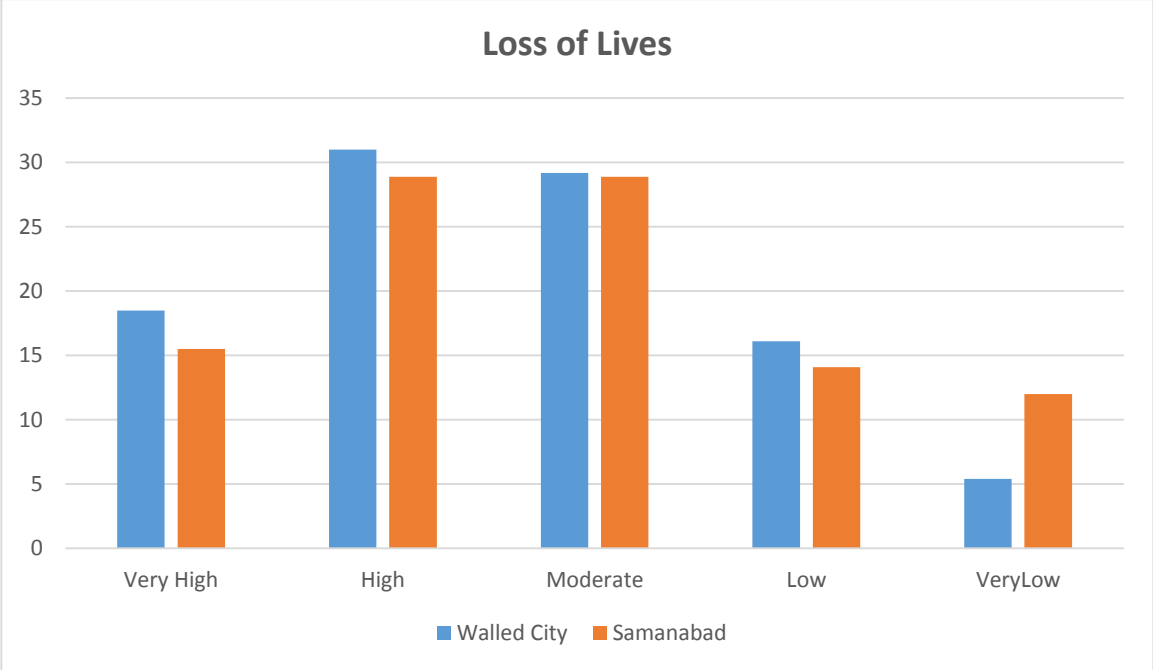


Figure 5.4 Loss of lives

5.5 Future damages to houses:

In addition to this, we question, “What is the likelihood of future damages to house by floods?” The infrastructure of homes is very important to people because it is the said

shelter from the Monsoon rains. So, it is crucial to know what their stance is on this issue.

Table 5.5 Future damages to houses

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 11.915
Very High	46	27.4	27	19	Sig= 0.018
High	55	32.7	37	26.1	
Moderate	45	26.8	47	33.1	
Low	18	10.7	16	11.3	
Very Low	04	2.4	15	11.5	
Mean	2.67		2.28		
Std dev.	1.199		1.055		

The statistics are shown in the above table range from very high to very low, further pictorially represented below in a chart. In Walled City, about 27.4%, i.e., 46 people, took the stance that houses can be damages by Monsoon Rains at a very high level, and 2.4%, i.e., 04 people, believed that houses could be damaged in low and very low circumstances respectively. Now, as the thesis study moves on to the survey of Samanabad, it is observed that 19% of the population took the stance that Monsoon Rains can damage the house at very high levels of flash flooding in comparison of about 11.5% of the population who affirmed it at very low levels of flash flooding. The middle levels like those of high, moderate, and low are followed by 26.1%, 33.1%, and 11.3% of the population, respectively, believing that houses can be damaged. Also, the

significant value of the Chi-Square Test is less than 0.05. It is 0.018, which means that there exists a major difference in both areas.

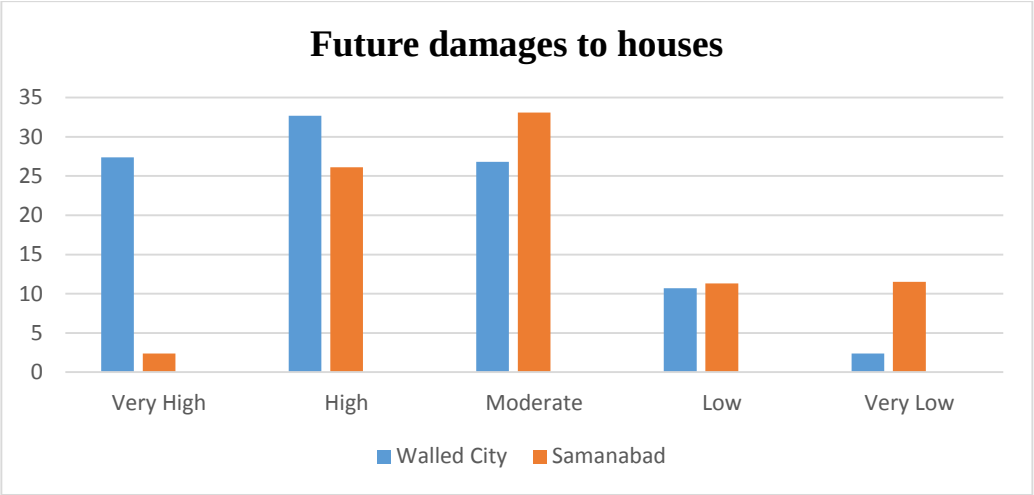


Figure 5.5 Future damages to houses

5.6 Emergency Protocols:

The recuperations are discussed as to what is the level of understanding people have regarding the emergency protocols. The answers are given below:

Table 5.6 Emergency Protocol

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 1.514
Very High	32	19	27	19.0	Sig= 0.824
High	18	10.7	19	13.4	
Moderate	40	23.8	36	25.4	
Low	53	31.5	37	26.1	
Very Low	25	14.9	23	16.2	
Mean	3.11		3.07		
Std dev.	1.328		1.346		

The Walled City area is one of the oldest neighborhoods of Lahore, the infrastructure dates to older times which means more fatal incidents can happen. Only About 32 people make 19% know about the emergency protocols at a very high level, and 18 people make 10.7%, know about them at a high level. Next, almost 40 people making 23.8 percent aware of the emergency protocols at a moderate level. In the end, about 53 people make up 31.5%, and 25 people that make 14.9% understood the emergency protocols at low and very low levels. Moreover, the Monsoon Flooding of the area of Samanabad shows about 27 people that makes 19.0% know about the emergency protocols at a very high level, and 19 people make 13.4% knows about it them at a high level. Next, almost 36 people making up a total of 25.4 percent, are aware of the emergency protocols at a moderate level. Now, in the end, about 37 people that make 26.1% and 23 people, making 16.2%, understood the emergency protocols at low and very low levels, respectively. In the end, the Chi-Square Test shows there is no massive significant difference in both areas because the value of the test is 0.824, which is more than 0.05.

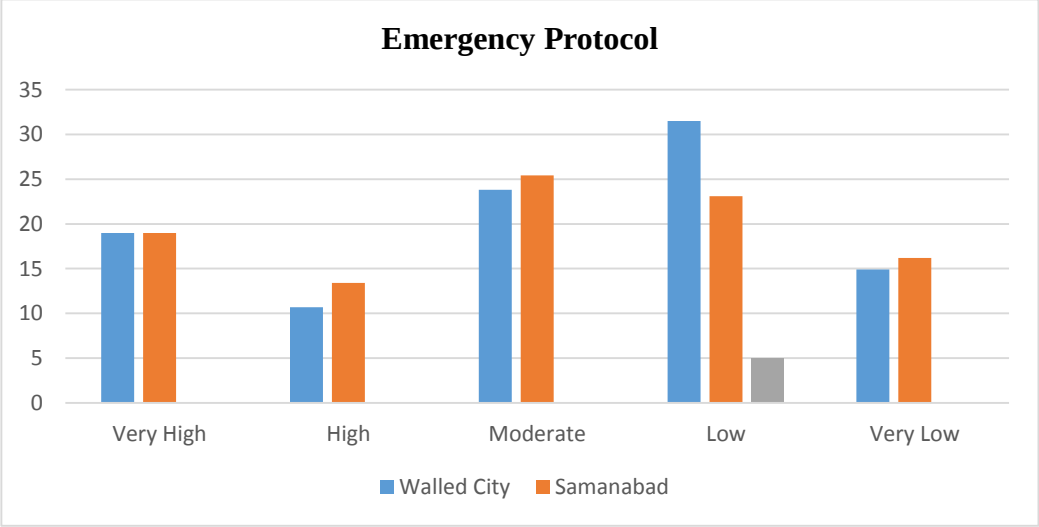


Figure 5.6 Emergency Protocol

5.7 Agree to government policies:

In time monsoon rains, government plays a vital role with its DRR and CC policies. The DRR refers to the disaster risk reduction policies where the government takes active measures to reduce the effects of natural disasters, i.e., urban flooding here. In addition to this, Climate change issues and the strategies to deal with them are also crucial because they deal with the variations in the system. People were asked how much they agree with the government's DRR and CC policies. Their response is as follows:

Table 5.7 Agree to government policies

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2= 0.678
Very High	14	8.3	12	8.5	Sig= 0.954
High	13	7.7	10	7.0	
Moderate	40	23.8	39	27.5	
Low	46	27.4	35	24.6	
Very Low	55	32.7	46	32.4	
Mean	1.239		3.65		
Std dev.	3.68		1.238		

The table above shows a point Likert scale data, ranging from very high to very low. In Walled City, about 8.3%, i.e., 14 people agree with the government's policies at a very high level. In the end, 32.7% of the population agree with the government's strategies of DRR ad CC at a very low level. Moving on to the study of Samanabad, it is observed that 8.5%, i.e., 12 people agree with the government's policies at very high levels compared to the 32.4% of the population who doesn't agree. Also, the significant value

of the Chi-Square Test is more than 0.05. It is 0.954, which is very high, meaning there does not exist a significant difference in both areas.

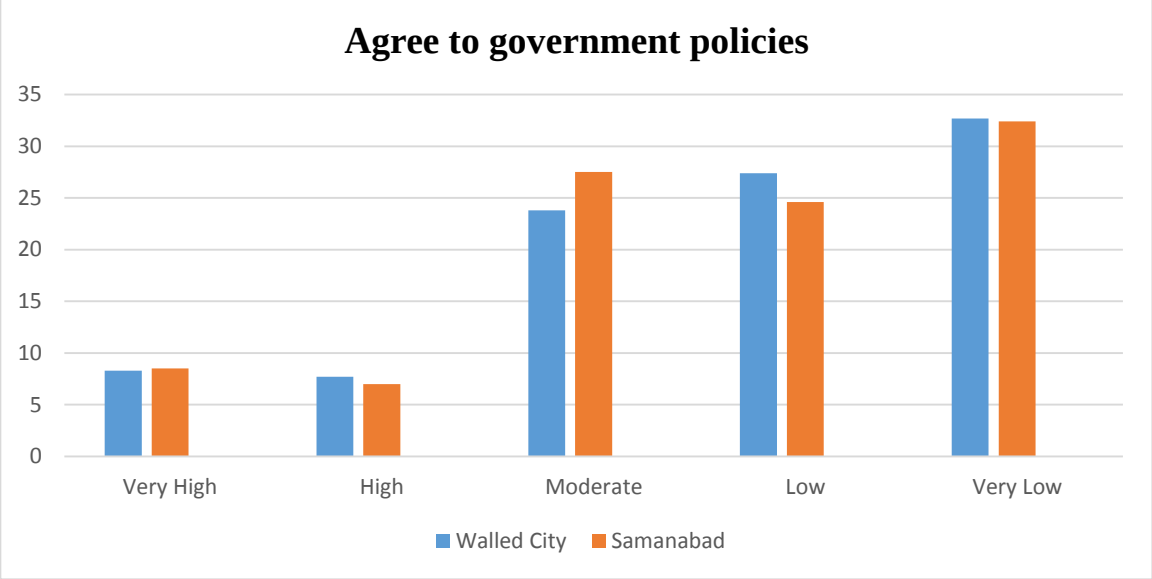


Figure 5.7 Agree to government policies

The following statistics (tables and charts) will be focusing on the opinion of the people about the damaged areas in the community during Monsoon Floods.

5.8 Houses:

Table 5.8 Houses

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	146	86.9	117	82.4	X2= 2.463 Sig= 0.292
No	22	13.1	25	17.6	
Mean	1.13		1.20		
Std dev.	0.338		0.499		

Out of 170 people in Walled City, about 86.9% of people felt that houses were greatly damaged by flash-flooding, while 13.1% felt that it was not much an issue. Also, from approximately 150 people in Samanabad, 117 people felt that houses were damaged. However, 25 felt that they were not. According to the Chi-Square test, there is no significant difference between the localities as the value is 0.292 (> 0.05).

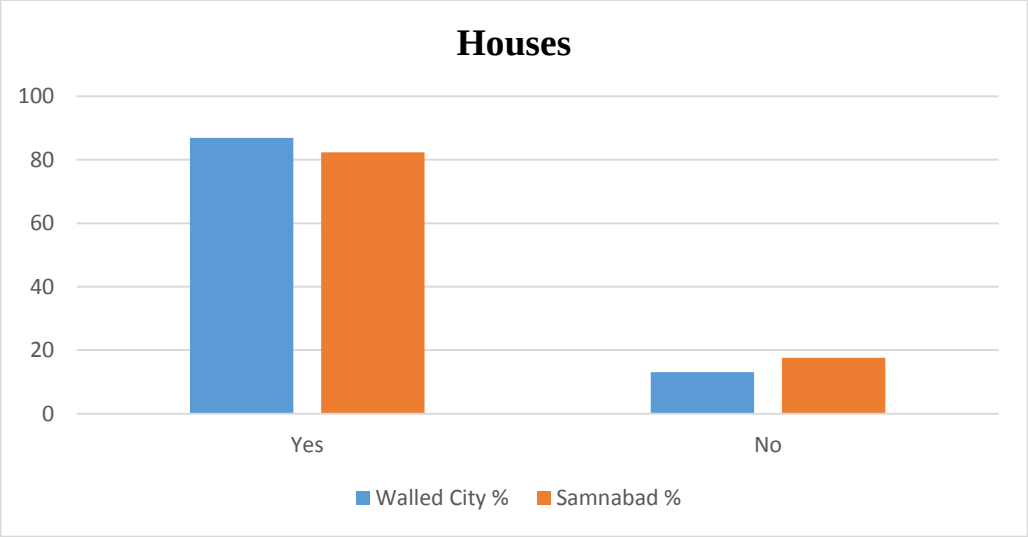


Figure 5.8 Houses

5.9 Schools:

Table 5.9 Schools

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	87	51.8	57	40.1	X2= 5.160 Sig= 0.076
No	81	48.2	85	59.9	
Mean	1.48		1.66		
Std dev.	0.501		0.929		

When the survey asked questions about the damage to schools, the results were almost equal on both sides. In the Walled City Area, 87 people said that schools were damaged, but 81 also said they were not. Then moving on to Samanabad, 57 people believed that schools were damaged, but 85 also believed that they were not. No significant difference existed between both sides because the result of the Chi-Square test was 0.076.

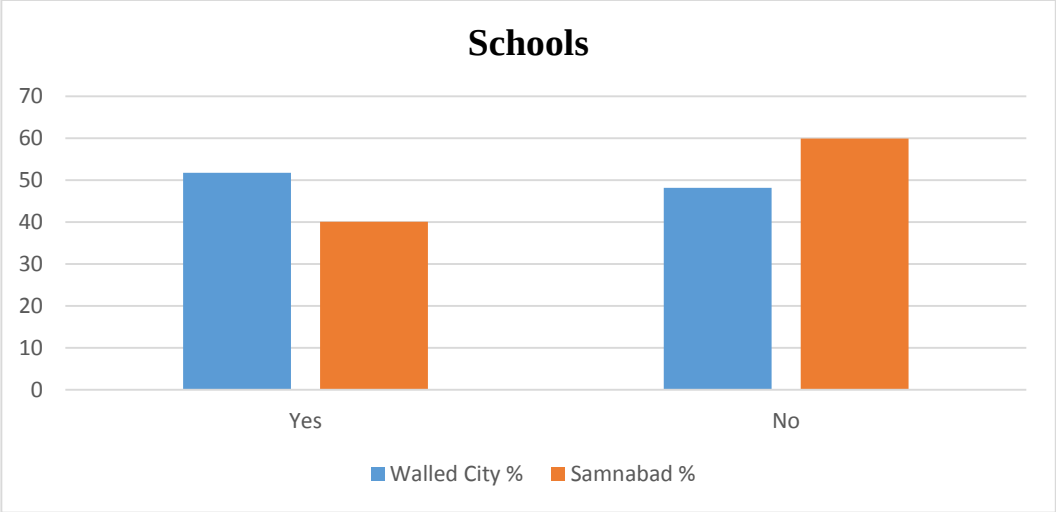


Figure 5.9 Schools

5.10 Shops:

Table 5.10 Shops

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	78	46.4	75	52.8	X2= 2.369 Sig= 0.306
No	90	53.6	67	47.2	
Mean	1.53		1.47		
Std dev.	0.512		0.501		

The market areas in the localities of Walled City and Samanabad are old and congested. So due to the Monsoon Rains, 46.6% of people in Walled City and 52.8% in Samanabad feel that the shops will be damaged by flooding. However, 53.6% of people in Walled City and 47.2% in Samanabad feel that the shops will not be damaged. No significant difference exists because the value of the chi-square test is 0.306, which is less than 0.05.

Figure 5.10 Shops

5.11 Offices:

Table 5.11 Offices

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	33	19.6	26	18.3	X2= 0.885 Sig= 0.643
No	135	80.4	116	81.7	
Mean	1.80		1.82		
Std dev.	0.418		0.388		

When questioned about the offices, almost 33 people, making a 19.6%, believed that offices would be damaged in Walled city while 135 people making 80.4%, believed that they would not be damaged. On the other hand, 26 people making 18.3%, believed that offices would be damaged in Samanabad, while 116 people were making 81.7% that they will not be damaged. The difference in both parts of city Lahore is not significant, according to the Chi-Square Test. Its value is 0.643.

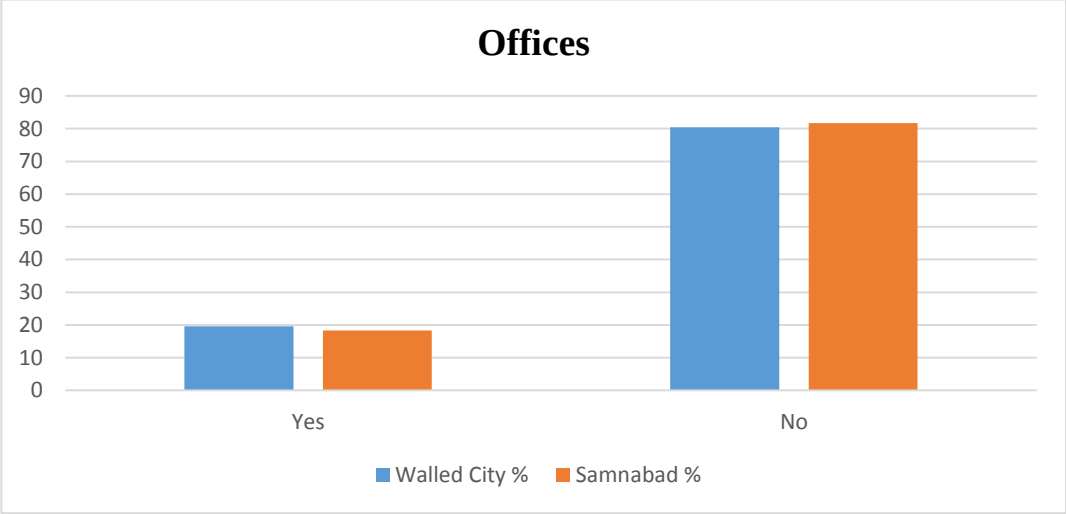


Figure 5.11 Offices

5.12 Parks:

Table 5.12 Parks

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	108	64.3	96	67.6	X2= 0.425 Sig= 0.512
No	60	35.7	46	32.4	
Mean	1.36		1.32		
Std dev.	0.481		0.470		

Parks are important recreational spots for the residents of any community. So, when the survey questioned if the damage could occur to parks, 108 people in Walled City and 96 people in Samanabad replied in affirmative. O the contrary, 60 and 46 people negated the idea in Walled City and Samanabad, respectively. Moreover, the Chi-Square Test does not show a major and heavy difference in both areas of Lahore because the value of the test is 0.512 only. This significant value is more than 0.05.

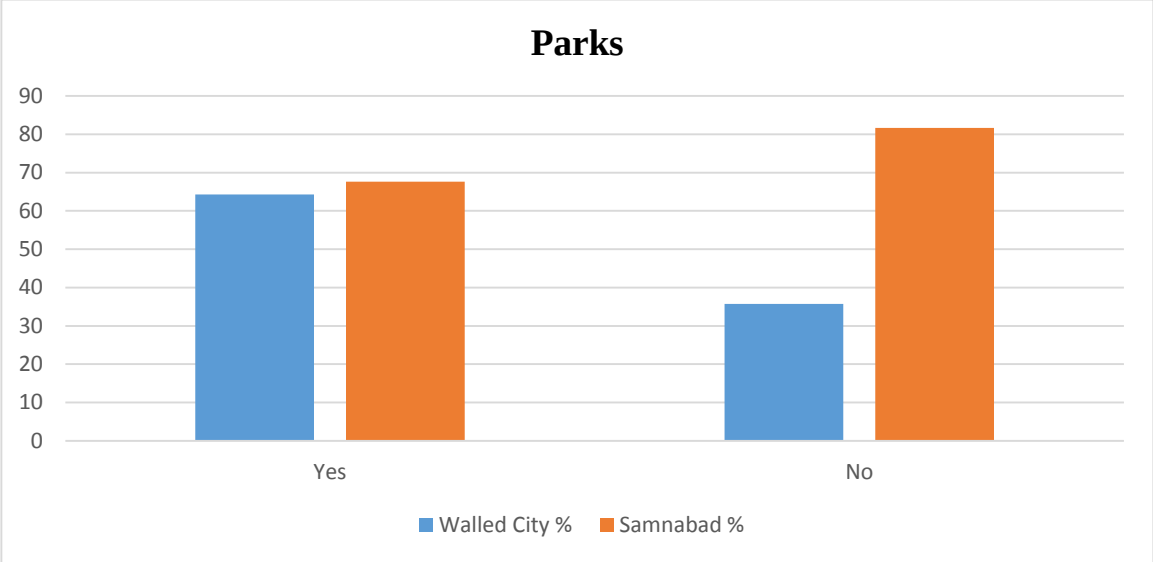


Figure 5.12 Parks

5.13 Water & Gas:

Urban flooding in areas of Lahore can primarily affect the day-to-day utilities such as Water and Gas. The underground pipelines for both of these can get affected along with issues of sewerage and low gas availability.

Table 5.13 Water and Gas

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	70	41.7	49	34.5	X2= 1.668 Sig= 0.197
No	98	58.3	93	65.5	
Mean	1.58		1.65		
Std dev.	0.494		0.477		

According to the statistical analysis, it clear that people in Walled city believe up to the extent of 41.7% that water and gas facilities are affected. In comparison, 58.3% believe that they are not. On the other hand, 34.5% of people in Samanabad responded that their water & gas facilities are affected during heavy monsoon flooding. Moreover, the Chi-Square Test shows no difference in both areas of Lahore because the value of the test is 0.197. This significant value is more than 0.05.

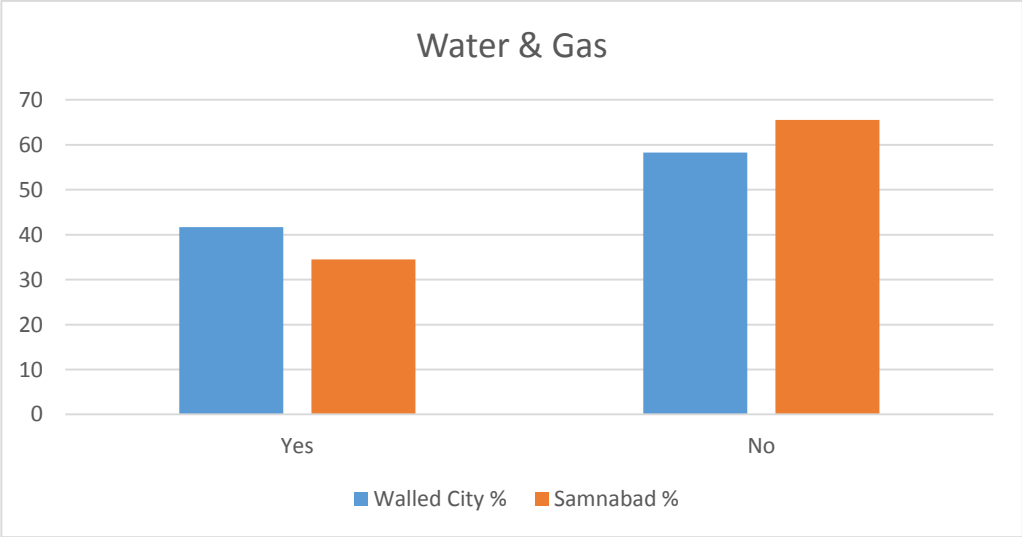


Figure 5.13 Water & Gas

5.14 High Tension Lines:

HT lines mean High Tension Lines or High Voltage Lines used for the transmitting of Electricity. In the major localities of Lahore, the HT lines are naked and unprotected, where they can affect the lifestyle of people in the Monsoon season. This could lead to issues of short circuits, where the residents' electricity supply can be damaged.

Table 5.14 Heigh tension lines

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	113	67.3	84	59.2	X2= 2.183 Sig= 0.140
No	55	32.7	58	40.8	
Mean	1.33		1.41		
Std dev.	0.471		0.493		

When the survey asked questions about the damage to electricity supply and HT Lines, the results were almost equal on both sides. In the Walled City Area, 113 people said that HT lines were damaged, but 55 also said that they were not. Then moving on to Samanabad, 84 people believed that HT lines were damaged, but 58 also believed that they were not. No significant difference existed between both sides because the result of the Chi-Square test was 0.140.

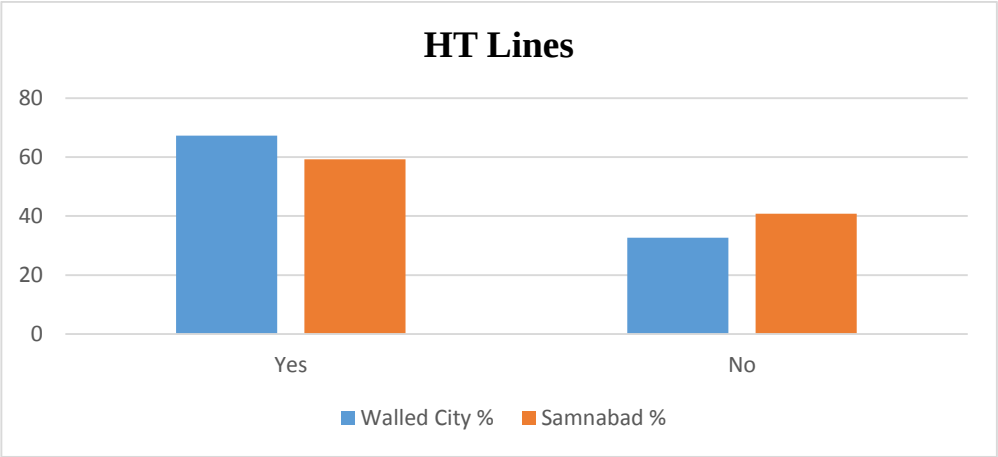


Figure 5.14 High Tension Lines

5.15 Telephone:

In Pakistan, people still use the Telephone as one of the primary modes of communication in households. However, the technology used by PTCL still dates to older times, where telephone poles and wires are not insulated properly. Moreover, it is observed that the wires are naked many times, which causes distortion in phone lines, and heavy rainfall can cut off the phone and internet facilities. Following are the views of people living in both Walled City and Samanabad on whether the telephone lines are affected or not.

Table 5.15 Telephone

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	134	79.8	109	76.8	X2= 0.409 Sig= 0.522
No	34	20.2	33	23.2	
Mean	1.20		1.23		
Std dev.	0.403		0.424		

So, when the survey questioned if the damage could occur to the telephone poles and wiring, 134 people in Walled City and 109 people in Samanabad replied in affirmative. On the contrary, 34 and 33 people negated the idea in Walled City and Samanabad, respectively. Moreover, the Chi-Square Test does not show a major and heavy difference in both areas of Lahore because the value of the test is 0.522 only. This significant value is more than 0.5.

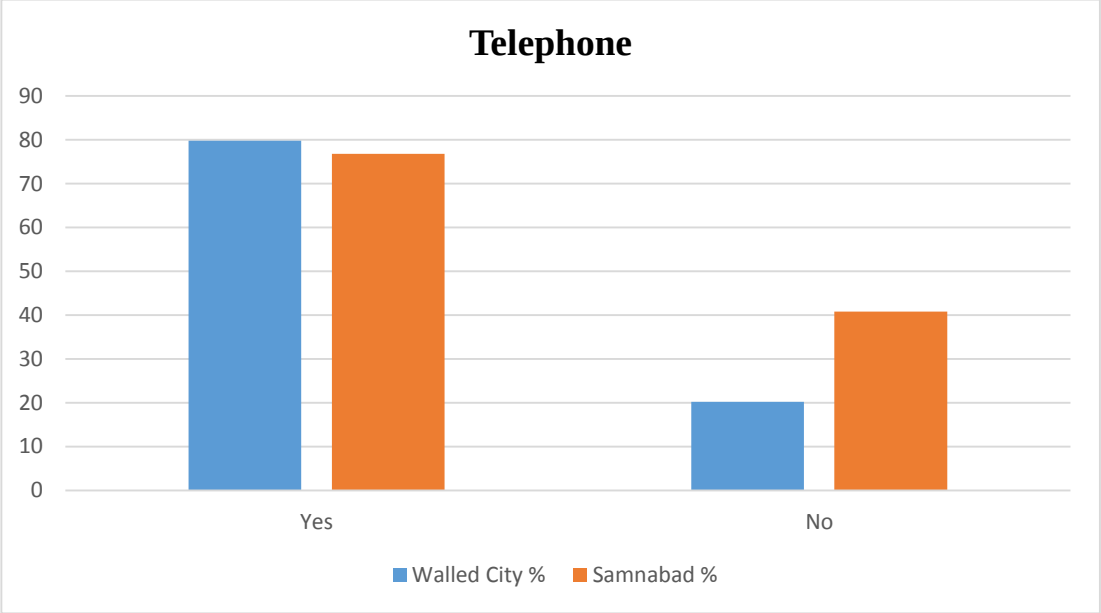


Figure 5.15 Telephone

5.16 Electricity:

When electricity issues are discussed, grid stations, electric poles, HT and LT wires, transformers, and much more come into play because all these utilities can be affected. Even though Governmental departments like WAPDA and WASA work effectively in Lahore during the Monsoon Rain Season, electricity gets cut off in major areas for long periods due to old equipment and poor management.

Table 5.16 Electricity

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	141	83.9	113	79.6	X2= 0.984 Sig= 0.321
No	27	16.1	29	20.4	
Mean	1.16		1.20		
Std dev.	0.368		0.405		

When the survey asked questions about the damage to the electricity supply, the results were almost equal on both sides. For example, in the Walled City Area, 141 people making up 83.9%, said that electricity facility is affected by rainfall and urban flooding, but 27 people make up 16.1% also said that they were not. Then moving on to Samanabad, 113 people making up 79.6%, believed that the electricity facility was damaged, but 29 people making up 20.4%, also believed that they were not. No significant difference existed between both sides because the result of the Chi-Square test was 0.321 (>0.05).

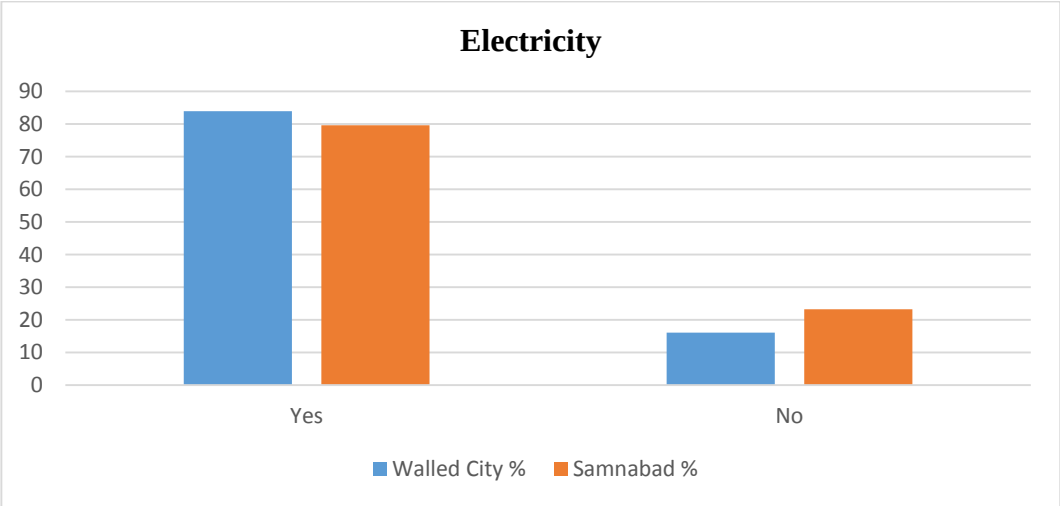


Figure 5.16 Electricity

5.17 Travel Route:

One important factor to take care of is the travel route which comprises main and supplementary roads in any locality. Monsoon Rains in Lahore can majorly hit these travel routes because of stagnant water, over-flowing sewerage water, and loss of stability to the roads because of exposure to water for longer times. In addition to this, many areas like Walled City and Samanabad do not have proper roads and walkways, so urban flooding can cause muddy pathways that affect local residents' movement.

Table 5.17 Travel Route

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	141	83.9	123	86.6	X2= 0.441 Sig= 0.507
No	27	16.1	19	13.4	
Mean	1.16		1.13		
Std dev.	0.368		0.342		

The above-mentioned statistical analysis from the survey asked questions about the damage to travel routes. Here, once again, the results were almost equal on both sides. For example, in the Walled City Area, 141 people (about 83.9%) said that travel routes were damaged, but 27 people (about 16.1%) also said they were not. Then moving on to Samanabad, 123 people (about 86.6%) believed that travel routes were damaged, but 19 people (about 13.4%) believed that they were not. A significant difference does not exist between both sides because the result of the Chi-Square test was 0.507.

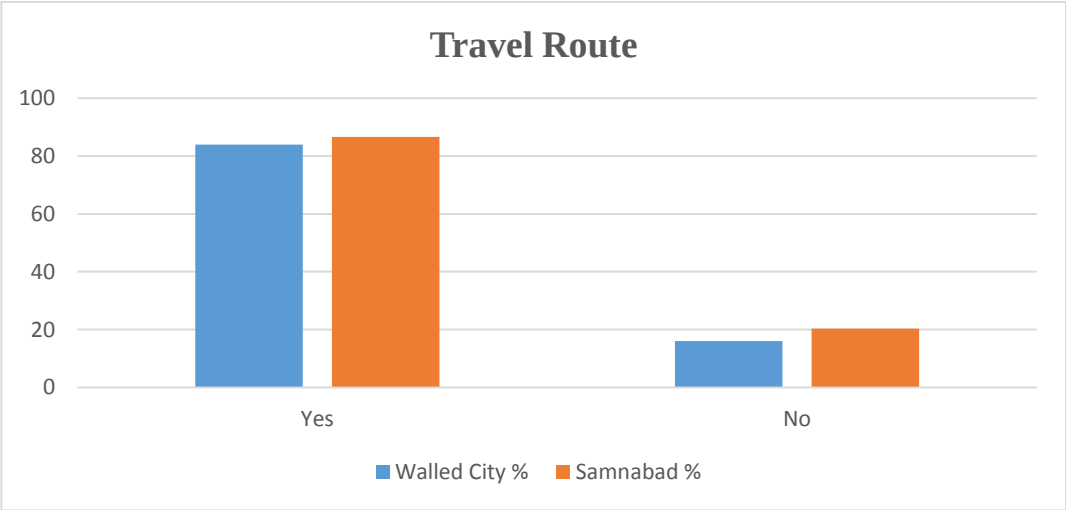


Figure 5.17 Travel Route

5.18 HH Property:

The household property, like electrical appliances and furniture, can be greatly affected by urban flooding. As the water enters the houses and stays there for hours or days, it can damage basic household property. This poses a discomfort to the daily lifestyle of people.

Table 5.18 Household Property

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	125	74.4	100	69.7	X2= 2.103 Sig= 0.349
No	43	25.6	43	30.3	
Mean	1.26		1.33		
Std dev.	0.438		0.585		

It is quite clear from the table above that 125 people in Walled City and 100 people in Samanabad affirm the idea the Household property is majorly damaged by urban

flooding and monsoon rains. On the other hand, 43 people in both localities believe that HH property is not damaged. According to the Chi-Square test, there exists no significant difference in both areas, as the value is 0.349, which is more than 0.05.

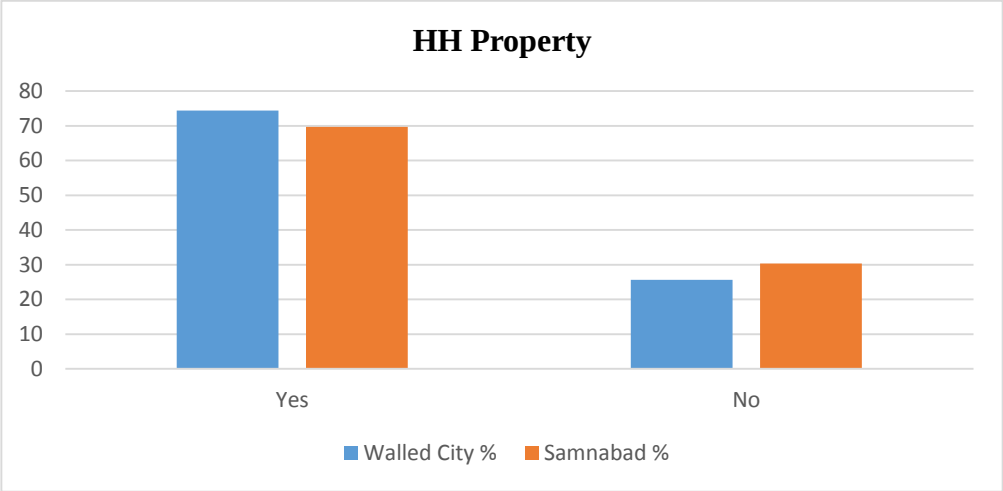


Figure 5.18 Household Property

A key point in Disaster Risk Management Situations such as urban flooding or flash flooding is to prepare for unforeseen circumstances beforehand. It is always considered better to be safe than sorry, so it is customary on parts of residents who are likely to be victims of such issues to have education and training to prepare them for the crisis. In addition to this, this preparedness can help them achieve better results in terms of crisis solving.

5.19 Attend Training:

The survey conducted asked people to respond to their level of preparedness for flash flooding elaborately. People were asked if they were given any training by school/NGO/Government for flood preparedness purposes. It could range from simple awareness campaigns to full-fledged mock drills. The results are as follows:

Table 5.19 Attend Training

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	37	22.0	21	14.8	X2= 2.649 Sig= 0.104
No	131	78.0	121	85.2	
Mean	1.78		1.85		
Std dev.	0.416		0.356		

Expounding the statistical data in the above table means that in the area of Walled City, about 22.0 percent of people, which is about 37 people received some kind of awareness and training for preparing for urban flooding situation. While 78.0 percent of people, which is about 131 people, did not receive any such training. Simultaneously, about 14.8 percent of people did receive training in Samanabad, while around 85.2 percent of people did not. Overall, the significant difference between both these localities is critically present as the value is 0.104 (of Chi-Square Test), which is less than 0.5.

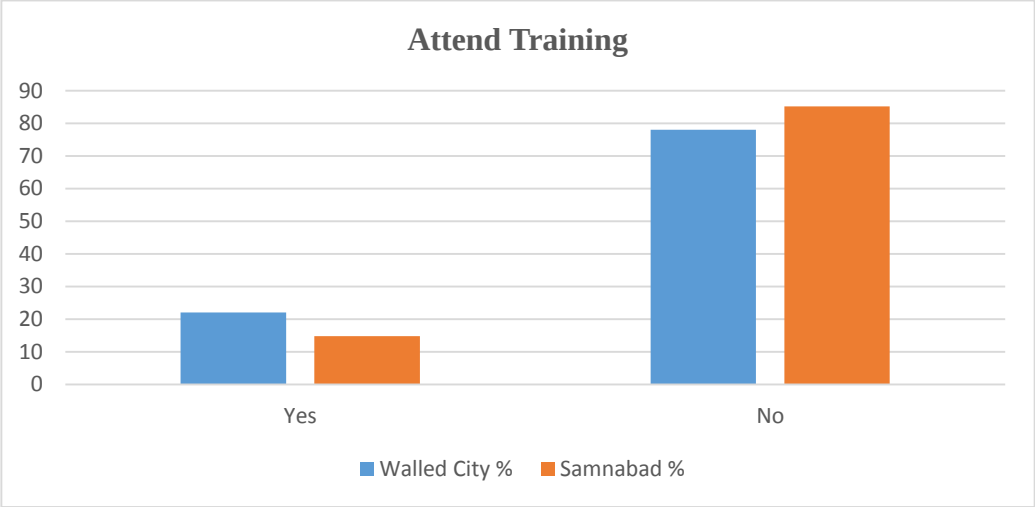


Figure 5.19 Attend Training

5.20 Taught Family:

In social science surveys, it is important to know the number of people who were aware of methods to deal with a crisis. For example, about 320 people were asked if they have taught their families appropriate measures in case of flood, like dealing with electricity issues, safeguarding the furniture, cutting power to electric appliances, taking care of sewerage issues, etc.

Table 5.20 Taught Family

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	49	29.2	41	28.9	X2= 0.003 Sig= 0.955
No	119	70.8	101	71.1	
Mean	1.71		1.71		
Std dev.	0.456		0.455		

The table above clearly shows that only about 29.2% (i.e., 49 people) in Walled City and 28.9% (i.e., 41 people) in Samanabad have taught their families about risk preparedness. However, a major portion of the population, like 70.8% people in the Walled City and 71.1% people in the Samnabad, did not teach any preventive measures or strategies to their families. To elaborate, there does not exist any significant difference between both areas because the value is 0.955.

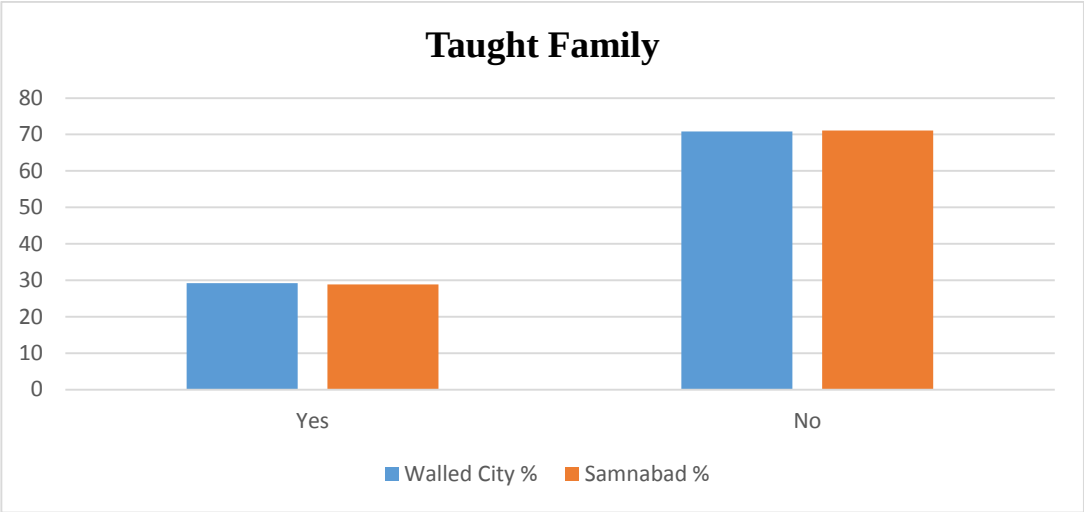


Figure 5.20 Taught Family

5.21 First Aid Training:

The basic idea of First aid is the first and immediate assistance given to any person who is suffering from a mild or significant illness or injury, with care given to save a life, prevent or encourage rehabilitation from worsening the condition. People must receive training for this basic yet critical skill of lifesaving. The surveyed people were asked if they have ever had any sort of first aid training, their responses are given below.

Table 5.21 First Aid Training

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	54	32.1	36	25.4	X2= 1.722 Sig= 0.189
No	114	67.9	106	74.6	
Mean	1.68		1.75		
Std dev.	0.468		0.437		

The above-mentioned statistical analysis from the survey asked questions about the first aid training. Here, the results were slightly in both areas. In the Walled City Area, 54

people (about 32.1%) said they had received some sort of first aid training, but 114 people (about 67.9%) also said they were not given any such training. Then moving on to Samanabad, 36 people (about 25.4%) believed that first aid training was given, but 106 people (about 74.6%) believed that they were not. No significant difference exist between both the sides because the result of the Chi-Square test is 0.180 (>0.05.)

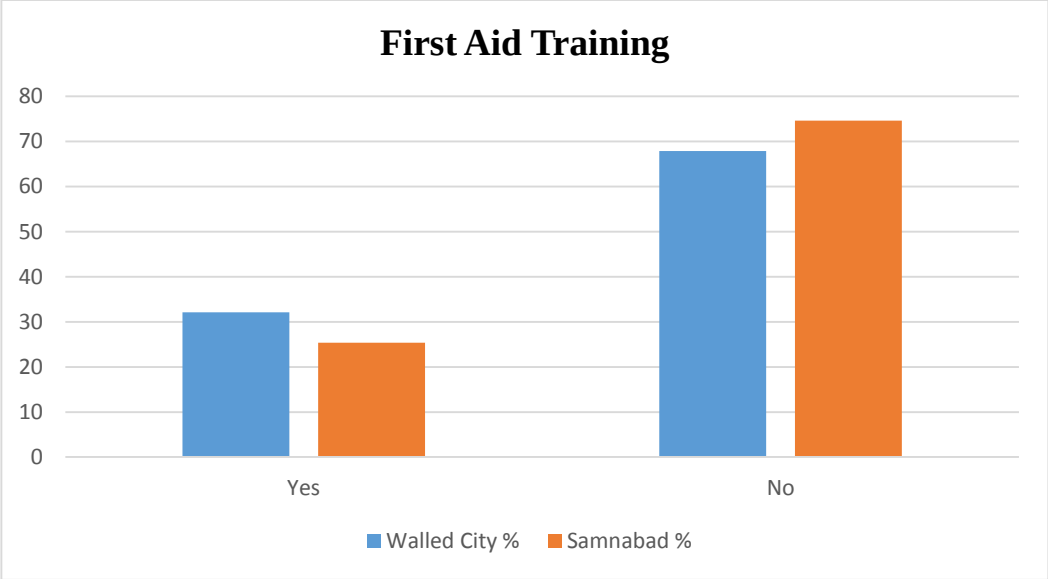


Figure 5.21 First Aid Training

5.22 Mock Drills:

It is vital that people are sensitized to emergency situations like a flood, fire, earthquake, tsunami, and many more. So, after recognizing the gaps between the risk management situations, mock drills and exercises should be performed to teach emergency preparedness, maximum resource usage, mobilization of organized operations, and related aspects. Around 320 people were asked in this survey if they have ever attended mock drills in terms of flash flooding issue.

Table 5.22 Mock Drills

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	35	20.8	25	17.6	X2= 0.514 Sig= 0.474
No	133	79.2	117	82.4	
Mean	1.79		1.82		
Std dev.	0.401		0.382		

The comparative analysis of both the area of Lahore shows statistically that 35 people (20.8%) have participated in mock drills and rehearsals for the purpose of flood prepared. In contrast, 133 (79.2%) did not participate in these drills in the area of Walled City. Moving on, about 25 people (17.6%) in Samanabad took part in these mock drills and exercises. However, a major chunk like 117 people (82.4%) did not attend these flood preparedness drills. There is no difference in the areas because the significant value of the Chi-Square Test is 0.474, which is more than 0.05.

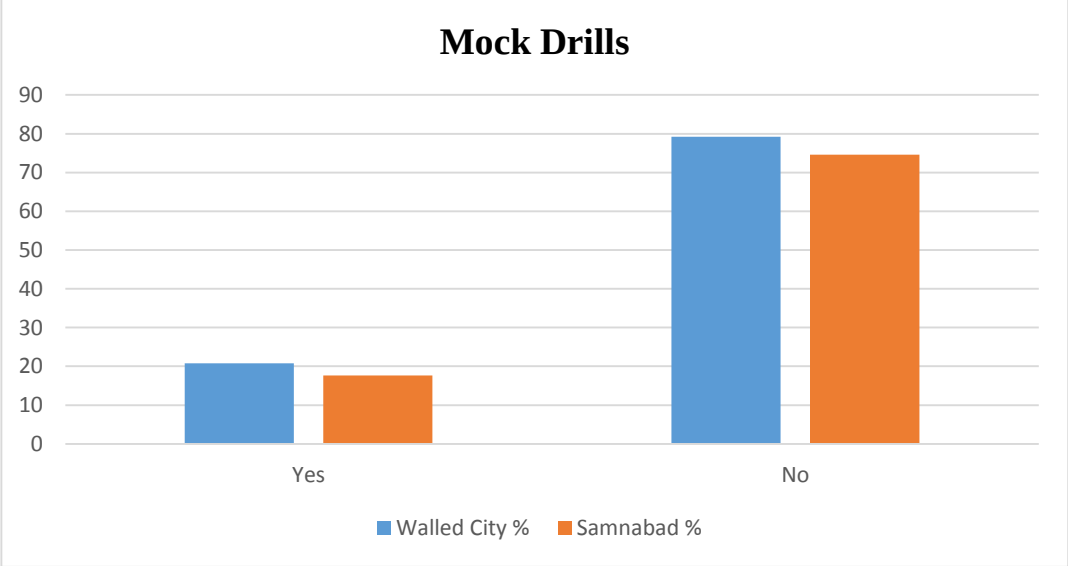


Figure 5.22 Mock drills

5.23 Read Preparedness:

An important factor in preparing people for these disaster situations like urban or flash flooding is the mode of communication. The way through which the audience was approached. In the current world of free media and digitization, people can be enlightened about these situations in numerous ways like Newspapers, Radio, Television, Electronic Media, etc.

Table 5.23 Read Preparedness

	Walled City		**Samanabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	X2=
Newspaper	07	4.2	14	9.9	36.976
Radio/Tv	20	11.9	25	17.6	Sig= 0.000
Electronic Media	38	22.6	56	39.4	
Other	14	8.3	19	13.4	
No where	89	53.0	28	19.7	
Mean	3.94		3.15		
Std dev.	1.270		1.216		

When people were asked about their way of receiving news about these sensitive issues, 07 and 14 people in Walled City and Samanabad were enlightened through newspapers, respectively. Moving on, 20 people in Walled City and 25 people in Samanabad were updated through Radio or TV. Electronic Media garnered the most audience in both localities; 38 people in Walled City and 56 people in Samanabad. However, 89 people (i.e., 53%) in Walled City and 28 people (i.e., 19.7%) in Samanabad had no idea about reading preparedness. Furthermore, the significant difference is of great magnitude because the value is exactly 0.00.

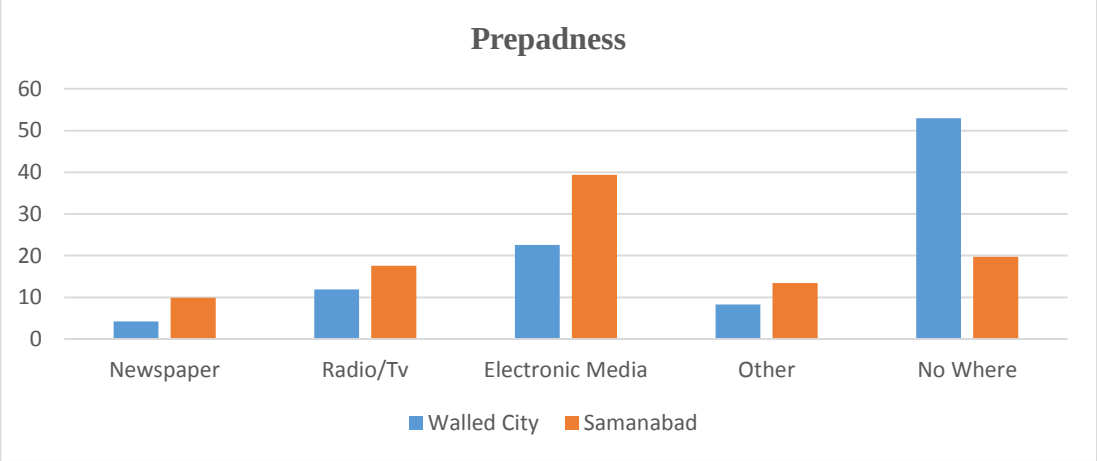


Figure 5.23 Read Preparedness

5.24 Summary:

Analysis of surveyed data reveals that people in both areas (Walled city & Samnabad) have developed a great fear of Monsoon flooding. Also, they think that the number of Monsoon flooding will increase as time will progress as our sewer systems, and other policies don't have enough capacity to withstand the catastrophic flood effects. A high percentage of surveyed areas believe that the risk of losing life and their houses in the future due to flood effects are more. A very low percentage of the population follows emergency protocols required for flooding. According to people, the Socioeconomic damage to the property is in the descending order of House>Parks>School>Shops>Offices. And similarly, for amenities is Travel Route>Electricity>Telephone>Household Property>HT Lines>Water/Gas. A low percentage of people have any kind of mock drills or first aid training for preparedness against flood and blames the government for not organizing such activities.

Chapter 6

PREPAREDNESS AND ADAPTATION STRARIGES AGAINST MONSOON FLOODING

6.1 Background:

One crucial aspect of risk management and disaster handling in situations is to prepare for the unfortunate circumstances in time. The survey conducted focuses heavily on this forte of preparedness that deals with resources and responses of the general public. This deals with the food and water supplies, first aid kits, money, and emergency numbers that people have as resources for rainy days because they are utterly needed and required for sustainability. In addition to this, light is also shed upon how many stakeholders, i.e., the government, civil departments, and military, help out the people. Holistically, it examines all the areas of preparedness and adaptation strategies against Monsoon Flooding.

6.2 Preparedness:

6.2.1 Food and Water:

Food and Water is a basic necessity of life required by every human being. During floods, most people suffer from various diseases by consuming spoiled food and water contaminated by floodwater. Therefore, it is important to throw away the food contaminated by floodwater. Similar such water is not safe for drinking even after

boiling or disinfection. Only approved containers should be used to store water in such a situation, and packed / canned food should be stored for the needy.

Table 6.1 Food & Water

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	107	63.7	88	62.0	X2= 0.97 Sig= 0.755
No	61	36.3	54	38.0	
Mean	1.36		1.38		
Std dev.	0.482		0.487		

The above table shows the comparative analysis of the Walled City and Samnabad. About 63.7% of people of the Walled city store food and water during the monsoon season, while 62% is the value for the people in Samnabad. In the past, people had faced a lot of inconvenience due to contaminated food and water during the flooding season. Therefore, about more than 60% of the surveyed population store food and water for rainy days. The Significant value for the Chi-square test is 0.755, which is greater than 0.05, which shows there is no difference between the opinions of the people in these two areas.

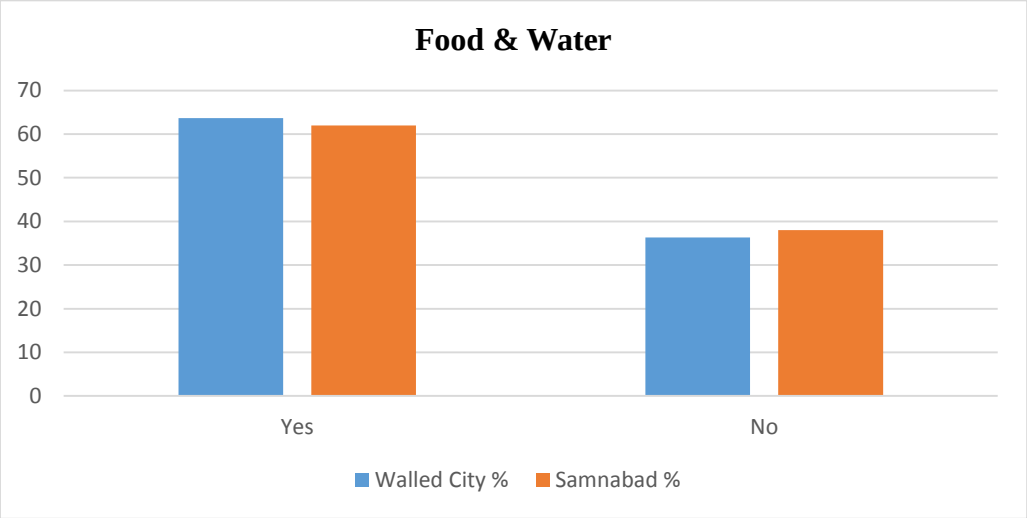


Figure 6.1 Food & Water

6.2.2 Money:

There is a concept of home insurance that basically covers your property damages, but it is not applicable to floods. Therefore, in many countries, flood insurances are offered. However, in Pakistan, such policies are not very common; therefore, people on their own save money for a disastrous or calamitic situation, which helps them in repairing property damages, health injuries, etc.

Table 6.2 Money

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	29	17.3	34	23.9	X2= 2.122 Sig= 0.145
No	139	82.7	108	76.1	
Mean	1.83		1.76		
Std dev.	0.379		0.428		

Figures in the table show that about 17.3 % of people in the Walled City and 23.9 % of people in Samnabad save money for flood damages. Such a low percentage (for saving money) is that the average household income of the Walled City is 72000 and that of Samanbad is 130,000. According to people, which is not enough for doing savings as they hardly fulfill their household necessities (utilities, grocery, education, etc.) in the earned money. 0.145 value of chi-square shows there is no significant difference as the value is less than 0.05.

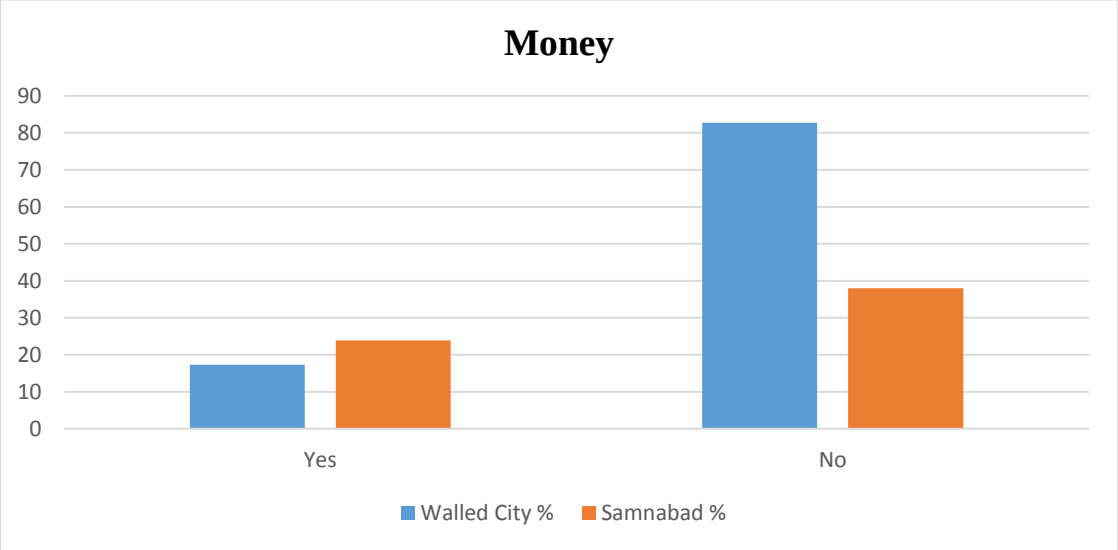


Figure 6.2 Money

6.2.3 First Aid Kit:

The First Aid kit is very important and provides essential items which help in surviving any unforeseen events. It must include bandages, gauze, antiseptic wipes, basic medicine, etc., and should be placed where it is easily accessible by adults but not by children.

Table 6.3 First Aid Kit

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	81	48.2	76	53.5	X2= 0.867 Sig= 0.352
No	87	51.8	66	46.5	
Mean	1.52		1.46		
Std dev.	0.501		0.501		

Statistical values of the table show that 48.2 % of people in the Walled City and 53.5% of people in Samnabad prepare first aid kits in their homes in case of emergency. In addition to this chi-square test shows the value of 0.352, which means there is a significant difference.

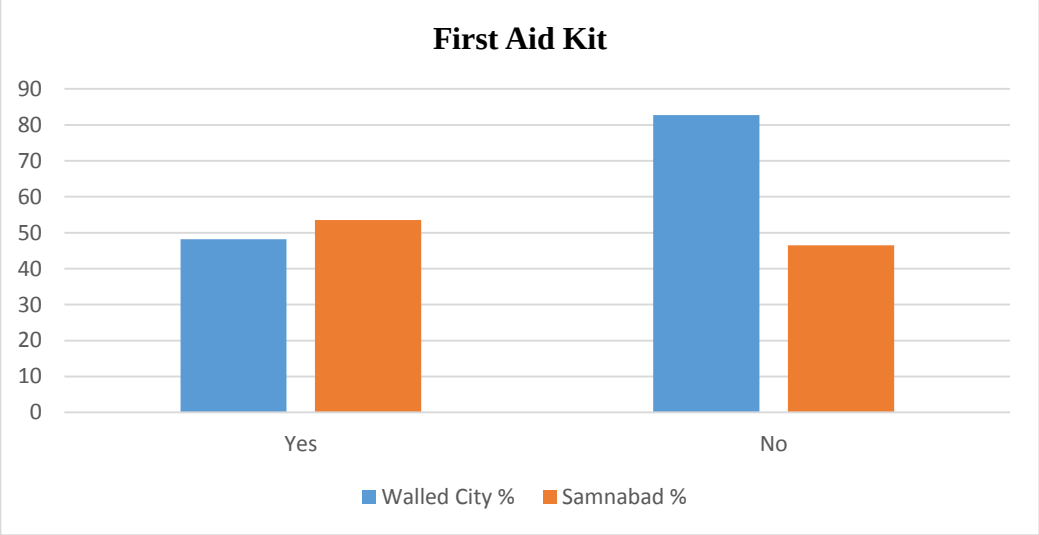


Figure 6.3 First Aid kit

6.2.4 Mosquito Net:

A very big issue faced by people after the flood is the mosquitoes. Mosquitoes produced from the stagnant flood water are less dangerous but are very hard to control. Their bite is fierce and is the cause of spreading many diseases. In order to avoid such a situation,

stagnant water should be immediately cleaned up outsides' homes in the parks, etc., and people should have a stock of mosquito nets and repellents in their homes.

Table 6.4 Mosquito Net

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	35	20.8	46	32.4	X2= 6.644 Sig= 0.036
No	133	79.2	96	67.6	
Mean	1.86		1.68		
Std dev.	0.884		0.470		

The above table shows that about 20.8% of people in the Walled City keep mosquito nets in their homes, while for Samnabad, the value is a little bit high, i.e., 32.4%. But when comparing both the area on preparedness grounds, the value is below 50%, which means people still need education and awareness regarding flash floods. The reason for such a low percentage is the lifestyle of families. In the olden time, people used to sleep in verandas (sehan) in the open air, where the likelihood of getting infected by mosquitoes was high. Nowadays, Air conditioners have restricted people from their homes, along with different mosquito-killing remedies (Mats, sprays, night liquids) that have made people fearless from mosquitoes. However, the chi-square value is 0.036, which means there is a significant difference.

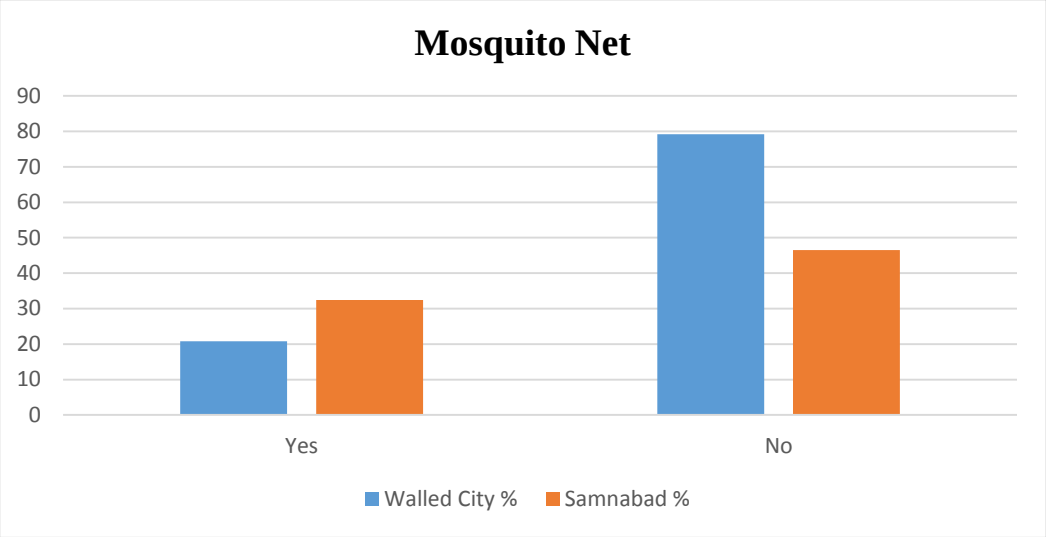


Figure 6.4 Mosquito Net

6.2.5 Emergency Numbers:

Floods can cause serious damages and can be fatal. A heavy flood can cause property damage (which sometimes results in loss of life.), breakdown of powerhouses, traffic jams, etc. In order to keep oneself prepared for the worst-case scenario, emergency numbers of rescue organizations, disaster helplines should be saved for the time of need.

Table 6.5 Emergency Numbers

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	60	35.7	53	37.3	X2= 0.086 Sig= 0.769
No	108	64.3	89	62.7	
Mean	1.64		1.63		
Std dev.	0.481		0.485		

The table shows the value of35.7% and 37.3%for Walled City and Samnabad, respectively. A few save emergency numbers, and while the remaining 60% of the lot suffers when first aid is not provided on time due to 0.769, the significant value for the chi-square shows no significant difference.

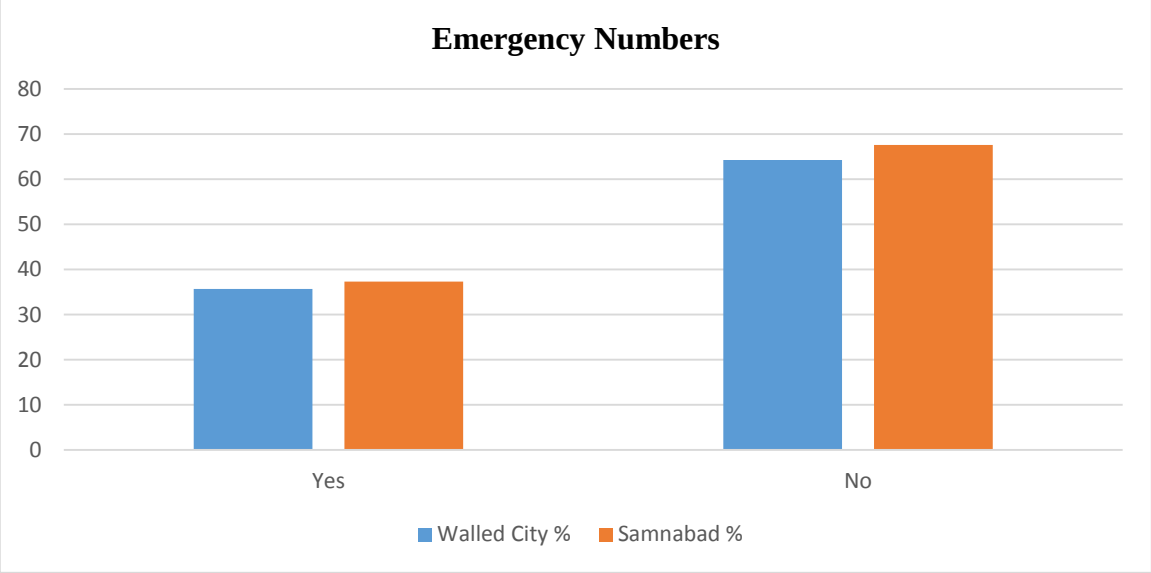


Figure 6.5 Emergency Numbers

To what extent government helps during flood season?

6.2.6 Maintain Infrastructure:

Infrastructure damage consists of two parts. One is the direct loss that is the destruction of roads, railroads, and the other indirect loss, which is the disruption of basic public services such as electricity, gas, telephone, etc. It is the responsibility of the local government and concerned departments to work immediately on the damages caused by flood water and try to restore life back to normal as soon as possible.

Table 6.6 Maintain Infrastructure

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	40	23.8	98	33.8	X2= 3.780 Sig= 0.052
No	128	76.2	94	66.2	
Mean	1.76		1.66		
Std dev.	0.427		0.475		

In the table above, the figures show the opinion of the people regarding efforts made by the local government and civil departments after the flood in restoring the infrastructure. 35.7% of the people in the Walled City and 37.3% of people in Samanabad agree that their local government bodies work efficiently to cover any damage done to the government (local) property to save people for the inconvenience. The value 0.769 of the chi-square shows no significant difference in the public opinion of the two areas.

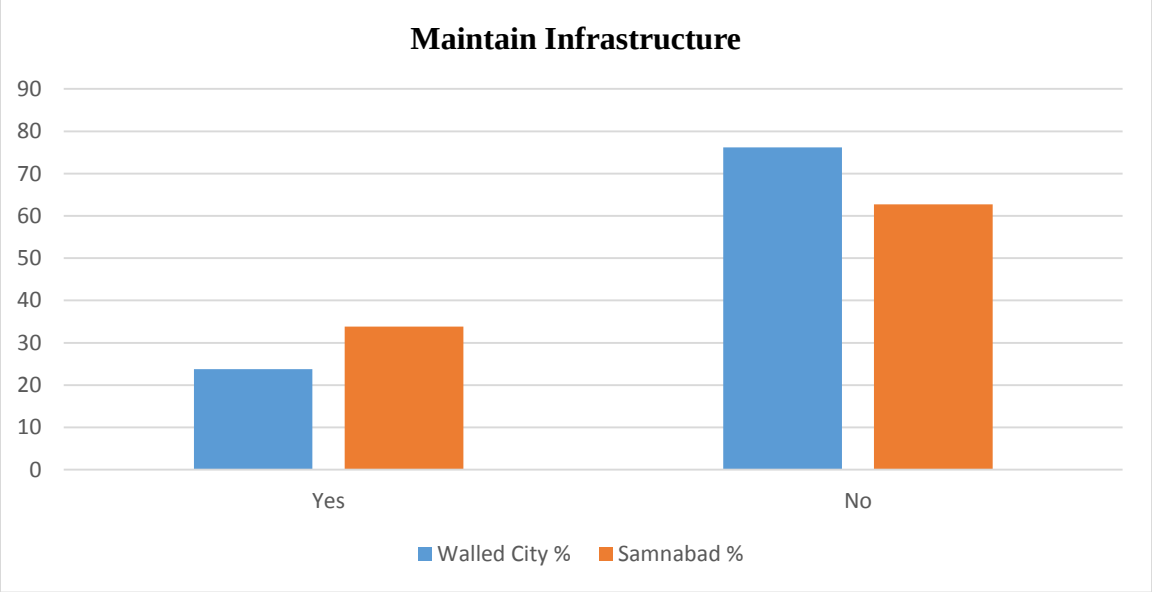


Figure 6.6 Maintain Infrastructure

6.2.7 Food Supply:

Disruption of the food supply chain is the major issue during the foods. Damaged infrastructure and sometimes crops destroyed due to flooding result in a shortage of food and water supply. In such a scenario, local governing bodies, NGOs, rescue organizations, and sometimes defence forces work hand in hand to offer food and required necessities to the affected.

Table 6.7 Food Supply

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	88	52.4	58	40.8	X2= 4.098 Sig= 0.043
No	80	47.6	84	59.2	
Mean	1.47		1.59		
Std dev.	0.501		0.494		

The surveyed data shows that 52.4% of the population in the Walled City and 40.8% of the population in Samnabad are satisfied with the government's action of providing food and other essentials of their daily need. However, there is a significant difference in the opinion of the two areas as the chi-square value for the significant difference is 0.043

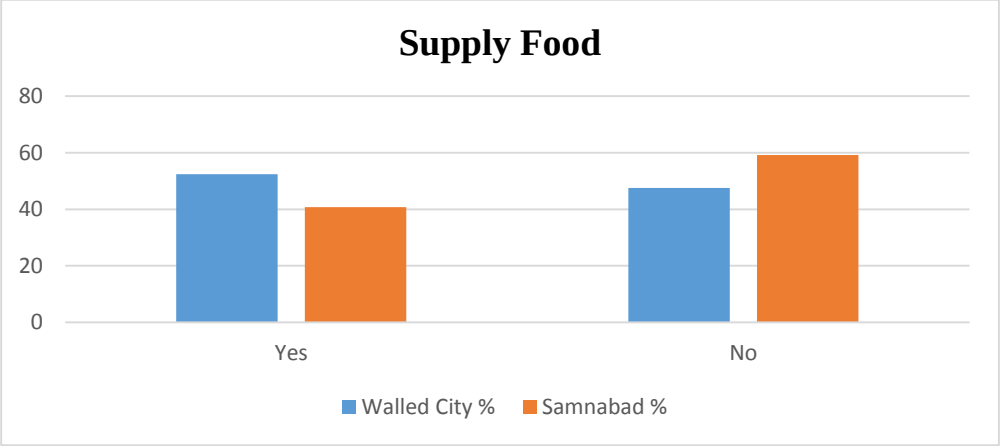


Figure 6.7 Food Supply

6.2.8 Provision of First Aid:

Small lacerations (due to glass debris), electrical shocks, diarrhea, food poisoning (by consuming contaminated food and water), and fatal injuries occur during flood and cleanup activities. Sometimes families are prepared for the initial first aid; however, in the worst-case scenario, rescue officials are needed.

Table 6.8 Provision of First Aid

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	88	52.4	77	54.2	X2= 0.211 Sig= 0.646
No	80	47.6	65	45.8	
Mean	1.48		1.45		
Std dev.	0.501		0.499		

The table shows a comparative analysis of the Walled City and Samnabad 52.4% and 54.2% of the people agree that the government rescue officials, respectively, provide an

immediate first-aid facility. 0.646 value of the chi-square shows no significant difference in public response.

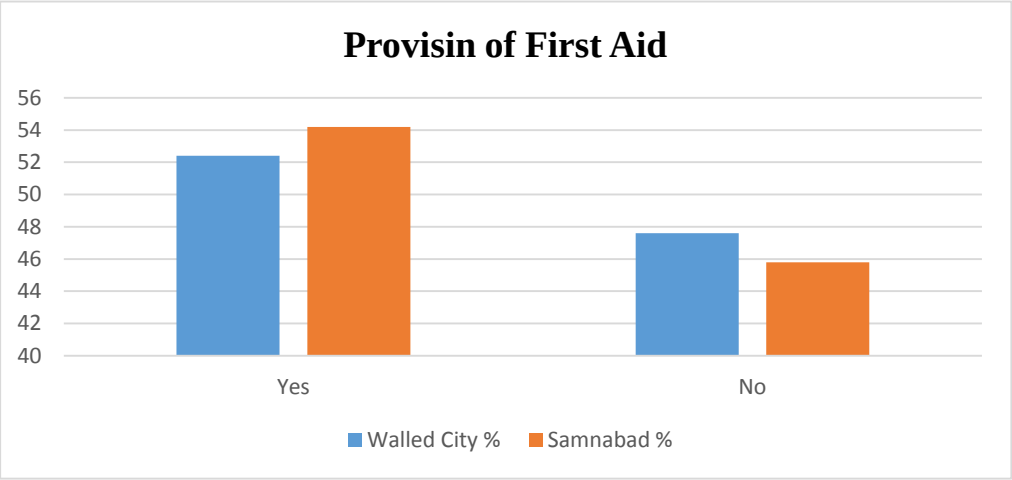


Figure 6.8 Provision of First Aid

6.2.9 Monetary Aid:

Flash floods have devastating effects on the economy, environment, and, most importantly, the people. During floods, people suffer a lot as their houses are collapsed sometimes their cars, bikes are damaged, and sometimes their property is ruined due to flooding.

Table 6.9 Monetary Aid

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	16	9.5	9	6.3	X2= 1.653 Sig= 0.305
No	152	90.5	133	93.7	
Mean	1.90		1.94		
Std dev.	0.294		0.245		

90.5% of the people in the Walled City and 93.7% of the people in Samnabad responded to the answer "NO". The government provides no monetary aid for recovering the losses of a flood through television announcements are made by officials.

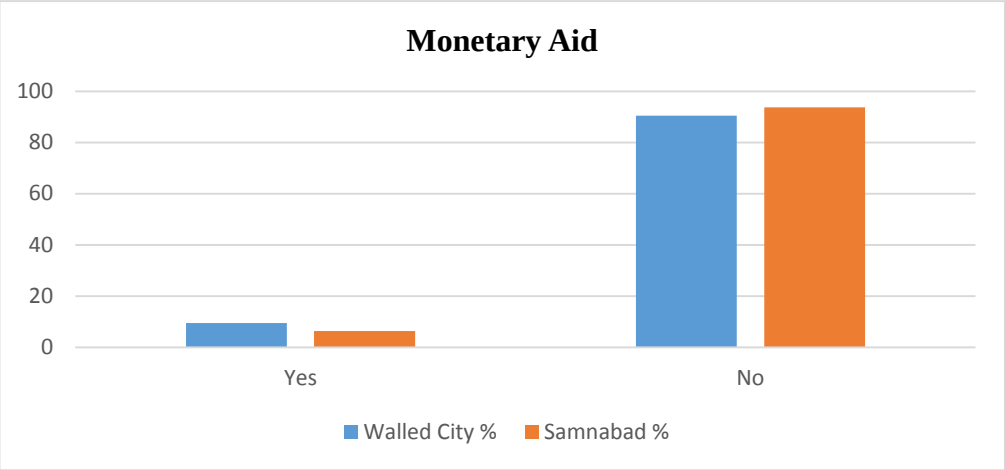


Figure 6.9 Monetary Aid

6.2.10 Rehabilitation:

Houses usually constructed with earth-based material and brick in mud mortar are more vulnerable to flash floods. Every year more than 100's houses are destroyed in the monsoon season due to heavy rainfall. Even then, in such a life-threatening situation, the government cannot provide alternative shelters or relocate the affected families.

Table 6.10 Rehabilitation

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	38	22.6	28	19.7	X2= 0.386 Sig= 0.534
No	130	77.4	114	80.3	
Mean	1.77		1.80		
Std dev.	0.420		0.399		

The surveyed data shows that 77.4% and 80.3% of the population from the Walled City and Samnabad (respectively) complained that no rehabilitation of houses is provided whenever their property is ruined due to heavy rain.

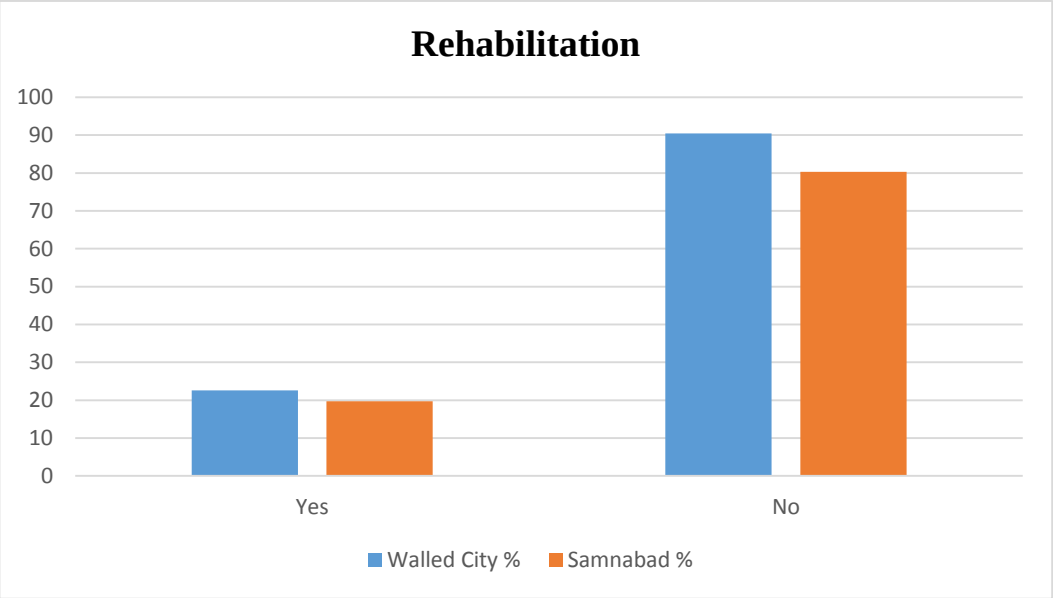


Figure 6.10 Rehabilitation

How are households contacted during floods?

6.2.11 Tv/Ad:

In July, August & September, heavy rainfall always takes the face of flash flooding resulting in a massive level of direct and indirect losses. In order to avoid such a situation, NDMA & PDMA issue warning alerts through various mediums to make the public aware of the emergencies. This helps many people as they get the chance to prepare themselves beforehand for any catastrophic situation.

Table 6.11 TV/Ad

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	40	23.8	38	26.8	X2= 0.356 Sig= 0.551
No	128	76.2	104	73.2	
Mean	1.76		1.73		
Std dev.	0.427		0.444		

The table shows that 23.8% of the population in the Walled City and 26.8% of the population in Samnabad responded that they are always notified through television advertisements about flooding warnings often maybe preparedness measures also notified. The chi-square test shows the value of 0.551, which means there is no significant difference in public opinion.

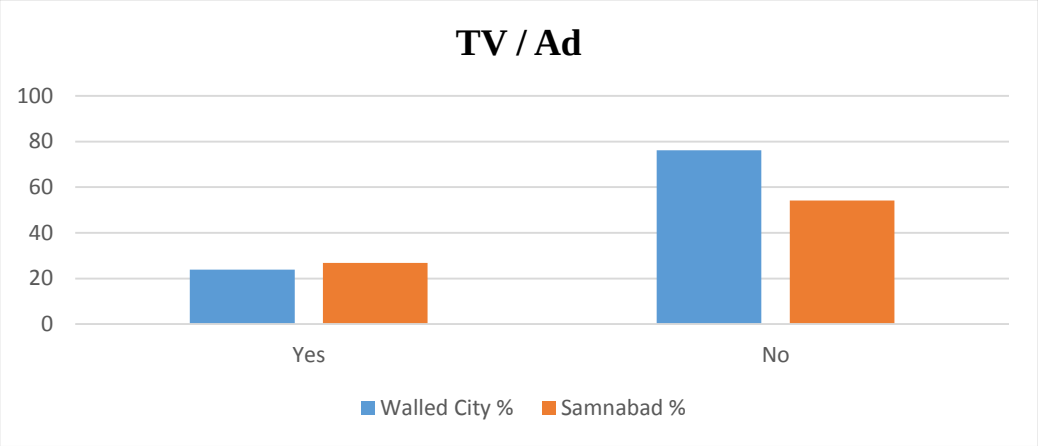


Figure 6.11 TV/Ad

6.2.12 Newspaper:

The majority of adults in Pakistan have a habit of reading newspapers daily. Therefore, newspaper advertisements are considered as an effective option for notifying the public regarding the odds of flash floods.

Table 6.12 Newspaper

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	30	17.9	23	16.2	X2= 0.189 Sig= 0.664
No	138	82.1	119	83.8	
Mean	1.82		1.84		
Std dev.	0.386		0.370		

17.9% of the people in the Walled City and 16.2% of the people in Samnabad agree that the government notifies them about flash floods through the newspaper. Different preparedness measures and adaptation strategies are also instructed along with the warnings. 0.66 value of significant difference shows no contrast in public response.

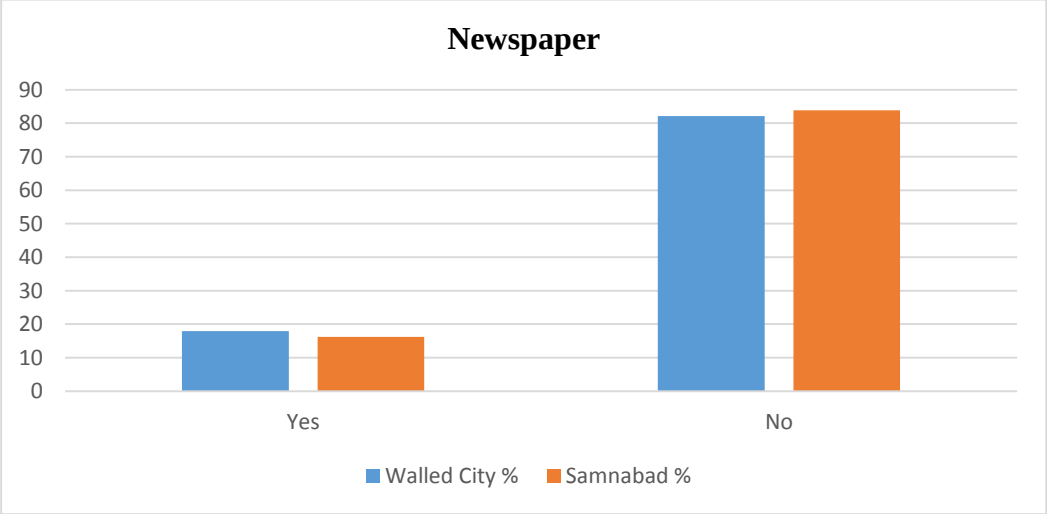


Figure 6.12 Newspaper

6.2.13 Public Announcement:

In Pakistan, residing areas of people comprises of “Mohallas.” These mohallas consist of parks, shops, mosques, along with people's houses. It is a common gesture in Pakistan that people interact outside their homes daily & discussing daily issues. Therefore,

public announcement through mosques is an effective medium in spreading the word as people listen to it attentively.

Table 6.13 Public Announcement

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	75	44.6	59	41.5	X2= 0.300 Sig= 0.584
No	93	55.4	83	58.5	
Mean	1.55		1.58		
Std dev.	0.499		0.495		

The comparative analysis of the Walled City and Samnabad shows that 44.6% and 41.5% of people are informed about the flood through public announcements. The chi-square test vale 0.584 shows no significant difference.

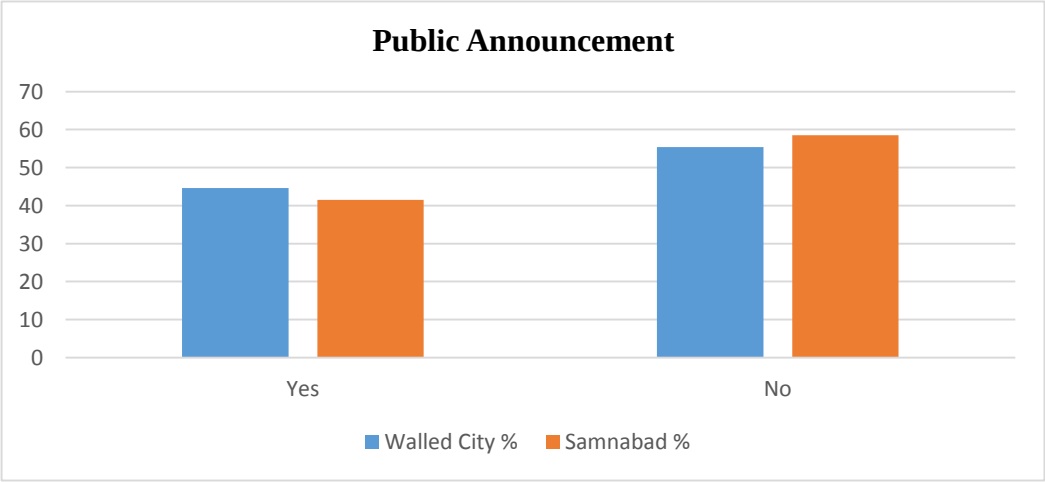


Figure 6.13 Public Announcement

6.2.14 Mobile:

The invention of mobile phones has made human life at ease. They are the heart of the current social and economic progress of the world. Communicating with people across

any part of the world was never this easy. They are no less than a computer and even manages the documents.

Table 6.14 Mobile

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	85	50.6	88	62.0	X2= 4.038 Sig= 0.044
No	83	49.4	54	38.0	
Mean	1.49		1.38		
Std dev.	0.501		0.487		

The above-mentioned statistical analysis from the survey asked whether people are notified about a flood warning through mobile phones. About 50.6% of people said that they were notified through mobile phones in the Walled City Area. Then moving on to Samanabad, 62% of people voted for yes.

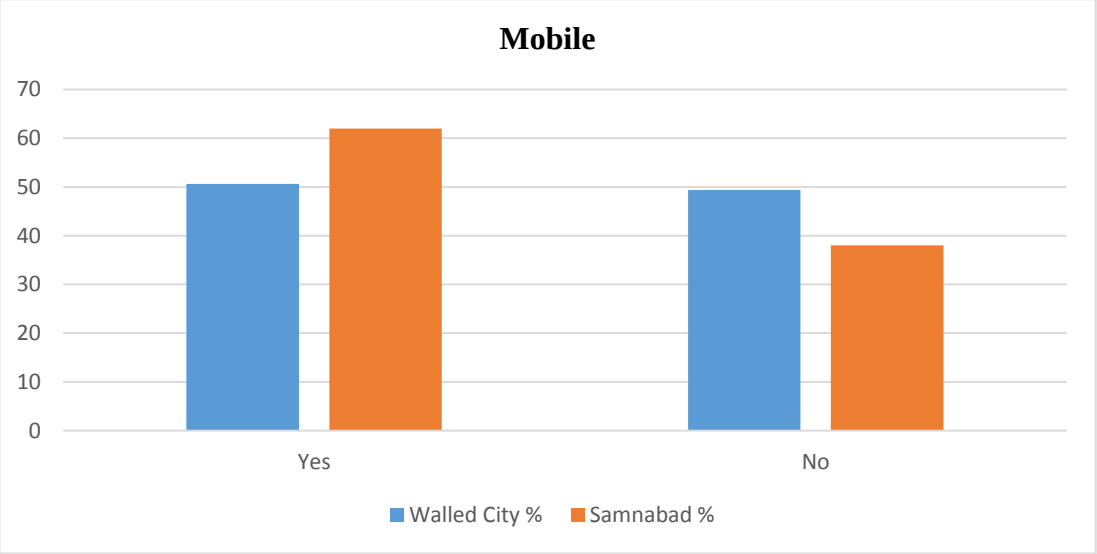


Figure 6.14 Mobil

6.3 Adaptation:

What are safety measures adopted for the protection of electrical appliances?

6.3.1 Mezzanine Floor:

A mezzanine floor is an intermediate platform between the two main floors of a building. Therefore, it is not considered as a "Floor" of a building. These floors are in the form of low-height ceilings or balconies. They serve as extra storage space while on houses. It gives a fancy display to the interior. Mezzanine floors can help place electrical appliances to save them from flash flooding due to heavy rain.

Table 6.15 Mezzanine Floor

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	32	19.0	33	23.2	X2= 0.816 Sig= 0.366
No	136	81.0	109	76.8	
Mean	1.81		1.77		
Std dev.	0.394		0.424		

The data in the above table shows that 19% of the people in the Walled City and 23.2% of the people in Samnabad have mezzanine floors in their houses, and these floors are used for an adaptive purpose against monsoon flooding. The reason for such a lower percentage is that most of the houses are 70 – 80 years old (built before partition). Mezzanine floors had their origin back in Italian architecture, while in Pakistan, vernacular architectural features are observed. Also, most of the population is not aware of the term mezzanine.

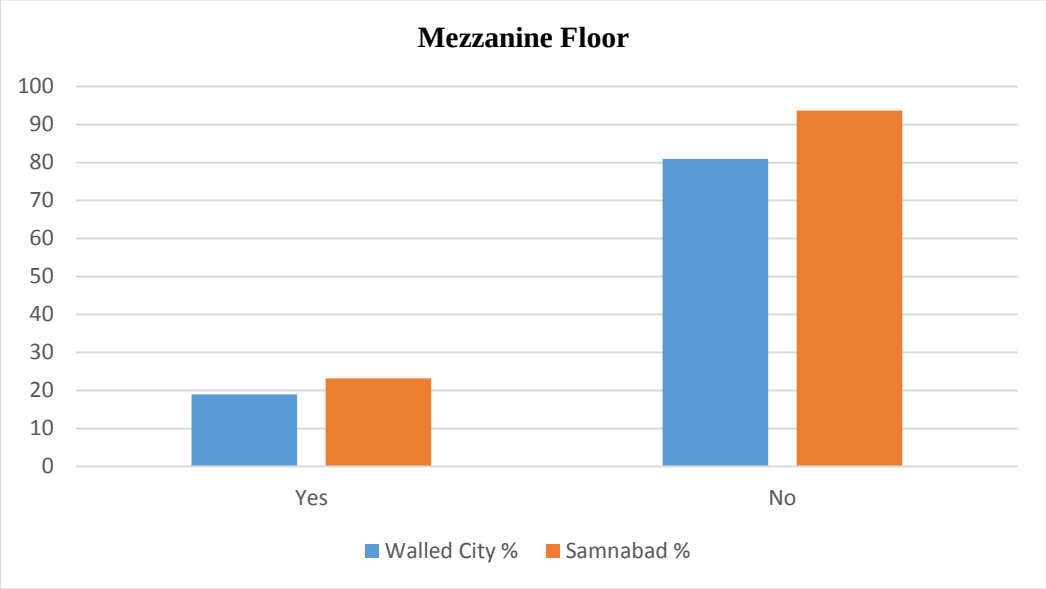


Figure 6.15 Mezzanine Floor

6.3.2 Covering Plastic:

Plastic is a poor conductor of electricity and is used in various appliances' wiring due to its insulating property. The most common problem in the monsoon season is that rainwater enters inside the houses through windowpane, balconies, and space under the doors. This water can damage household property, especially electrical appliances. Covering electrical appliances with plastic sheets when not used saves the consumer from the risk of electric shock.

Table 6.16 Covering Plastic

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	97	57.7	89	62.7	X2= 0.782 Sig= 0.377
No	71	42.3	53	37.3	
Mean	1.42		1.37		
Std dev.	0.495		0.485		

The tables show the statistics of the Walled City and Samnabad. 57.7% and 62.7% of people in the respective areas cover their electrical appliances and expensive household items with plastic during flooding season or when not used. According to people, plastic sheets are very cheaply available. Therefore, they don't have to spend much, and they easily save their appliances from getting damaged. The chi-square value of 0.366 shows that there is a significant difference.

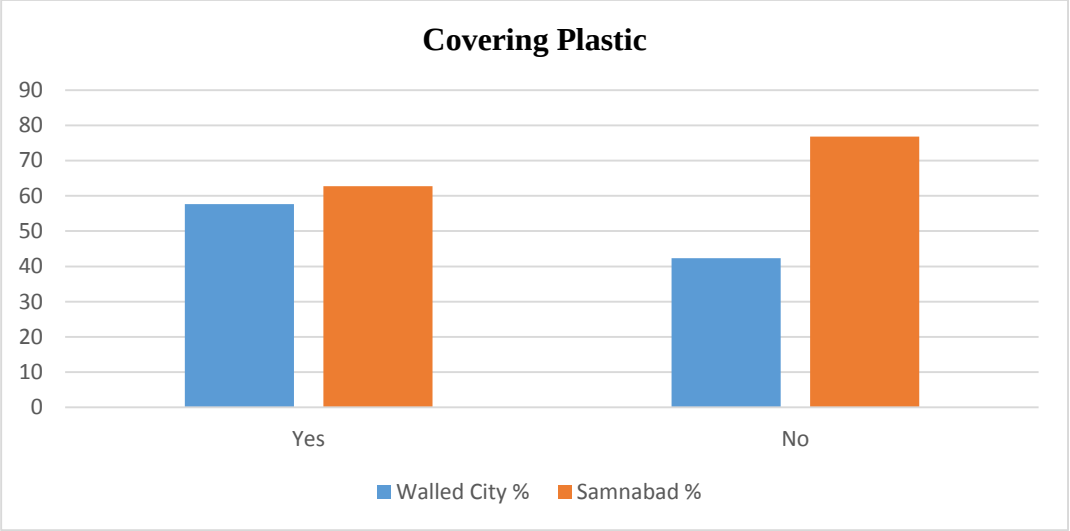


Figure 6.16 Covering Plastic

6.3.3 Safe place:

Table 6.17 Safe Place

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	82	48.8	68	47.9	X2= 0.026 Sig= 0.871
No	86	51.2	74	52.1	
Mean	1.51		1.52		
Std dev.	0.501		0.501		

The above table shows the opinion of the surveyed sample. 48.8% and 47.9% of the people in Walled City and Samnabad place their electrical appliances in safe places. The majority of the people have a separate area for keeping washing machines. Most of the people place their iron stands in the storerooms far away from balconies and windows. Televisions are fixed on the walls at the height of 4 feet, and above these are the few techniques that people adopt to save their appliances.

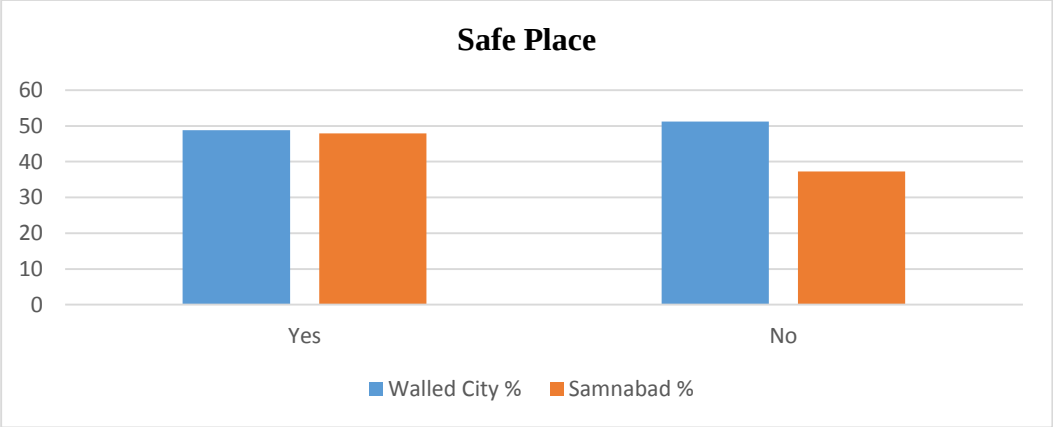


Figure 6.17 Safe Place

What measures are taken for leaking roofs during monsoon?

6.3.4 Tarpaal:

Tarpaal or Tarpaullins are comprehensively used to protect people and things from sunlight, rain, and winds. They are used in constructions of the buildings and after a disaster to protect temporarily built structures

Table 6.18 Tarpaal

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	71	42.3	56	39.4	X2= 0.254 Sig= 0.614
No	97	57.7	86	60.6	
Mean	1.58		1.61		
Std dev.	0.495		0.490		

Comparatively analysis reveals that 42.3% and 39.4% of the population of the Walled City and Samnabad uses tarpaal in their roofing system to avoid seepage and dripping roof. Tarpaals are very cheap and are affordable. Also, when it's time to dispose of them, it is used as an alternative to louvers protecting people's home in the extremely hot season. Therefore, the use of tarpaal is very cost-effective and economical for the people.

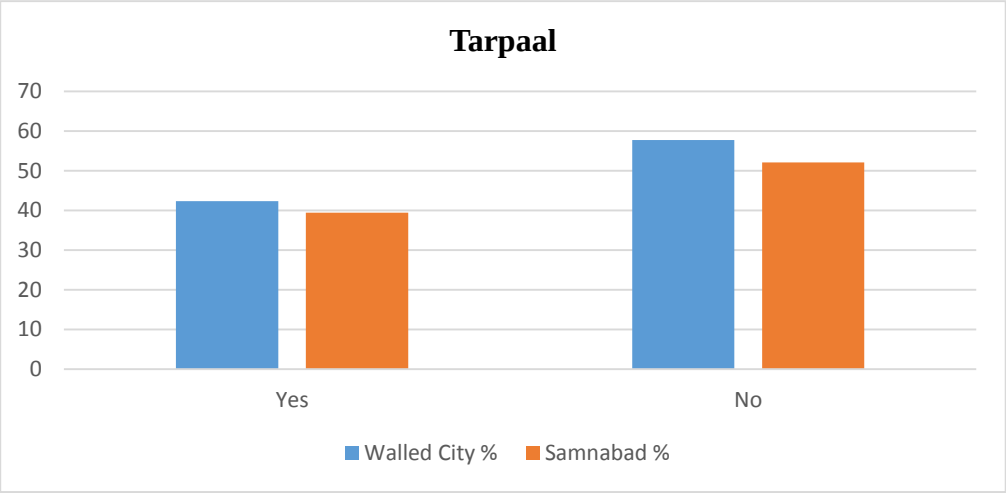


Figure 6.18 Tarpaal

6.3.5 Placing Bucket:

Roof leaks and similarly leaking walls and floors are the worry some problem during heavy rainfall. Unfortunately, most of the leakage occurs close to the connection points resulting in a short circuit, and the worst-case scenario is the fire.

Table 6.19 Placing Bucket

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	30	17.9	26	18.3	X2= 0.011 Sig= 0.918
No	138	82.1	116	81.7	
Mean	1.82		1.82		
Std dev.	0.384		0.388		

In order to deal with such hazard, 17.9% and 18.3% of the people is a Walled City, and Samnabad place buckets under their dripping roofs and walls. This stops the water from going inside the home and causing any damage. However, the reason for such a low percentage of using the strategy that it is a very obsolete method. Now a day tarpaulins, waterproof paints, and other remedies are introduced that are cost-effective and long-lasting. The chi-square value of 0.61 shows no significant difference in public opinion.

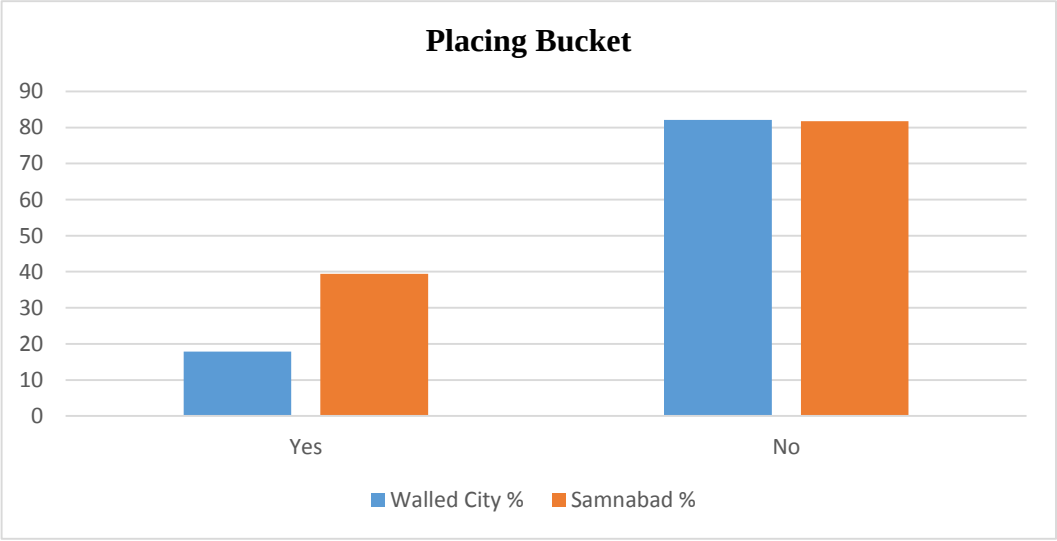


Figure 6.19 Placing Bucket

6.3.6 Waterproof Paint:

Waterproof paint is an impermeable barrack to water. They can be used on floors, masonry walls in basements, etc.

Table 6.20 Waterproof Paint

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	80	47.6	76	53.5	X2= 1.210 Sig= 0.271
No	88	52.4	66	46.5	
Mean	1.52		1.46		
Std dev.	0.501		0.500		

47.6% people of the Walled City and 53.5% people of Samnabad use waterproof paint as roofing treatment. It is long-lasting compared to tarpaulins. However, the chi-square test shows a significant difference (value: 0.271) in the two areas. The reason is people of Samnabad show an average income of 130,000. Therefore, they can afford & use other waterproofing methods like bituminous waterproofing, polyurethane liquid, polyuria coating, etc., which are a bit costly.

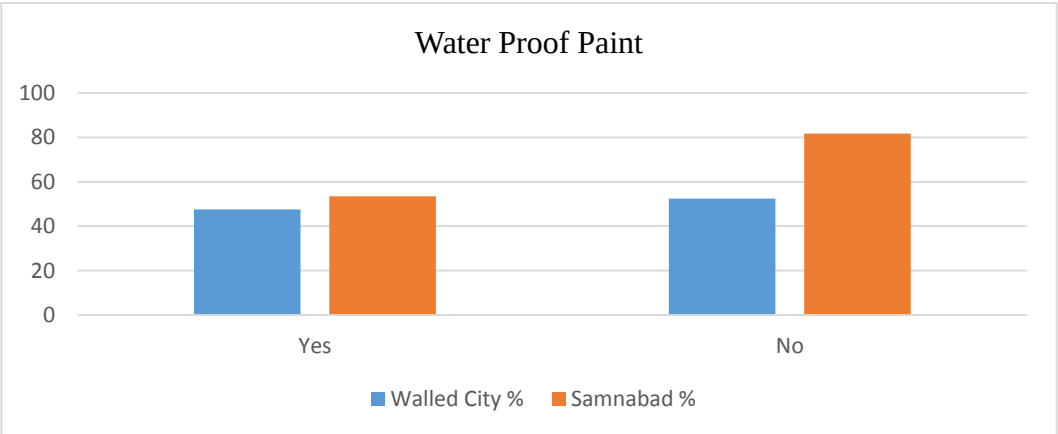


Figure 6.20 Waterproof Paint

To avoid wetting by rain, what measures are taken?

6.3.7 Umbrella:

Umbrella is a handheld device used for protection against rain and sunlight. It is portable and can be used for other purposes too.

Table 6.21 Umbrella

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	131	78.0	120	84.5	X2= 1.851 Sig= 0.174
No	37	22.0	22	15.5	
Mean	1.15		1.22		
Std dev.	0.363		0.412		

Statistical figures in the table show that 78.0% of people in the Walled City and 84.5% of people in Samnabad uses umbrella when traveling during rain. It is a locally made product which is cheaply available and is afforded by everyone. That is the reason a high number of populations use an umbrella for protection against rain.

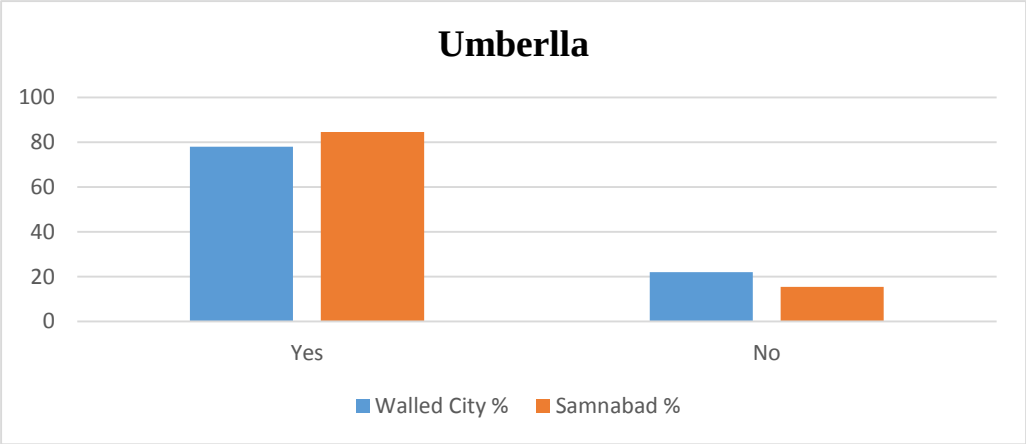


Figure 6.21 Umbrella

6.3.8 Raincoat:

A raincoat, also term as a rain jacket, is a water-resistant coat used to protect oneself from rain. It is sometimes combined with rain pants and rain boots, making a full suite. It is best for surviving long-term wet conditions. A raincoat is made from plastic or rubber as the materials have low permeability to water.

Table 6.22 Raincoat

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	93	55.4	64	45.1	X2= 3.258 Sig= 0.071
No	75	44.6	78	54.9	
Mean	1.45		1.55		
Std dev.	0.499		0.499		

The tables show that 45.1% and 55.4% of the population in the respective areas (Walled city and Samnabad) uses raincoats. The percentage is low compared to the use umbrella as it is a little bit costly compared to an umbrella

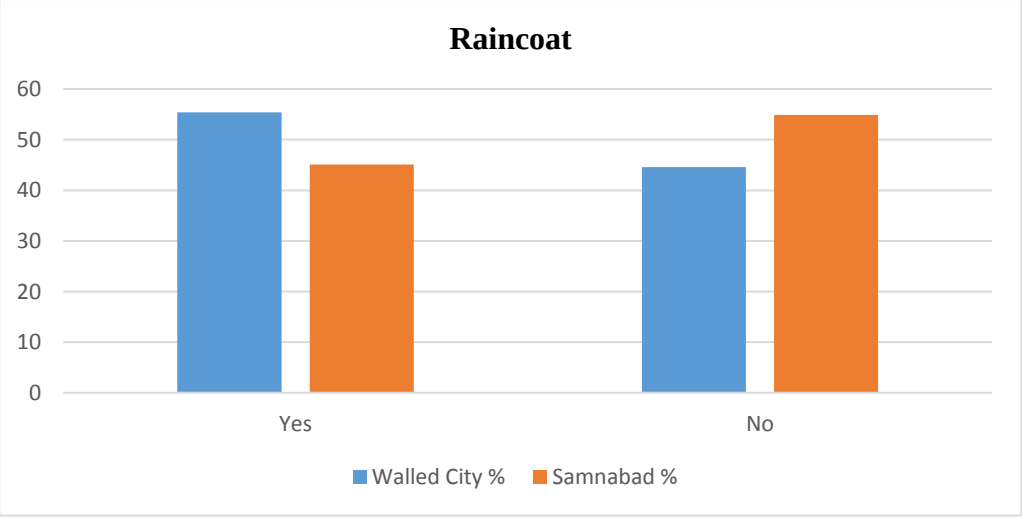


Figure 6.22 Raincoat

6.3.9 Travelling by Car:

Although flash flooding damages the basic amenities causing inconvenience for the public, routine commitment still needs to be carried. People need to go to their workplace, schools, shopping, etc. for which travelling by personal car is considered safe.

Table 6.23 Travelling by Car

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	25	14.9	59	41.5	X2= 27.705 Sig= 0.000
No	143	85.1	83	58.5	
Mean	1.85		1.58		
Std dev.	0.357		0.475		

14.9% and 41.5% people in the Walled city and Samnabad respectively use a car for the travelling to their destinies. This big difference in the percentage in two areas shows a significant difference of opinion between two areas. The reason for using the car by most people in Samnabad is that their average household income compared to Walled City is 130,000. And for them affording a car is easy. However, according to the people in the Walled city, they don't have enough income to own a car

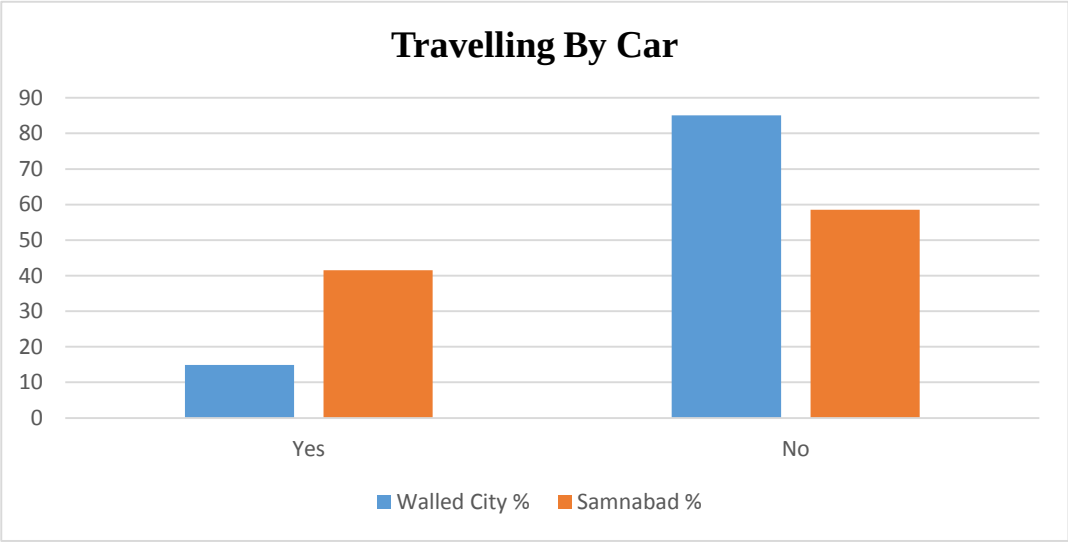


Figure 6.23 Travelling by Car

6.3.10 Covering Shoes:

The commonly used vehicle in Lahore as a mode of transportation is a motorcycle/bike. Compared to cars, it is affordable and economical and has a low maintenance cost. However, motorcycles are unsafe too. During flash flooding, becoming wet due to rainwater is 100% compared to traveling by car. Therefore, most bike travelers cover their shoes with plastic bags to save them from getting wet.

Table 6.24 Covering Shoes

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	23	13.7	15	10.6	X2= 0.700 Sig= 0.403
No	145	86.3	127	89.4	
Mean	1.86		1.89		
Std dev.	0.345		0.308		

The table shows that 13.7% of people in the Walled city and 10.6% of the people in Samnabad cover their shoes with plastic bags when travelling by car. The reason for such a low percentage is that flash flooding damages roads the most. People are concerned about their vehicles as taking them out on damaged roads might break them down. Therefore, they prefer travelling by local transport instead of using a bike. But those who travel my bikes always cover their shoes.

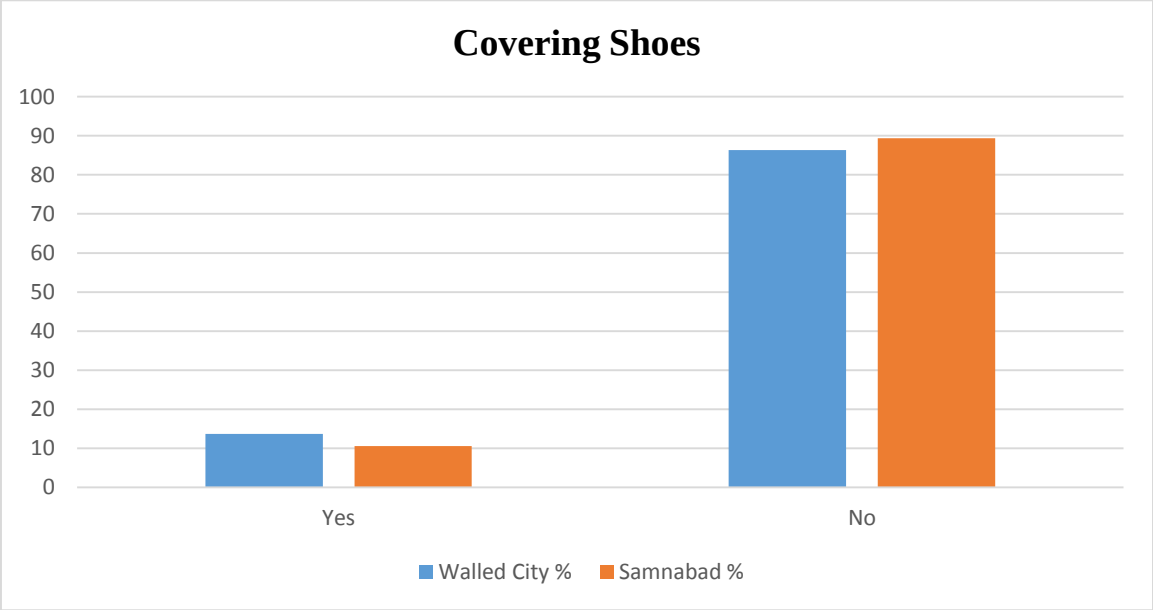


Figure 6.24 Covering Shoes

Which of the following measures are taken in homes to withstand floodwater?

6.3.11 Tiles Instead of Carpet:

Flash flood water entering into the house through balconies windowpanes firstly put the furniture and electronics at risk. Therefore, most people prefer carpeting in their homes. However, it is not easy to drain floodwater out from carpet surfaces. On the other hand, Tiles give a fancy look to the home interior and are also very home friendly regarding health and floods.

Table 6.25 Tiles instead of carpet

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	109	64.9	114	80.3	X2= 9.041 Sig= 0.003
No	59	35.1	28	19.7	
Mean	1.35		1.20		
Std dev.	0.479		0.399		

64.9% and 80.3% of the population in surveyed areas (Walled city and Samnabad, respectively) have used tiles in their homes instead of carpets to withstand rainwater. As tiles are a lifetime investment and require not much maintenance, people have changed their carpet flooring to tiles floors. The 0.003 value of chi-square shows a significant difference in the two areas. The reason stated by people for that is a house constructed in Walled city are very old and have marble flooring according to their times. Therefore, shifting to tiled floors from marble cost them a lot.

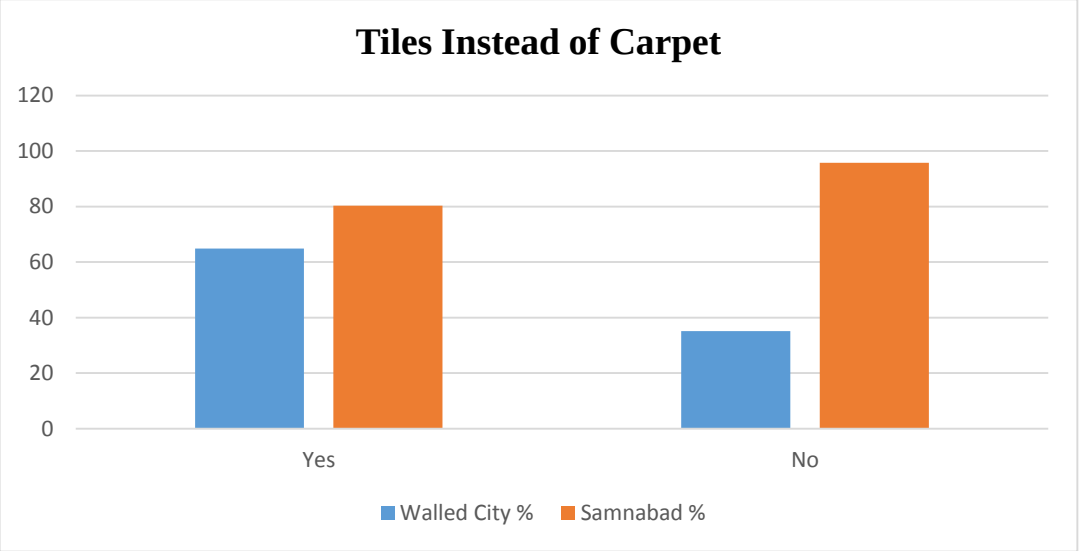


Figure 6.25 Tiles instead of carpet

6.3.12 Placing Cloth:

The main source of rainwater entering into the house is balconies, underneath space of doors and windowpanes. The technical way to stop the water is that a thin rubber bar is temporarily fixed in windows and underneath doors; however, in Pakistan, people use their self-created home remedies, i.e., placing the cloth in windows and under doors.

Table 6.26 Placing Cloth

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	80	47.6	37	26.1	X2= 15.227 Sig= 0.000
No	88	52.4	105	73.9	
Mean	1.52		1.74		
Std dev.	0.501		0.440		

Comparative analysis shows that 47.6% of people in the Walled City and 26.1% of people in Samnabad use this strategy in their homes. The chi-square test shows a value of 0.000, which represents a significant difference in opinion. The education level in Samnabad is higher compared to Walled City. Therefore, people do not use these old methods of adaptation.

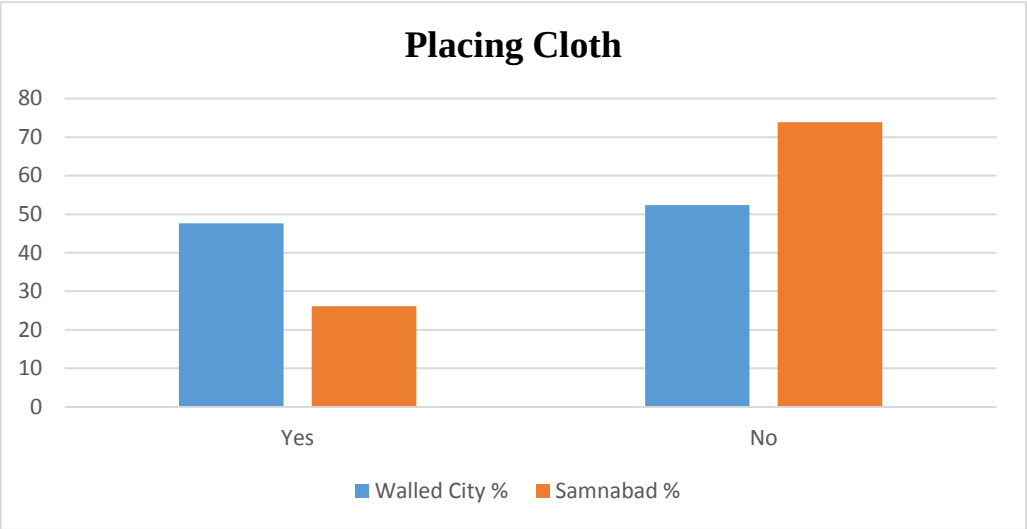


Figure 6.26 Placing Cloth

6.3.13 Wire Rugs:

"Foot traffic" is a key element in bringing slushy mud from rainwater into the house. It's not only a dirty and ugly look but also brings around many bacteria causing skin diseases. Consequently, people use meh wire rugs outside their homes so that anyone entering the house can clean their shoes.

Table 6.27 Wire Rugs

	Walled City		**Samnabad**		**Chi-Square Test**
	Frequency	Percentage	Frequency	Percentage	
Yes	66	39.3	57	40.1	X2= 0.024 Sig= 0.878
No	102	60.7	87	59.9	
Mean	1.61		1.60		
Std dev.	0.490		0.492		

39.3% and 40.1% population from the Walled City and Samnabad uses wire rugs in their homes. The percentage is meager as people are not aware of this type of product. Another reason for the low percentage is that people do not consider this any problem and don't even use doormats at home entrances. Also, the chi-square test shows no significant difference in people's opinion as the value (0.878) is greater than 0.05.

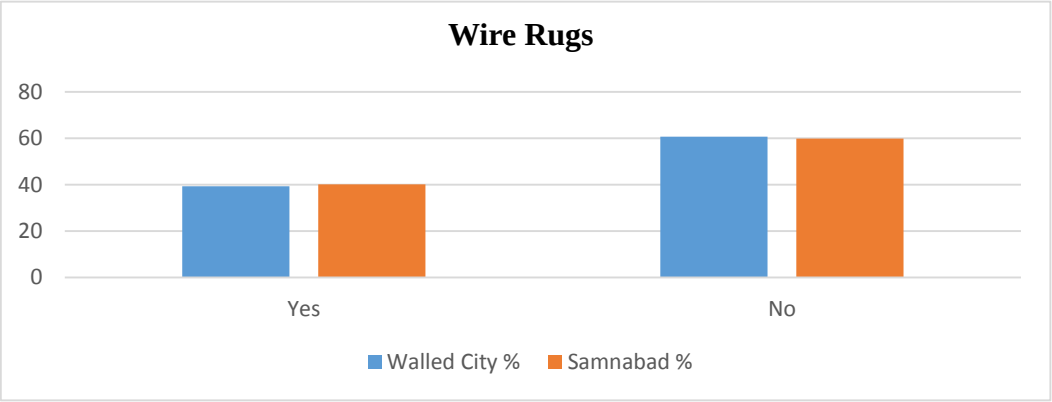


Figure 6.27 Wire Rugs

What measures are taken to deal detrimental effects of seepage?

6.3.14 Wall Panel:

Other than a decorative purpose, wall paneling is used for structural support and to enclose any space that has been damaged. Most people use wall paneling in their homes to cover up the seepage in the walls caused by rainwater.

Table 6.28 Wall Panel

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	37	22.6	46	32.4	X2= 4.221 Sig= 0.040
No	131	78.0	96	67.6	
Mean	1.78		1.68		
Std dev.	0.416		0.470		

Comparing Walled City and Samnabad reveals that 22% and 32.4% of people in respective areas use wall paneling in their homes to enclose their wall deterioration. Also, the value 0.040 shows a significant difference that means a variance of opinion in the two areas. According to the people of the Walled City, wall paneling is quite expensive and is considered extravagant spending according to their family earnings. However, people in Samnabad do not find it handy because the material used in wall paneling is wood, which expands during monsoon season, making the wall look even more substandard.

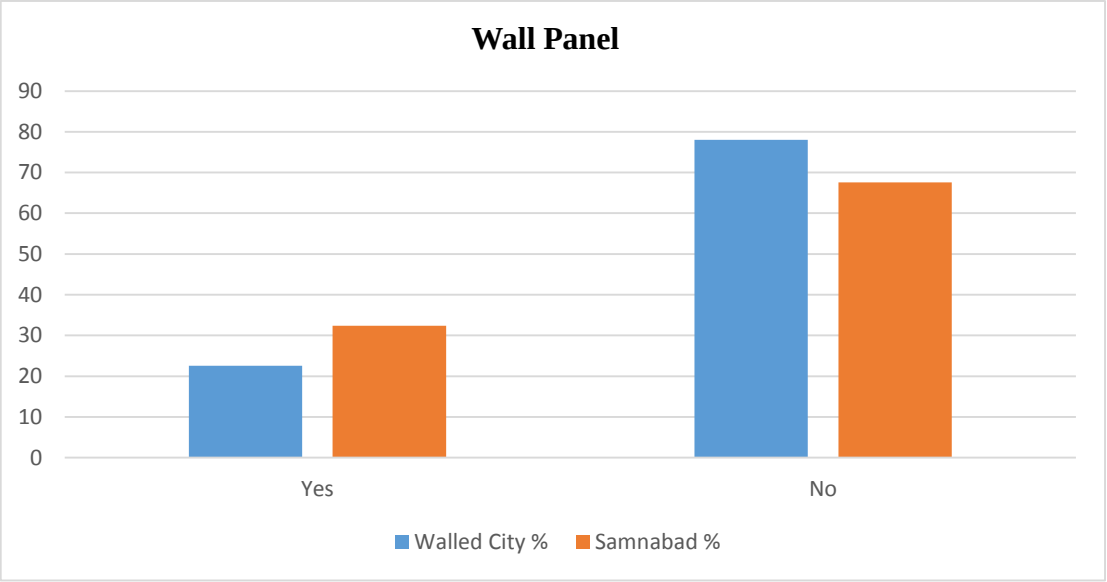


Figure 6.28 Wall Panel

6.3.15 Wallpaper:

Wallpaper is basically for interior decoration and gives a luxurious look to the room. Other than they also used to cover the detrimental parts of the wall. Some of the wallpapers are made of material that eco-friendly and washable.

Table 6.29 Wallpaper

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	69	41.1	52	36.6	X2= 0.641 Sig= 0.423
No	99	58.9	90	63.4	
Mean	1.59		1.63		
Std dev.	0.493		0.483		

However, the survey statistic shows that 58.9% and 63.4% of people (Walled City and Samnabad) do not use the wallpapers in their homes to cover their seepage. It is more expensive than waterproof paints, and sometimes in damp weather, edges separate from the wall.

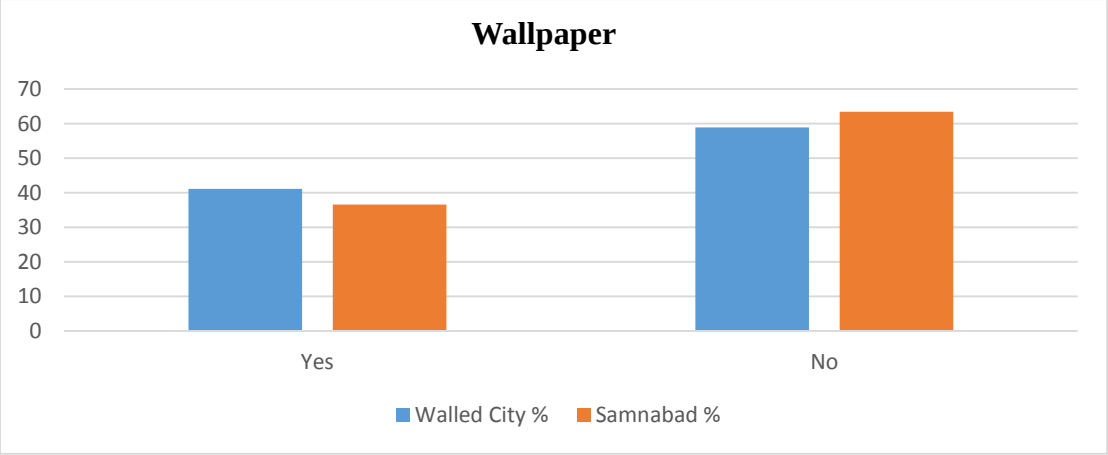


Figure 6.29 Wallpaper

6.3.16 Waterproof Paint:

Waterproof paints are impermeable and don't allow water to penetrate through the wall. With the advancement in the chemical world, UV paints are also introduced to protect the wall paint from peeling for cracking. They are also eco-friendly.

Table 6.30 Waterproof paint

	Walled City		Samnabad		Chi-Square Test
	Frequency	Percentage	Frequency	Percentage	
Yes	113	67.3	104	73.2	X2= 1.309 Sig= 0.253
No	55	32.7	38	26.8	
Mean	1.33		1.27		
Std dev.	0.47		0.444		

Comparing Walled City and Samnabad reveals that 67.3% and 73.2% of people in respective areas use waterproof paints. According to the people of both areas, waterproof paints are cheap and affordable. They are long-lasting.

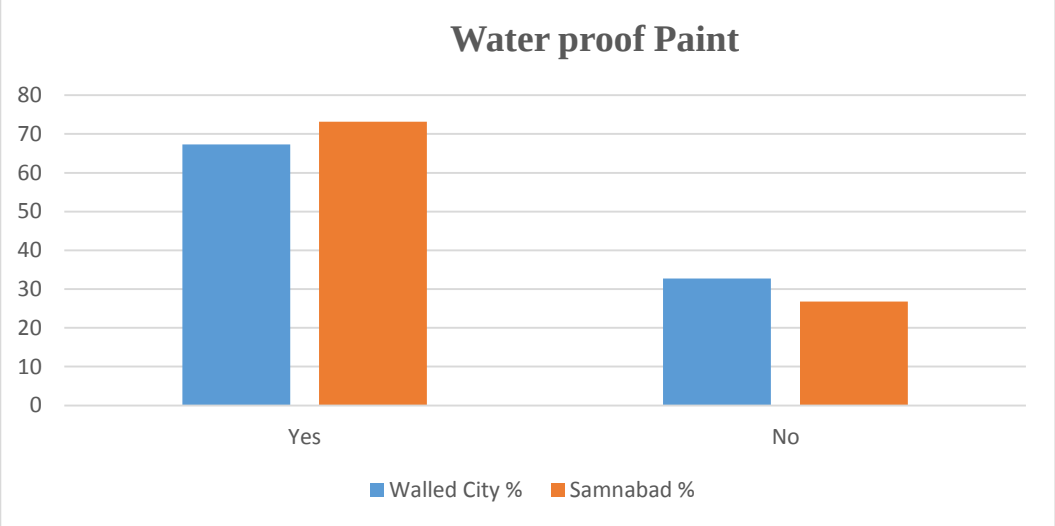


Figure 6.30 Waterproof paint

6.4 Summary:

The survey of the two areas reveals that people here in Pakistan are not properly prepared for the floods according to the protocols. From the listed indicators, people only prepare extra food and a first aid kit beforehand. The reason is that they are bound to their

financial expenditures, which do not allow them to save for flood situations. Also, in their opinion government has failed to provide them with any monetary aid for recovering their losses from floods. All they provide is first aid. Rehabilitation, Food Supply, and Infrastructure maintenance are far more at a distance from their claims. When it comes to adaptation, people still follow old-school methods as they are affordable to them. For example, majority of the population cover their electrical appliance with plastic sheets, place buckets under dripping ceilings, do not travel by cars during rain, also waterproof paints for avoiding seepage. All these strategies are cost-efficient. The major problem is finance. Being a 3rd world country, people don't have jobs. The government is unable to provide any kind of financial support or subsidies to the public in disastrous events due to lack of funds.

Chapter 7

INSTITUTIONAL CHALLENGES IN MONSOON RISK REDUCTION

Lahore is the second largest metropolitan of Pakistan. The total area of the city is 1,772 square kilometers and houses a population of 12,642,000 (according to 2020 data). Lahore is divided into 9 towns and is run under the jurisdiction of different local government authorities. When it comes to deal the Monsoon impacts, WASA (Water and Sanitation Agency) is the department that handles the city.

7.1 Challenge faced by WASA:

Lahore does not have a separate sewerage system. The sewerage system is divided into municipal sewer system caters the industrial waste) and storm sewer system (cater to the stormwater), But the areas of Lakshami Chowk towards Yateem khana are being converted to a stormwater sewer system. The size of pipes in a stormwater sewer is larger than usual pipes.

7.2 Preventive Measures:

When it rains heavily in the monsoon, it results in urban flooding or urban ponding at various critical points in Lahore, which WASA has marked according to their field surveys. A total of 21 points are identified in Lahore, where the severe outcomes of urban flooding are to see. These are the areas where the sewerage system is undersized in comparison to rainfall intensity. Rainfall intensity varies from area to area. Before the start of a monsoon season, a complete mechanism is developed by WASA. In monsoon, all the drains and streets in Lahore (e.g., Satu Katla drain, Cantt drain) are de-silted

extensively, due to which rainwater easily exit through the city without choking the sewer system. De-silting is a process in which all the silt present in drains is removed. For this, extensive machinery is used, for example, jaw and jib crane, dumpers, Jetter sucker machines. During Monsoon, emergency camps of WASA are set up on all the sore points with the appointments of WASA staff 24/7. According to the SOPs, when it rains, all the officers (SDO, XCN, Director, Chief Engineer & Managing Director) are ordered to be present on the site until the rainwater is completely drained. Another Strategy WASA has adopted to cater to rainwater is the development of underwater storage tanks. They provide temporary relief in case of urban flooding. The water stored in underwater storage tanks is re-used and is supplied to the PHA (Park horticulture Authority) for landscaping. Before the monsoon, the maintenance of all the disposal and pumping stations is ensured. All the wet wells and dry wells are de-silted. Pumping stations work on the principle of flushing out the rainwater; therefore, stand-by generators are prepared if the area's electricity or city collapses. These pumping stations flush rainwater to their consecutive disposal stations, ultimately draining the rainwater into River Ravi. Other than this, in every Sub-station jetter and duce-engine are present, these machines clear the drains and standing water in the streets.

7.3 Financial Constraints:

The biggest hindrance faced is the financial issue. The department's two major problems are maintenance of pumping and disposal stations and fuel required by the heavy machinery for traveling to the critical areas. Despite these, the department has to rent generators during the monsoon season as their own generators are not enough to fulfill

the electricity capacity. With the limited budget, it is difficult to cater to these issues all at once.

Chapter 8

CONCLUSION AND RECOMMENDATIONS

8.1 Summary of Findings

The first objective of the thesis was to determine the socio-economic losses due to flooding and what adaptive strategies are opted by the people. About 86% of the people report damage to their houses and household properties, for example, the collapse of the roof or any structural / partition walls, seepage that damages the foundation, short-circuiting of wiring, which sometimes results in house fires. These damages are widespread and result in loss of human life in 31% of cases. Electricity and telephone (communication) also greatly affect. People have to sit for hours in blackout just because HT wires fall in their areas due to heavy rain. Most of the time, they are unable to register any complain as telephone communication is also disrupted. The list does not end here, flooding also results in water & food contamination, and people suffer severely from diarrhea, food poising, jaundice, etc. Moreover, flooded roads make it difficult for people to reach their destination; hence human life is badly turned upside down in monsoon season.

Due to a lack of education, people are still following old-school methods to combat monsoon flooding. To protect their houses from seepage, waterproof paint is used by people. Household appliances are covered with plastic sheets to avoid rainwater getting into them. House construction in Samnabad and Walled City is very old, to the time when there was a concept of chips or cement flooring, which does not give a fancy look

to the house. To make the house look presentable, people use carpet. The majority of the people have changed the flooring to filed one to avoid the wetting of carpets. 78% of the population have switched to travel by local transport in rainy season as using of personal vehicles make them late for their destination and cost them a lot of fuel.

The second part of the thesis dealt with the institutional challenges. In Monsoon, WASA plays an active role in dealing with monsoon flooding. Despite taking preventive measures, monsoon flooding still causes catastrophic damages. Issues lie as the department does not have enough staff and workforce to carry the orders on time effectively. Also, their financial budget is not enough to cater to all the issues all at once.

8.2 Recommendations

The final part of the thesis is to suggest measures to reduce monsoon flood risks.

1. The very first problem is the rainwater. Stagnant water on roads is due to the choking of the sewer system and in the capacity of drainpipes. For this purpose, there is a high need to construct percolation wells. It works on the principle of rainwater harvesting. Surface water is filtered through the soil into aquifers and helps in the refilling of groundwater. The well has a foundation of triangular-shaped iron frames with brick and R.C.C walls pre-cast panels of filter slabs are placed on the beams with the layers of brick ballast above the filter slab (for filtration). This process is cost-effective, and it can be easily constructed with locally available technology.

2. Walled City and Samnabad is an area with less than 30% of green spaces. These two areas are an example of urban heat Island as all the streets and roads are paved with mud and concrete. This acts as a catalyst in causing monsoon flooding. Therefore, there is a dire of rain gardens. Rain gardens consist of local and natives shrubs, flowers, and plants seeded in a small depression created through natural slopes. Rainwater from the roofs, driveways, and roads is flowed into the rain garden and is soaked by the plants.
3. Disaster issuance is a facility provided by many issuance companies. The majority of the population is unaware of this protocol. People need to be educated about these policies to get their losses and damage covered up.
4. People in Pakistan are not aware of the mock drills, training sessions, and disaster awareness campaigns. Therefore, when floods or any other disaster hits them, their loss is severe as they are not prepared to combat floods. However, such training and drills should be practiced at all school levels as basic education. It will not only make the people prepared for the disaster situation but also helps in reducing the socio-economic loss of a flood.
5. Finally, the Government needs to provide a separate budget to the concerned department working during monsoon season.

8.3 Limitations:

The study was limited to only two towns of Lahore (Walled City & Samnabad Town). However, it's important to carry out such flood assessments all over Pakistan. The study

only focused on the socio-economic losses, preparedness measures, and risk perception towards monsoon flooding. However, future research should e carried out on psychological effects on people due to monsoon flooding, how to bring awareness among people regarding the importance of disaster preparedness. The data collected during the survey was almost 360 questionnaires as people due to Covid-19 was reluctant to co-operate.

8.4 Conclusion:

Climate Change has affected humanity and its habitat disastrously. One of the destructing effects of climate change is the seasonal variation resulting in increased and heavy monsoon rainfall. Heavy rainfall is becoming the cause of urban flooding in the cities and disrupts human life completely by damaging their houses, properties, amenities (water, gas, electricity, etc.). Being the second biggest city of Pakistan, Lahore also faces heavy rainfall in the monsoon resulting in urban flooding. The main and core problem lies in the sewer system of the city. The city's sewer system is designed on a municipal sewer system instead of a stormwater system. Hence the sewer pipes choke when it rains heavily, resulting in urban flooding. The after-effects of the flooding are numerous. Some of them are damaged to people's public and personal properties, break-down of amenities, damaged infrastructure, and the worst-case scenario is the loss of human lives.

After conducting a survey and analyzing data through the Chi-square test following results were concluded:

Houses and household properties are the most affected by monsoon flooding. The collapse of the ceiling, seepage in the basement, and foundation of houses are the most reported problems. Another inconvenience faced by the people is the tripping of feeders in monsoon season, blacking out the whole city, and changing the travel route of the people to reach their destinations. Despite facing these problems, people still do not prepare themselves according to flood guidelines. The reason for this careless behavior is the lack of education. Less than 50% of the population is graduated and considers that awareness training programs regarding floods are just a waste of time. Another factor for the unpreparedness is the non-serious attitude of the government. Flood awareness mock drills are not conducted at the school and NGO levels.

Combating the damages of a flood is not easy; however, the severity of damages can be reduced by adopting various strategies. Flood water entering the house can damage the electrical appliance, furniture, important documents, etc. all people do is cover their household items with plastic sheets. To stop rainwater from dripping through the roofs, tarpaulin is used. While traveling in the rain, people prefer local transport compared to their vehicle as they fear that they might get stuck in traffic jams. And waterproof paint is used to deal with the detrimental effects of the seepage. With the introduction of various modern adaptive strategies, people in Lahore still use their old school strategies to withstand flood effects. The reason is affordability. Most of the new techniques require money, whereas people have limited income and a huge to feed; therefore, they prefer cost-effective, long-lasting, and re-useable remedies.

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Questionnaire Sr. No: _____ Date: _____ Area: _____

The purpose of this study is to make "Assessment of Monsoon Flood Risks in Lahore Metropolitan." This study is being conducted at National University of Science and Technology (NUST) Islamabad. The information provides will be kept in the strictest confidentiality and used for research purposes only.

1. Age: _____ 3. Average Household Income: _____
2. Education: _____ 4. Gender ☐ Male ☐ Female

Part I: Demographic and Household Profile

1. Household size: _____
2. What type of family system do you have? ☐ Single ☐ Nuclear ☐ Joint
3. Extended Number of elderly (60+ yrs.) in the household: _____
4. Number of children in your household: _____
5. Number of Chronic patients in your household: _____
6. Number of people earning in a household: Males _____ Females_____
7. How long have you been living in your community? _____

i) Type of dwelling	Owned	Rented	**iii) Resistance level of building**	Permanent construction	Temporary construction
ii) Type of a building	Single Unit	Apartment	**iv) Presence of Ground floor**	Yes	No

Part II: Flood and Risk Perception

1. Have you experienced a flood before? ☐ Yes ☐ No
2. Did water enter your house? ☐ Yes ☐ No
3. If yes, how many times has water entered your house due to floods? _____
4. How long the water stayed in your house? _____
5. How high was the floodwater in your house? _____ (feet)
6. If water did not enter the house, was the access road submerged underwater? ☐ Yes ☐ No

7. If yes, what was the height of water on the road? _____ (feet)

S. No	Statement	Very High	High	Moderate	Low	Very Low
1	How much are you afraid of Monsoon Flooding?					
2	How much do you think these monsoon floods can occur in the future?					
3	How much afraid will you be from these monsoon floods if can occur more often?					
4	What do you think are the chances of loss of lives in floods?					
5	What is the likelihood of future damages to house by floods?					
6	What is the level of understanding of emergency protocols?					
7	How much do you agree with govt. policies for DRR and CC?					

1. Damaged Areas in Community during Monsoon Floods (may choose more than one):
   ☐ Houses ☐ Schools ☐ Shops ☐ Offices ☐ Parks
2. Do you own this house? ☐ Yes ☐ No
3. Housing Type?
   ☐ Single/Detached (Bungalow) ☐ Semi-Detached (Row) ☐ Combined/Attached (Flat)
4. Number of storeys of house _____ (number)
5. How long have you been living in this house? _____ (years)
6. Any damage to your house or your household in any monsoon flooding (details)?

   _____

   _____

   _____

   _____ _____

1.	Do your water and gas lines rupture during the monsoon?	**Yes**	**No**	2.	Do HT Power lines fall in your area during monsoon?	**Yes**	**No**
3.	Does Telephone exchanges are affected the monsoon?	**Yes**	**No**	4.	Are Electricity substations affect	**Yes**	**No**

5.	Does Monsoon Flooding affect the travelling route to school and offices?	**Yes**	**No**	6.	Does Monsoon affect your household properties?	**Yes**	**No**

Part III: Preparedness (Education and training)

1. Have you ever attended training held by school/NGO/Government for flood preparedness purposes?
   ☐ Yes ☐ No
2. Have you taught a member of the household what to do in case of a flood? ☐ Yes ☐ No
3. Have you ever attended first aid training? ☐ Yes ☐ No
4. Have you participated in mock drills or rehearsals for the purpose of flood preparedness?
   ☐ Yes ☐ No If Yes to the above questions, then answer the following:
5. From where did you read preparedness measures on floods?
   ☐ Newspaper/Pamphlet ☐ Radio/Television ☐ Electronic Media

Part IV: Preparedness (Resources & Response)

(may choose more than one)

1. Select the following resources you are prepared within your homes during flood season.
   ☐ Food & Water ☐ Money ☐ First Aid Kit ☐ Mosquito Net ☐ Emergency Nos.

2. To what extent government helps during flood season?
   ☐ Maintain Infrastructure ☐ Supply Food ☐ Provision of First Aid ☐ Monetary Aid
   ☐ Relocation of households ☐ Government groups available for help

3. How are households contacted during floods?
   ☐ Television Advertisement ☐ Newspapers ☐ Public announcement in the area ☐ Mobile messages

Part V: Adaptation Strategies

(may choose more than one)

1. What are safety measures adopted for the protection of electrical appliances?
   ☐ Placing them on mezzanine floors ☐ Covering them with plastic sheets ☐ Packing them in a safe place if not used

2. What measures are taken for leaking roofs during monsoon?

☐ Use of tarpaal on roofs ☐ placing buckets under dripping ceiling ☐
Waterproof paint coating on the roofs ☐ others _____

3. To avoid wetting by rain, what measures are taken?
   ☐ Use of Umbrella ☐ Use of Raincoat ☐ Travelling by Car instead of bike ☐
   Covering of shoes by plastic bags while riding a bike

4. Which of the following measures are taken in homes to withstand floodwater?
   ☐ Using tiled floor instead of carpets ☐ placing cloth pieces under windows & doors
   ☐ Wires rugs at door entrances ☐ Shoe Wrapping papers for guests

5. What measures are taken to deal detrimental effects of seepage?
   ☐ Wall paneling ☐ Use of wallpapers ☐ Use of Waterproof Paint

6. Did you ever think of moving away from this place due to the risk of flooding?
   ☐ Yes ☐ No If No, Why _____
   _____

If any other strategy is used, write below and give your comments and suggestion:

_____

_____