ENHANCING URBAN RESILIENCE THROUGH SMART CITY CONCEPT

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THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of the thesis titled "ENHANCING URBAN RESILIENCE THROUGH SMART CITY CONCEPT." written by Mr. Khurram Shahzad (Registration No. 00000328643), of Urban and Regional Planning (NICE-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.

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DEDICATION

This research work is dedicated to my beloved parents, who realized the importance of education and made me capable of reaching this level. At the same time, it is dedicated to my dearest brother & sisters, who supported and guided me in every field of life. It is their love and support that enabled me not only to complete this task but also to walk every step of life with confidence and commitment.

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Signature of Student

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ABSTRACT

The transformation from Rural to Urban population is increasing sharply. According to an estimate, it is expected that about 70% of World's population will be living in Urban areas till 2050. This has created a strong need for transitioning cities into resilient cities. As a result, several ideas and techniques has been developed for preparing cities to cope with future challenges.

Pakistan is among the most urbanized countries of South Asia. The current growth rate of Pakistan is 2.0 % (2020), with this rate Pakistanis are flocking to cities faster than any other country in South Asia. By 2030, more than half of Pakistan's projected 250 million citizens are expected to live in cities. Other than urbanization cities are also facing other challenges like Climate Change, Natural Disasters, Economic Development, haphazard development, Urban Governance etc.

Urban Resilieance and Smart city factors have been indicated for the analysis. Urban Resilience is based on 4 dimensions (Infrastructure Resilience, Environmental Resilience, Physical Resilience, Economic Resilience).While Smart City is based under 6 dimensions (Smart Economy, Smart People, Smart Mobility, Smart Governance, ICT and Smart Environment).On the other hand, Smart City concept has emerged worldwide to promote responsive, intelligent, connected and sustainable cities. In short self-sufficient city is a Smart city. So, the basic aim of this research is to look into options for enhancement of Urban resilience of 4 metropolitans of Pakistan, by using Smart City Concept. For this study primary and secondary data has been collected and analysed with respect to each city.

TABLE OF CONTENTS

LIST OF GRAPHS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background

Cities now contribute to the expansion of the economy and provide people with possibilities to relocate, but they are also faced with a variety of challenges, both internal and external, such as poverty, migration, pollution, decay, natural disasters, and economic crises. Therefore, shifts in patterns have an impact on each and every city. It is most probable that these internal and external worries (problems) become most apparent during the transition that occurs in post-industrial areas. There is a possibility that some of them may be able to overcome these challenges, while others could see a decline in population as a result of structural change. In light of this, the concept of urban resilience and urban economic resilience seems to give a framework that makes it simpler to comprehend and manage. (Baron, 2012)

The location of urban centres in developing nations, along with the fact that these regions are constantly evolving, makes them more hazardous. They also have a greater likelihood of being negatively impacted by the consequences of climate change. People are made more susceptible when there is a large population that is concentrated in a small area, when the economy is expanding, and when there are rapid changes in the way land is utilised. the changes in land use that come about as a direct result of unregulated urban expansion as well as the things that are harmful to the environment. Extreme weather, floods along the shore, and landslides are just examples of climate-related threats that are becoming more severe and more regular as time goes on. Cities need to be equipped to manage more before there is a chance for issues to arise. These objectives can be accomplished with the help of sound planning and urban management strategies, such as enforcing land use rules and restrictions, making available urban infrastructure that is resilient to the effects of climate change, increasing the amount of resources available to the government, and educating the general public about the dangers posed by climate change. The results will be undesirable if these precautions are not implemented. (Sitinjak et al., 2018)

To cater the ongoing rapid increase in the urban population, smart city concept entails importance to incorporate increasing population systematically. It is the need of the hour to make our cities resilient and make them adapt the sudden changes in the urban infringe. Smart cities are resilient to the rapid change and so is the focus of our study too. To cater the ongoing rapid increase in the urban population, smart city concept entails importance to incorporate increasing population systematically. It is the need of the hour to make our cities resilient and make them adapt the sudden changes in the urban infringe. Smart cities are resilient to the rapid change and so is the focus of our study too.

1.2 Justification

As the cities are growing the number of challenges is also increasing. The increasing population adding fuel to the fire. Other problems like unplanned development, struggling economy, climate change etc. affecting cities greatly. These challenges not only slowing down the progress of our cities but also inviting expertise to look into the options that provide cover to cities from these challenges. So, there is dare need to increase resilience of cities against the issues. The metrolpolitans of Pakistan requires great urban resilience. So, this research aims to study best examples of urban resilience in the World and its applicability in the context of Pakistani Cities. This study will look into the options that how the urban resilience of Pakistani Cities can be enhanced by using techniques of Smart City concept. The number of studies on urban resilience in Pakistan is very limited. This factor put emphasis to conduct this study in Pakistan.

In view of above, it can be concluded that there is a dare need to work on resilience of Urban areas that will help to build prosperous future. So this study will look into the options to enhance U.R through Smart Cities techniques. Few studies have been carried out on proposed Topic but in different context and different timeframe. Number of studies being done in context of Pakistan is in area of environmental sustainability, socio-economic sustainability, health sustainability, etc. There are literatures / journals which are helpful to the extent that they contain description of the sustainability and neighbourhood concept at a particular time and place. To fill this gap, efforts will be made to collect up-to-date data and information to complete this research.

1.3 Research Questions

After the industrial revolution, unceasing environmental degradation have become serious concern of our cities. Cities are unable to respond to these factors. In consonance with (UN Habitat, 2015) article, owing to rapid urbanization, increased population growth, urban sprawl, deletion of scarce land in suburbs, increased pollution & congestion working not less than a disaster for the urban development. The answer to these factors is resilience development that enhance the ability of urban areas to respond these factors. Kepping in view the above, following questions has been arising:

i. What are the potential of smart city for selected metropolitan?
ii. How much people are eager to adopt smart city concept?
iii. What are rules and regulations of urban planning and barriers in achieving resilience through smart city?
iv. What are the recommendations / policy for effective urban resilience?

1.4 Reasearch Objectives

The objectives of the study are:

i. To assess the potential of smart city for selected metropolitans.
ii. To assess Urban Resilience for selected metropolitans.
iii. To quantify the readiness of Experts for adopting smart cities.
iv. To suggest policy / measures for effective urban resilience.

1.6 Scope of the study

This study is important because the smart cities concept is very much important for the cities of developing countries. The number of difficulties is expanding along with the cities. The growing population is stoking the flames. Cities are significantly impacted by other issues including uncontrolled growth, a faltering economy, and climate change, among others. Our cities' growth is being slowed down by these issues, which also prompt experts to search for solutions that shield cities from them. Therefore, there is a dire need to strengthen cities' resistance against problems. So, this study will guide about the concept of smart cities through urban resilience.

Research is being done to assess the potential of being smart cities. Moreover, this study also assesses urban resilience of 4 metrolpolitans of Pakistan in case of an extreme event.

CHAPTER 2

LITERATURE REVIEW

[SMART CITIES & URBAN RESILIANCE]

2.1 Concept of Smart City

The term "smart city" initially popped up in the academic turf and literature in the year of 1998 and has since evolved to include eco-cities thanks to urban simulations and knowledge bases (Anthopoulos 2013, Anthopoulos 2015). This term has gained significant popularity since last few years and has influenced urban planning methods in both major and small cities. Although technology is indisputably the footing of a smart city but with time, it has been observed that it has proved to be insufficient to facilitate the urban inhabitants with public benefits. There must be human involvement for those who reside there, are enrolled there, are employed there, or are merely visiting on business or holiday to truly incorporate smart activities into their everyday life.

It has been noted that there are various notions associated to the concept of Smart City (SC) which is also evident in the most recent literature evaluations and research studies conducted. When we the recent literature and academic studies, we come through numerous definitions of "smart city" term but none of these definitions gained widespread acceptance which points out the complexity in this concept and term. Furthermore, it appears to be rather usual at the present to discover a useful definition on every publication (Camero & Andrés 2019). The phrase "smart city" is currently in vogue, particularly in public policy decisions and efforts. It is also frequently used in academic and scientific research (Dameri and Rosenthal-Sabroux 2014). We will use some of these definitions here in our literature.

According to Hall and Bowerman, SC is defined as "A city that continuously monitors and integrates the conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails/subways, airports, seaports, communications, water, and power, can more effectively use its resources, plan its preventive maintenance activities, and monitor security aspects while maximising services to its residents". This includes mega projects, high rise buildings and skyscrapers as well. Systems and structures will

keep track of their own health and make repairs on their own as "required" (Hall, Bowerman et al. 2000).

According to Dameri and Negre, smart city is "a well-defined topographical area where innovative technologies, such as ICT, energy production, logistics and other stakeholders work closely to provide benefits to the citizens in terms of well-being, inclusiveness and contribution, environmental superiority, and smart development; it is governed by a well-defined pool of ideas, capable of uttering the guidelines and strategy for the city government and development" (Dameri, Negre et al. 2016).

According to Giffinger, who is the most cited and admired academic author of all who worked and participated on the research related to smart city topic and field. He defined it as "A well-functioning urban center based on the concept of 'smart' amalgamation of fundings & finances and measures of self-deciding, sovereign, and knowledgeable inhabitants" (Giffinger and Pichler-Milanović 2007, Dameri and Rosenthal-Sabroux 2014).

Although the term "smart city" first debuted in 1998, its context, purpose and meaning are still unclear (Anthopoulos 2015). A few years ago, the concept of a SC appeared on the horizon of literature and it was termed as the approach or method through which "how the available information, new data and communiqué technologies can advance the working of cities" (Batty et al., 2012). Though the term smart city is becoming more and more popular (more and more cities are being called smart every day), the concept is still a work in progress.

As the city grows with time, new complexities, problems and sudden situations arise which include: environmental degradation and pollution, waste management issues, traffic related issues loke transport systems and congestion and parking issues. The resources and fundings are insufficient and cities face difficulties to counter these issues. Around the world, everything from city councils and businesses to research labs are launching initiatives in an effort to make cities better places to live. These initiatives are mostly related to build sustainable and benefitting integrated transit systems, transport related policies and underground roads and pathways.

The researchers, experts and scientist from diverse fields of sciences, belonging to different cultures, having vast and compelling history and personal and collective interests reach to a common solution to all these issues and that is: to make the city smart.

If we conclude this discussion then it is clear that some of them emphasise the components and the need to manage them collectively intelligently, while others place more emphasis on their connections. Others are more abstract and mention the benefits of living a healthy, intelligent life in the metropolis. CS/IT ideas are often explicitly mentioned, while in other conditions, they are obliquely required to attain the desired goals and attach the features as conversed.

2.2 Types & Characteristics of Smart Cities

The concept of the smart is one of the crucial parameters to achieve sustainable development goals at the global level. The smart city can be defined as **the city that has incorporated information and communication technology to ease the lives of the residents**. The development is not only made to incorporate the government development projects to bring the efficiency in the system but also the operational effectiveness can be increased. The smart city is based on the effective implementation of policies to reduce the city's problems (SHestakova, 2020).

Figure 1 Smart City Framework (SHestakova, 2020)

Smart cities are established based on the “cities with an intelligent economic, institutional, social and physical infrastructure, which ensure the centralization of their citizens in a sustainable environment” to overcome the city problems such as poverty, hosing problems, transportation network, congestion, and the institutional network. Smart cities should be resilient and sustainable cities to protect the environment and provide them equal opportunities to all the people for development (Min, Yoon, and Furuya, 2019). It is not possible to achieve the comprehensive approaches that can meet the parameters of sustainable development, but the smart cities are based on the comprehensive model of urban planning and development to resolve the environmental issues, global warming, and managing the urban problems. The inclusion of the information and communication technology is necessary to incorporate the Intelligent Transport System for mobility as well as the adoption of the Internet of Things (IoT) in the system that can ensure the excellent incorporation of urban policy to improve urban governance (Min, Yoon, and Furuya, 2019). The components of the smart city include sustainability and resilience along with connectivity, transportation network, and good governance. The smart city is an umbrella to improve the urban quality of future urban areas based on new emerging parameters such as sustainable smart environments, smart technology, smart energy, smart transportation, smart mobility, and smart government (Agwu, 2021).

Smart cities introduce smart practices and services that can give direction to the development of urban policies and planning as they can synchronize with the urban facilities. The city planner should incorporate the smart planning parameters focusing on all the sustainable smart environments, smart technology, smart energy, smart transportation, smart mobility, and smart government so that the smart city framework can be made functional. The transportation system of the smart city should be linked with the Quality and to the Viability Timeline planning dimensions (Hügel, 2017).

2.3 Component of Smart City

When we see at the numerous aspects and constituents of Smart Cities, then these components include: smart transportation system, energy efficient buildings, smart infrastructure, smart mobility, education, smart government etc. (Silva, Khan et al. 2018) connected IoT (internet of things) as a basic component with the smart cities.

Nam and Pardo believed that a city turn into a smart city when social and financial investments are done on the human capital of the city and IT infrastructure and steps are taken to encourage resilient growth and then contribute to advance the eminence of life through integrated and participation based urban governance (Nam and Pardo 2011).

Caragliu and Nam identified three major constituents of a SC and further classified these components into three further subcategories or factors which are: (1) Technology which mostly circumscribe the areas like infrastructures related to the objective existence and the software side as well (2) The Citizens which circumscribe inventiveness, variety, and indoctrination and (3) The Institutions which circumscribe the governance aspect and the policy making mechanisms and procedures (Caragliu, Del Bo et al. 2009, Nam and Pardo 2011)

Technology is crucial to SC concept because it transmutes life and work in the urban center in a momentous and essential means and big thanks goes to ICT. Well-functioning substructure is unquestionably essential, but not adequate to convert it to a SC. IT substructure and requisition are fundamentals, but if we exclude the real pledge and inclination towards the main cause to join forces with communal institutions, the private sector, volunteer officialdoms, education institutes and the people, there is no possibility of smart city. Government backing and governance policies and transparent policy making system is vital in the planning and execution of smart city initiatives (Nam and Pardo 2011).

The over-all concept of a SC encompasses generating the accurate atmosphere for the emergent creative people. A inventive city is the one standpoint of a SC (Duan, Nasiri et al. 2019). A SC is well-thought-out large association comprised of apparatuses called subsystems. Urban subclasses and subsystems accomplish roles and processes distinct in their field with explicit goals and are combined with communiqué and collaboration to accomplish the decisive goalmouth of a smart city scheme (Duan, Nasiri et al. 2019).

Key components of smart city as considered by Duan (2019) include: (1) The Smart Management (2) Smart Energy Generation and consumption (3) Smart Transportation Means and Systems (4) Smart Infrastructure Design and Planning (5) Smart health care system and procedures and (6) Smart and responsible Citizenship (Duan, Nasiri et al. 2019).

2.4 Trends in Smart City

Despite the continuous new and advanced challenges, there are so many examples of successful smart cities around the world. The distinguished examples of such cities are Seoul (from South Korea), Riverside, New York, Columbus (from USA), Mitaka (from Japan), Singapore, Montreal, Waterloo, Calgary, La Grange, Toronto (from Canada), Stockholm (from Sweden), Eindhoven (from Netherlands), Glasgow (from Scotland), Taichung (from Taiwan), The list is about cities that are smarter than other cities in the world, there are many cities that will soon become smart (Intelligent Community Forum 2017, Sanjaya, Krisna et al. 2018).

The implementation of smart cities has been found to advance the competitive spirit among the cities to upsurge the feasibility and resilience of true futuristic smart cities. Some of these cities which stay in the front in the Smart city inclination are: Santander city (from Spain), London (from UK), Barcelona (from Spain), Padova (from Italy), San Francisco (from USA), Nice (from France). These described cities are the advanced and leading examples of smart cities in the world (Silva, Khan et al. 2018).

In Indonesia, 22 local governments have launched smart city projects. The local governments are: Jakarta, Medan, Pontianak, Bandung, Pekanbaru, Aceh, Palembang, Depok, Denpasar, Yogyakarta, Tangerang, Surabaya, Bogor, Makassar, Bekasi, Padang, Banyuwangi, Lombok, Semarang, Balikpapan, Samarinda and Manado. Apart from this list, other local governments in Indonesia are also looking to implement a smart city (IISMEX 2017). The first 25 cities which are actively working on the smart city initiatives are: Makassar, Tangerang, Bandung, Cirebon, Samarinda, Badung, Sukabumi, Jambi, Banyuasin, Kutai Kartanegara, Singkawang, Banyuwangi, Tomohon, Pelalawan, Sleman, Bogor, Semarang, Bojonegoro, South Tangerang, Bekasi, Mimika, Sidoarjo, Purwakarta, Gresik and Siak (Ministry of Communication and Information Technology 2017).

While a "smart city" is more than roads connecting vehicles to reduce congestion. Smart cities are responsive, intelligent, connected and resilient. Singapore ranked first in Juniper Research's global ranking of smart cities. The other examples of in the World include New York, Seoul, Masdar etc.

2.5 Challenges in Smart City

Despite the fact that the idea of SC is generally acknowledged and put into reality in the actual world, it has been required to address current issues in some areas in order to make even more advancements. There are challenges that every new concept or technological solution to every problem faces. Smart cities also face many challenges. The design, implementation, and operation phases of smart city implementation is difficult. Some of the major obstacles include development and operating costs, equipment diversity, big data collecting and analysis, information security, and sustainability (Silva, Khan et al. 2018).

Cost optimization across a smart city's lifespan is still a challenge. Heterogeneity is additional significant challenge of SC architecture. The cities working on the integration of “smart city” concept have advance technology-based sensors, devices and godets, multi-functional devices, etc. However, there is currently a lot of discussion on how to defend smart cities and their operations from potential attacks due to the parallel development of technology and hostile threats. As a result, even though stronger security entails higher construction and maintenance expenses, infrastructure security and information security in "smart" cities are considerably improved.

The municipal network gathers a variety of data, including extremely private information on its residents, which is susceptible to numerous security risks such bypasses, cross-site logging, and data leakage. As a result, another crucial component of any smart city system is data privacy (Vogt, Nentwich et al. 2007, Papadimitriou, Garcia-Molina et al. 2010, Silva, Khan et al. 2018). As a result, smart cities endeavor to expand the possibilities and innovative approaches for using big data generation and analysis.

The key difficulties facing today's smart cities are lowering carbon footprints and making optimal use of resources to preserve the urban environment and resources for future generations. Modern cities therefore prioritize renewable energy sources while also assuring the sustainability of urban activities and non-renewable energy sources in order to reduce carbon dioxide emissions.

Due to pollution and land disposal, waste management is a significant concern in contemporary smart cities. Effective waste management prioritises accelerating the collection and separation procedures (Authority 2016). Any city development effort must overcome the formidable issue of failure management. Natural disasters like

floods, earthquakes, and hurricanes, as well as system breakdowns including infrastructure problems and network unavailability, can cause outages. The sustainability model identifies quick fixes to deal with problems and get the city back to normal (Authority 2016, Silva, Khan et al. 2018).

2.6 Urbanisation and vulnerability

Cities all across the world are becoming exposed to more and more dangers. Most of these currently imminent threats are ecological which include loss of biodiversity, issues related to water shortage and scarcity, life-threatening climate change based events, failure of climate change mitigation and adaptation and continuously increasing pressure on other naturally existing resources (Sharifi and Yamagata 2018).

3.3.1. Urban resilience through Smart City China

In China, the development of urban sustainability and urban resilience is still in its beginning and has not matured. The government of China active to turn around the things quickly and effectively though. In recent years, some of the major cities of China have tried to improve the city resilience and have introduced frequent building notions to advance urban resilience and urban sustainability of its cities across the whole country.

If we talk about the most recent steps then in the month June of 2017, the China Earthquake Administration anticipated for the execution and workability of the already existing "National Earthquake Science and Technology Innovation Project" in different cities of China. This project mainly focused on bringing in the techniques and mechanisms to make cities more resilient (Zhou, Zhu et al. 2021).

Then, in the month of September of that very year, the plan named "Beijing City Master Plan (2016-2035)" expressed the inevitability to "advance the standard of already existing urban governance system of Chinese cities and anticipated to style the cities further habitable and according to the international standards of liability". After that, in the month of January of the very next year of 2018, the plan named “Shanghai City Master Plan (2017–2035)” manifestly familiarized to an “additionally maintainable and most preferably, resilient environmental urbanity” to accomplish and cope with worldwide climate change policies and trends, expansively improvise the environmental eminence, meaningfully advance ecological eminence, and advance urban wellbeing.

After that, in the month of March of the very next year of 2019, the new plan named "Guangzhou Land and Space Master Plan (2018–2035)" suggested to shape the city of Guangzhou into a more dynamic, sustainably developed "safe and resilient city". Previously, some of the unpredictable hazards such as heavyweight rains and storms, landslides from the hilly areas, smog and fog in polluted urban centres, as well as frequent adversities, have examined the safety and stability of the Chinese cities (Zhou, Zhu et al. 2021). Therefore, the main question and goal of current city-based research is that how can the authorities upsurge the resilience and flexibility of the Chinese city structures while facing the condition of uncertainty, future threats and help in advance the forecasting and direction of urban planning of these Chinese cities.

In China, urban flooding has converted into a foremost danger to many cities (Chan et al., 2018). China has experienced very rapid and uncontrolled urbanization process. However, the expansion of subversive rainwater infrastructure (such as drainage system) is far behind populace evolution and financial commotion in cities. Above-ground infrastructure is usually "visible", highly valued and therefore given high priority in urban development. The 2017 Chinese Government Performance Report emphasizes proper urban flood risk management (Zhou, Zhu et al. 2021). The Chinese government has made great efforts to promote the development of smart cities by executing numerous policies and steps in the past decades and promote the concept of Smart City Development in China internationally.

In many "smart" cities, different types of sensor platforms have been established to assist, support and monitor the conditions in everyday life, such as traffic street cameras, signal cameras, special road deposit sensors and the quality of air and also supervising different working stations. There are, currently, 290 pilot city plans approved by China's Ministry of Housing and Urban-Rural Development since 2013. In the vision of a SC, the priority of construction is more focused on advanced technologies and economic development, ignoring green spaces, ecological preservation and protection and better urban infrastructure based on futuristic principles (Shen, Huang, Wong, Liao, & Lou, 2018; Wu, Zhang, Shen, Mo, & Peng, 2018).

Every year since 2011, the Chinese government has also carried out a thorough evaluation of the city; the evaluation papers are available to the public. The Chinese Academy of Social Sciences Information Center and the Research Center of Guomai City are responsible for carrying out the task. The reports show the ingenuity level of

initiated pilot project based smart cities in China in terms of smart and futuristic infrastructure design and planning, good urban governance and administration system, smart and knowledgeable citizens, smart economy based on sustainability principles and reliant security system through 17 ICT-based indicators.

Smart infrastructure in the report references to the authenticity and standing of a city's infrastructure system according its futuristic and technology-based initiatives and cloud platform. Smart management focuses on government network services and the use of public business platform resources. Smart means the standard of the civil network of life and the use of information. A healthy and sustainable economic system hinges on the expansion of the information industry and the ease of the usage of internet by the citizens and the multinational companies alike. And the security system encompasses mutual work based initiatives and the protection of the material and the citizens alike (Zhu, Li et al. 2019).

2.7 Concept of Urban Resilience

In recent years, the acceptance of "sustainability" has blasted in academic and policy discourse, with many clarifications for this astonishing increase (Brown 2014). In particular, sustainability has converted into an gorgeous looking vision for cities, which are frequently observed as extremely complex, dynamic systems (Batty 2008).

The origin and roots of resilience term came from the Latin word resilio, which actually means “to bounce back”. As an academic notion, its ancestries and connotation are more complex. Resilience has a theoretical complexity that is important because it allows it to work as a "boundary object," an object or general concept that covers the "social world" and therefore can facilitate interdisciplinary academic association. The connotation of Resilience is changing, letting participants to unite in a single term without needing them to settle on a precise definition. But this vagueness can brand it problematic to gadget Resilience or to advance wide-ranging indicators or procedures of it (Pendall, Foster et al. 2010, Lhomme, Serre et al. 2013).

Meerow the urban resilience expert, defined Urban Resilience as “resilience mainly denotes to the capability of an city system-and all its components socio-environmental and socio-practical systems crosswise sequential and longitudinal gauges-to uphold or swiftly return to anticipated meanings in the look of a trouble, to familiarize to variation, and to rapidly transmute structures that bound existing or forthcoming adaptive volume” (Meerow, Newell et al. 2016).

Wamsler one of the researcher who worked on the Urban Resilience concept defined it as “A disaster buoyant urban area can be taken as a urban that has accomplished to: (a) decrease or dodge existing and forthcoming threats; (b) decrease existing and forthcoming vulnerability to dangers; (c) create operative mechanisms and assemblies for disaster reply; and (d) create working apparatuses and assemblies for disaster retrieval” (Wamsler, Brink et al. 2013).

Wagner another researcher who worked on the Urban Resilience concept defined it as “The universal capacity and capability of a communal to endure anxiety, endure, acclimatize and recoil back from a disaster or tragedy and quickly move on” (Wagner, Breil et al. 2013).

Henstra another researcher who worked on the Urban Resilience concept defined it as “A climate-resilient urban area, has the capability to endure climate change pressures, to reply efficiently to climate-related threats, and to recuperate speedily from remaining undesirable effects” (Henstra and Practice 2012).

2.8 Types & Characteristics of Urban Resilience

The 2030 Agenda for Sustainable Development has been introduced in 2015 by the United Nations Member to bring peace and prosperity to the developed and developing countries. The 2030 Agenda for Sustainable Development is a blueprint based on the 17 goals and goal 11 states the “Sustainable Cities and Communities (United Nations, 2015).” The goal is explained as to “Make cities and human settlements inclusive, safe, resilient and sustainable.” Resilient cities are the need and the requirement of sustainable development that can be achieved through smart city incorporation (United Nations, 2015). Here are the following parameters of the “Sustainable Cities and Communities” goals that cover the aspects of resilient cities as

- To provide the access to adequate, safe, and affordable housing and basic services and upgrade the slums (United Nations, 2020).
- To provide the access to safe, affordable, accessible, and sustainable transport systems at all levels while keeping the needs and the requirements of the women, children, and disabilities in the introduction of the Mass Transit System.
- To ensure the inclusive and sustainable urbanization and capacity for participatory, integrated, and sustainable human settlement planning and management in all countries (United Nations, 2020)

- To reduce the number of deaths and the number of affected people and substantially decrease the direct economic losses relative to the global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- To improve the environmental quality of the cities by developing strategies to improve the air quality and waste management operations (United Nations, 2020).
- To support positive economic, social, and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning (United Nations, 2020).

There is a need to develop resilient cities to overcome the complexities of the stresses and shocks of the cities because of unplanned and haphazard development. The residents of the cities and the urban areas should be secured from any disaster and risk that can impact their lives and stability. There is a need to focus on urban resilience (World Bank, n.d.). The emerging global issues and uncontrolled urbanization can impact the sustainability of the cities to provide services to their citizens. The new parameters of resilient development should be incorporated to manage the issues of urban growth and uncontrolled urbanization.

In June 2017, the World Bank Group's City Resilience Program (CRP) was established for the major cities of the world that are based on strengthening urban resilience. The financial support to the cities was held back to make the necessary investment because the cities lack the capital and the technical assistance (World Bank, n.d.). The objective of the program was followed by the investment to build great resilience to climate and disaster risks. The urban challenges can be reduced by focusing on the integrated and spatially informed priorities to sustain the natural and built environment of the cities (World Bank, n.d.).

The measurement of urban resilience is based on the four factors as economy, environment, governance, and society that are the pillars of sustainable development. The resilient cities are having the ability to absorb, recover and prepare for the future stresses and urban shocks of the cities while focusing on as economy, environment, governance, and societal development (OECD.org., n.d.). The incorporation of urban resilience can promote sustainable development, well-being, and inclusive growth in the cities. Here are the factors to measure the urban resilience of the city as

Economy

- The diversity in the industrial development
- The dynamic way to generate economy and growth
- The factors to incorporate the innovation in the system
- Equal opportunities for all people for employment, education, services, skills training (OECD.org., n.d.).

Society

- Society should be inclusive and cohesive
- The networking system in the community is active
- The neighborhood is safe, and the citizen are having access to health care centers (OECD.org., n.d.)

Governance

- Comprehensive leadership and management
- Strategic and integrated approaches adopted by the leaders
- The government system is effective and transparent (OECD.org., n.d.)

Environment

- Diverse and sound ecosystem
- The parameters for the environmental protection and sustainability
- Coherent policies for environmental protection
- Infrastructure is adequate for the residing population (OECD.org., n.d.).

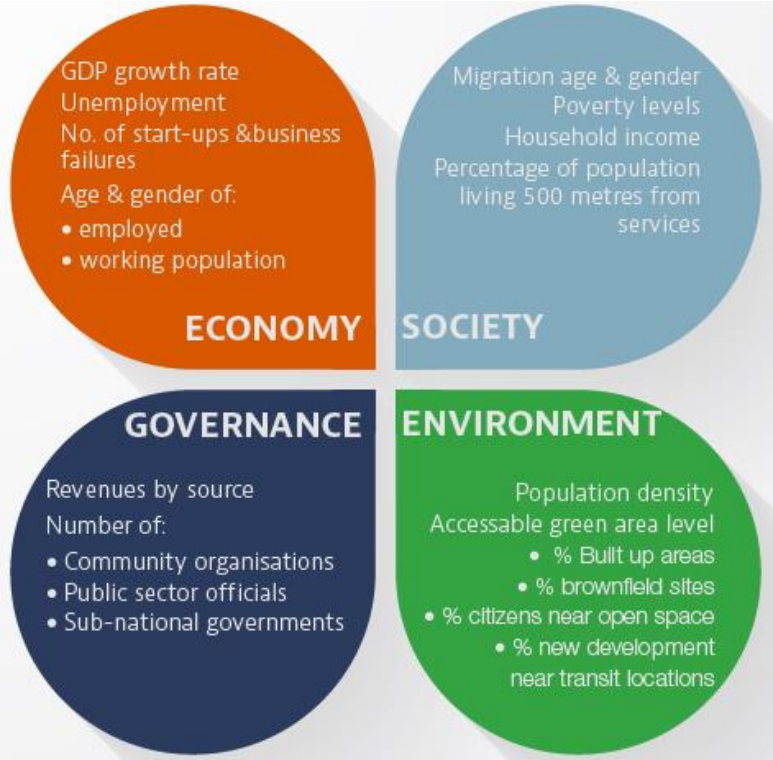


Figure 2 The factors of Urban Resilience (OECD.org., n.d.

2.8 Overview of the CITYRAP Tool

Building the capacity of local governments in risk management and resilience planning should be an important strategy to reduce the many risks that cities and their residents face. Advances in information technology offer some support towards concerns important to resilience planning. The complexity and unavailability of data in developing countries is a special concern. These issues need special mechanisms to handle it and streamline this data for better decision making and long-term planning. Sustainable Development Goals given by the United Nations and the New Urban Agenda demand proposed by the UN-Habitat, emphasized that the sustenance utensils for urban planners that retort to the urban complication matters (Spaliviero, Pelling et al. 2020). Another reply to these encounters is the City Resilience Action Planning (CityRAP) Tool which was proposed and implemented by the UN-Habitat in African countries (UN-Habitat 2019, Spaliviero, Pelling et al. 2020).

CityRAP was comprehended and established by UN-Habitat between the years 2014 and the year of 2019 in a joint venture with numerous local and municipal governments in sub-Saharan Africa and this tool mainly intends to understand, evaluate and then solve the complexities raised in any city and provide city resilience. The CityRAP tool

is constructed on participating approaches and harmony-building procedures to encompass all the related stakeholders to recognize the entrance opinions to twitch structure the city's resilience in a broadminded method, with negligeable outside backing. The equilibrium amongst city management and outside facilitation is crucial to the CityRAP placement as a instrument that allows somewhat than exceeds city leadership, tactical rational and action development, rendering to distinct primacies for universal resolutions to urban jeopardy and resilience related issues and their solutions (Spaliviero 2019).

The conceptual framework of CityRAP aims to create a coordinating setup between the external expertise and the local decision-makers and make it a participatory planning process that plans for the long-term planning for any city in the world. There are five pillars of this CityRAP tool: (1)The urban governance system and policy making process, (2) urban disaster risk management system to fight the sudden threats to city, (3) sustainable urban economy and society management, (4) sustainable urban planning and ecological management and (5) designing of advanced infrastructure and provision of basic services to the people. These stages can lead the city government in aggregation and investigating nearby accessible data, information and evidence in a technique that allows city management in tactical rational and act forecasting for plummeting urban danger and constructing urban resilience system in the city (Spaliviero, Pelling et al. 2020).

The CityRAP was mainly designed to respond to their problems by providing simple tools and methods allowing municipalities with very low management capacity to understand what complex concepts such as resilience are about, and to make them able to elaborate and to implement themselves resilience action plans (Hébert 2016).

2.9 Resilience Orientated Land Use Planning

The concept of urban resilience is applied primarily in research areas which are five in number. These areas of resilience include advanced urban and city planning, things related to the energy generation and consumption, things related to taking care of the urban communities and general public, things related to the conditions arising due to the change in the climate of areas and finally the occurrence and frequency of man-made or natural disasters and catastrophise (Ribeiro, Gonçalves et al. 2019). Urban

resilience spreads over mostly to five investigate areas: urban societies, climate change, vigor and tragedies (natural or humanity caused) and sustainable urban planning.
The new strategies being adopted to restore and renew the urban resilience will consent us to grow a additionally useful and vigorous techniques for the cities to endure and answer to diverse types of interruptions, such as troubles/limitations to the movement of the general public. By seeing the things with this point of view, the local stakeholders and investors should contemplate urban resilience as a elastic and malleable method, in relative to the altering global atmosphere and in relative to precise local circumstances and requirements (Ribeiro, Gonçalves et al. 2019).

3.3.2. Resilience Matrix for Comprehensive Urban Resilience Planning

Big cities seem to be more involved in resilience planning, based on the logic of greater resources and greater vulnerability to greater risks. Additionally, there is a positive correlation between contingency planning, risk and resilience planning. Speaking of extensions, the largest group of respondents was made up of emergency managers and engineers (Keenan and Policy 2018).
Mixing resilience rational into urban development and project is vital for constructing urban resilience. The implication of accomplishing such incorporation is highlighted in numerous policy credentials such as the famous document named as “Hyogo Framework for Action 2005–2015”, and it is also mentioned in the famous “Sendai Framework for Disaster Risk Reduction 2015–2030” (Sharifi and Yamagata 2018).
Resilience is a new notion in the turf of sustainable urban and city planning and infrastructure design and it was actually familiarized about two decades ago. Since the beginning of this century, sustainability has been receiving a lot of attention in the field of sustainable urban planning and infrastructure design based on futuristic mindset. This notion can be enlightened by the datum that the cities around the globe are visible to additional jeopardies than ever previously (Sharifi and Yamagata 2018). This chapter discusses several basic practices and interventions for integrating sustainable thinking into sustainable urban planning theory and practice. This conversation comprises of arguments for the position and reimbursements of mixing resilience into urban planning, as well as some explanations on how such incorporation can be attained.
Outdated city disaster risk management has largely focused on vulnerability valuation and the development of action strategies to reduce the vulnerability of the city and its

population. Vulnerability is a stationary idea that delivers a photograph of the state of a system and is frequently assessed before an incident occurs. However, resilience-based disaster management distinguishes the standing of considering the system dynamics and complication and goals to clarify how these undercurrents and returns alteration over chronological and longitudinal gauges. Therefore, resilience can be viewed as a dynamic property that is constantly altering and reflects changes in system vulnerability over the long period of time (Irwin, Schardong et al. 2016).

Developing a vision and strategy is one of the most important parts of any planning. Traditionally, the establishment of the expected growth path and its preservation was at the center of planning. Resilience rational queries the rationality of strategic planning on the lands that progress paths want to be continually modernized to cope with a changing profile of jeopardy and uncertainty (Sharifi and Yamagata 2018).

Understanding the constraints of planning is necessary for incorporating sustainable thinking into urban planning. It is crucial to remember that threats cannot always be neutralised because the future is unpredictable. Urban planning necessitates taking steps to comprehend and take into account the complexities and uncertainties inherent in urban planning as dynamic social and ecological systems. Mainly, experimental methods created on "learning by trying" philosophies including co-design and intradisciplinary methods that engross dissimilar shareholders in urban planning are Adopted according to the situation of the problem. It is a influential social learning approach for dealing with the ambiguity intrinsic in communal ecologies and attaining adaptive planning and design (Orleans Reed, Friend et al. 2013, Sharifi and Yamagata 2018).

Planning authorities need to comprehend the potential dangers and grow ground-breaking and effective planning and plan approaches so that the system can fail safely. By developing long-term scenarios and analyzing future changes over a longer time horizon, resilience-based planning and assessment provide greater opportunities to respond to uncertainty and complexity (Orleans Reed, Friend et al. 2013, Ahern, Cilliers et al. 2014).

3.3.3. Assessing City Resilience

In China, maximum parts are susceptible to numerous kinds of natural disasters which generally include earthquake, storm, and overflow and flash floods (Lyu, Sun, Shen, & Arulrajah, 2018). Noteworthy financial injections and investments in the sustainability

of the existing economy, the most needed infrastructure design and its planning, and most importantly the social system have been demolished by tragedies during last many years. As per the commission formed in the year 2017, named, National Development and Reform Commission (NDRC), 13 earthquakes occurred with 5.0 magnitude or higher and 43 heavy storms or rains occurred across the country. These various natural disasters caused the death of 881 people, the destruction of 153,000 houses, and the direct economic loss of RMB 301.87 billion. Therefore, risk reduction and disaster resilience building have attracted more attention in China than before.

To this date, only four Chinese cities have amalgamated the World's 100 Resilient" Cities program since the year 2014 which are: Deyang, Huangshi, Haiyan and Yiwu. These cities have not reached the epitome of the resilience yet too (Chen & Li, 2017). Just seven Chinese cities have been in lined to rank as the program of "making cities resilient" which was initiated by the UNISDR in the year 2011. These cities include Luoyang, Xining, Baofeng, Mianyang, Sanya and Chengdu (Xie, 2017). All of them promised to prepare plans to adapt to the situation and provide support strategies and resources to the city to increase its ability to withstand shocks and natural disasters. Additionally, Beijing has become the first city to include a sustainable city in its city development plans (Zhou, 2018).

The idea of urban resilience hasn't yet attained a state-wide consensus in China, despite study and preparation efforts. Additionally, the development of resilience has been separated from other national initiatives like the smart city. Despite the fact that most large cities have created their own urban sustainability plans, China lacks few national standards, guidelines, or mechanisms for assessing urban resilience. In addition, residents' perceptions of urban sustainability are limited. The basic aptitude to distinguish variation, shape inner harmony, and implement a dynamic approach in an open framework proficient of updating and thought-provoking technical standpoints is sheathing behind (Zhu, Li et al. 2019).

3.3.4. Relevance to National Needs

Certainly, disasters will keep impending with cumulative occurrence and fierceness. Tsunamis, a city of Japan, Sumatra a city in Indonesia, heavy floods in many areas of Pakistan, and powerful forest fires in different area of Australia, which cost tens of thousands of lives, these are just a few of the many recent tragedies. The sole issue is not related to climate change alone. There are many other global challenges that interact

with interdependent human societies and are developing at the pace of globalization. Therefore, climate change combines with other global challenges to cause disasters.

Therefore, the current Government in Pakistan is putting great emphasis on sound and sustainable development. The Prime Minister of Pakistan himself spoke out about the importance of Urban Planning. Consequently, Master Plans and area development zones are being framed at each level of Government. The current study will help the decision makers the need of Urban Resilience in proposed development of the country. Pakistan is one of the South Asian nations that is most vulnerable to natural disasters. From 1997 to 2016, Pakistan was the eighth-most severely hit nation by extreme weather events. Over the last ten years, the nation has sustained losses and damages that are estimated to have cost 18 billion US dollars. According to EM-DAT statistics (as of June 10, 2022), disaster-related incidents in Pakistan between 1990 and 2013 affected 83 million people and claimed 99,374 lives. Due to greater vulnerability, these incidents are occurring more frequently and having greater effects (Khan 2017, Shahid, Rana et al. 2022).

Thus, the majority of Pakistan's metropolitan regions are the least robust to disasters, with a few outliers like the nation's capital, Islamabad. They could sustain significant financial and physical losses in the event of a minor disaster. Little research has been done on resilient urbanisation in Pakistan despite significant urban issues. As a result, there is still a sizable research deficit in the nation's urban literature. This work has made an effort to close this gap while also drawing attention to a crucial problem with Pakistan's resilient Urbanisation for the next generation of urban scholars (Abdul and Yu 2020).

3.3.5. Advantages.

This study has the following advantages;

a. This study will establish a bridge between smart development and Urban Resilience.
b. This study will highlight the needs of Urban Resilience in context of Pakistani Cities.
c. This study helps the professionals Town Planners & other professionals to design sustainable neighbourhood which helps and satisfies the ultimate users.

d. It encourages the decision makers to build cities that respond to all kinds of catastrophise and disasters.
e. This study will provide guidelines for efficient execution of development works.

3.3.6. Area of Application

As the cities are growing the number of challenges is also increasing. The increasing population adding fuel to the fire. Other problems like unplanned development, struggling economy, climate change etc. affecting cities greatly. These challenges not only slowing down the progress of our cities but also inviting expertise to look into the options that provide cover to cities from these challenges. So, there is dare need to increase resilience of cities against the issues. The Islamabad being the Capital and first planned city of Pakistan requires great urban resilience. So, this research aims to study best examples of urban resilience in the World and its applicability in the context of Islamabad. This study will look into the options that how the urban resilience of Islamabad can be enhanced by using techniques of Smart City concept. The number of studies on urban resilience in Pakistan is very limited. This factor put emphasis to conduct this study in Pakistan.

This study can be applied in every field while thinking about city development. this will put emphasis on Urban Resilience and its applicability in Pakistani cities. Since cities are economic engines for any country so, healthy and sound cities are concern of everyone. This study will help Urban Planners to design and build strategies that helps to construct sustainable cities and communities. The research will add significant value to the literature. The urban resilient cities will help to collect information for natural hazard and climate change.

CHAPTER 3

METHODOLOGY

3.1 Study Area Selection

The Cities are undergoing quick changes due to the unplanned catastrophes that are happening worldwide. Cities must be resilient, or have the capacity to revert to their pre-event state, in order to sustain their essential activities. Sadly, due to the interconnection of the various infrastructure systems that make up cities, their behavior is complex. (May Haggage, 2020)

The idea of the Internet of Things (IoT) is applied in smart cities. Continuous population growth and urbanization have increased the need for creative approaches to managing urbanization with little negative influence on the environment, citizen lifestyles, and governance. Telicity, information city, and digital city concepts have been advocated as a result of the initial integration of information communication technology (ICT) into city operations. (Bhagya Nathali, 2018)

"Urban resilience is the capacity of an urban system including all of its component socio-ecological and socio-technical networks to maintain or quickly resume desired functions in the face of a disturbance, to adapt to change, and to swiftly transform systems that restrict current or future adaptive capacity" (Sara Meerow, 2015). There is a need to develop resilient cities to overcome the complexities of the stresses and shocks of the cities because of unplanned and haphazard development. The residents of the cities and the urban areas should be secured from any disaster and risk that can impact their lives and stability. There is a need to focus on urban resilience (Bank).

Pakistan is a country of South Asia and sixth most populous in the world and 22nd biggest economy. Climate calamities have severely damaged Pakistani cities. For instance, Karachi, the nation's largest metropolis, saw the worst floods in August 2020, and the summer heat in 2015 also claimed the lives of hundreds of locals. Lahore, another megacity in Pakistan, is now the third most polluted city in the world. (Anjum). Pakistan is facing economic crisis too. It is the need of the hour manage cities in a sustainable and smarter way.

So, keeping in view the above, this study aims to look into the smartness & resilience of 4 metropolitans of Pakistan i.e. Faisalabad, Lahore, Islamabad & Multan through different dimensions / indicators.

3.2 Questionnaire Design & Indicators Selection

To plead with the professional opinions questionnaire survey technique has been broadly used as a systematic technique of data collection. The questionnaire for this study was designed primarily to lead data collection from expert respondents. The questionnaire is divided into two parts. Section A will focus on the collection of personal information of respondents including type of organization, designation of respondent, academic qualifications and years of working experience. Sections B will consist barriers extracted from extensive literature. The five-point Likert scale was selected since it gives unambiguous results, which is easy to understand (Darko, Chan, Ameyaw, He, & Olanipekun, 2017). To acieve the objectives of the study the data collection has been divided into two portions. The detail is as under:-

In order to achieve objective No. i & ii, secondary data has been collected from various articles, reports & websites. To assess the smartness and resilience of the selected metropolitans different dimensions of Smart City & Urban Resilience has been selected which further divided into measurable indicators. The detail is as under:-

Smart City Dimensions:

i. Smart Economy.
ii. Smart people.
iii. Smart Mobility.
iv. Smart Governance.
v. ICT.
vi. Smart Environment.

Urban Resilience Dimensions:

i. Infrastructure Resilience.
ii. Environmental / Ecological Resilience.
iii. Physical Resilience.
iv. Economic Resilience.

In order to achieve objective No. iii, a questionnaire has been designed and data has been collected from Urban Planning experts through online surveys.

3.3 Sampling & Data Collection

The current study is mixed method research in nature, collection of data is essential to explore the unexplored thing. The current study opts detail literature review, questionnaire survey and in-depth interview as its core method of data collection. The secondary data was collected through desktop study by going through different research papers, newspaper articles, books etc. regarding Smart City & Ubran resilience indicators. The data was collected in numeric values to make a statistical comparision between selected cities. While the primary data was collected through a detailed questionnaire from Urban Planning experts of selected metropolitans through online surveys, it means that a set of questions was used to gather information from respondents.

3.3.1. Secondary Data

Secondary data collection is much easier and less costly as compared to primary data therefore first secondary data will be collected. Secondary data related to Smart City & Urban Resilience indicators is obtained via various sources encompassing journal articles, published reports, technical manuals, dissertations, newspapers, information from relevant departments.

3.3.2. Primary Data

Primary data is quantitative in nature. Data related to the perception Urban Planning Experts of selected Metropolitans is collected through questionnaire survey technique and in-depth interviews.

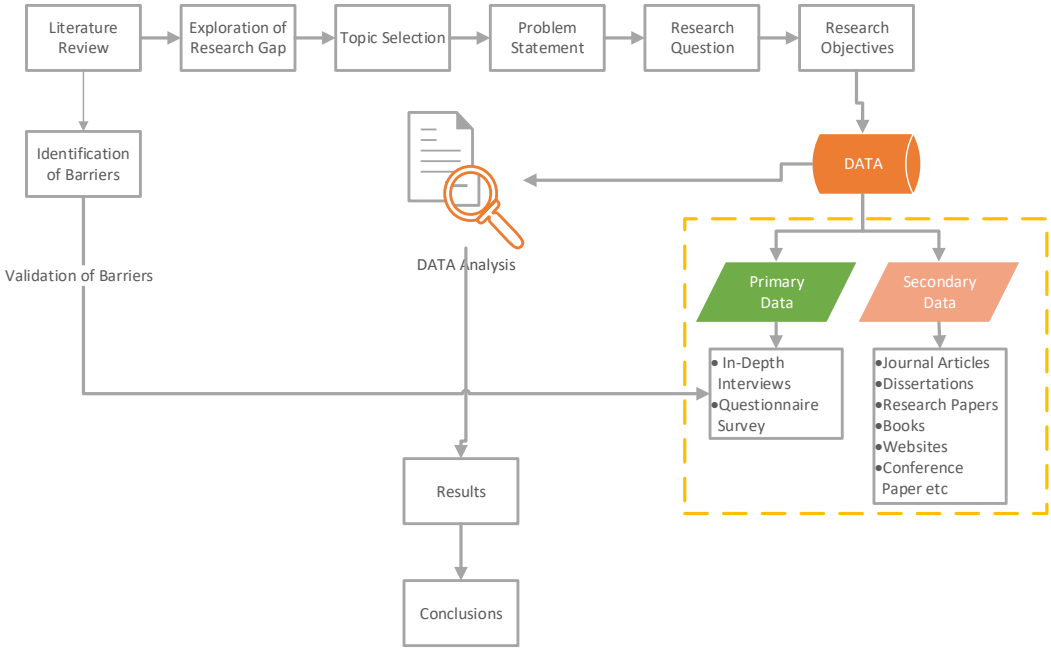


Figure 3 Data Collection steps

3.4 Analytic Technique

The data was analyzed using descriptive analysis, frequency analysis, and cross-tabulations. Data collected from survey was analysed using IBM-SPSS 23 and Microsoft Office. IBM-SPSS was used to execute various statistical analysis on collected data from questionnaire survey.

CHAPTER 4

SMART CITIES ASSESSMENT

4.1 Introduction

Assessing a city's "smartness" involves evaluating the city's ability to leverage technology and data to improve efficiency, sustainability, safety, and quality of life for its residents. Here are some key aspects to consider when assessing a city's smartness:

1. Infrastructure: The quality and efficiency of a city's infrastructure are essential for a smart city. Smart cities often have upgraded or innovative infrastructure, including smart grids, renewable energy sources, and high-speed internet connectivity.

2. Mobility: Smart cities prioritize mobility and transportation options that are sustainable, efficient, and accessible. This includes public transportation systems that are connected and integrated with technology, as well as shared mobility options such as bike-sharing or car-sharing programs.

3. Technology and Innovation: Technology is at the core of smart cities, and a city's adoption and use of technology is a key indicator of its "smartness." Smart cities often use technology to collect and analyze data, which can inform decision-making, optimize city services, and improve quality of life.

4. Sustainability: A smart city must be sustainable, meaning it is designed to minimize its environmental impact and promote the health and well-being of its residents. This involves adopting green infrastructure, promoting renewable energy, reducing waste, and prioritizing sustainable development.

5. Quality of Life: A smart city should prioritize the well-being and quality of life of its residents. This can involve initiatives such as smart healthcare, community engagement, and public safety programs that are designed to improve residents' overall experience of living in the city.

Overall, a smart city is one that leverages technology, data, and innovation to create a sustainable, efficient, and livable urban environment for its residents.

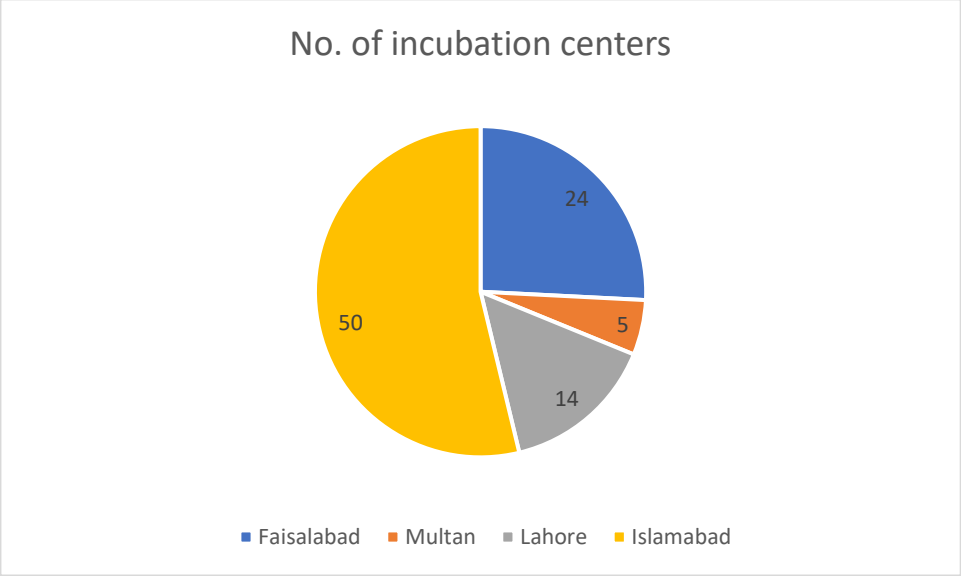
4.2 Data Analysis & Results

Entrepreneurship:

The given figures represent the number of incubation centers in four cities of Pakistan - Faisalabad, Multan, Lahore, and Islamabad - as an indicator of entrepreneurship in these cities. An incubation center is a place where startups and small businesses can receive support, resources, and mentorship to help them grow and succeed.

From the figures, it can be observed that Islamabad has the highest number of incubation centers with 50, indicating a strong focus on entrepreneurship in the capital city. Faisalabad comes in second place with 24 incubation centers, followed by Lahore with 14 incubation centers. Multan has the lowest number of incubation centers among the four cities, with only 5.

This analysis suggests that Islamabad is the most supportive city for entrepreneurs in Pakistan, with a large number of resources available for startups and small businesses to grow and succeed. Faisalabad also appears to be a relatively strong city for entrepreneurship, with a significant number of incubation centers available.

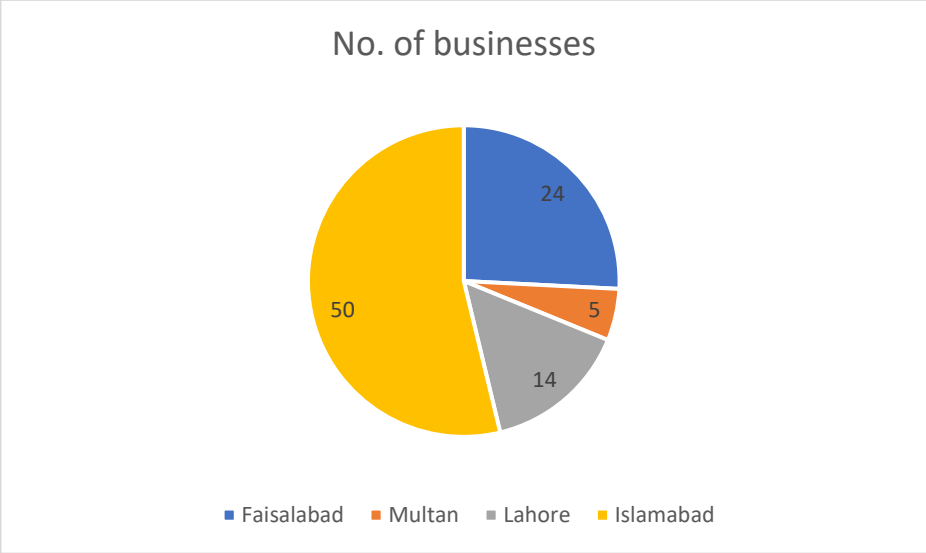


Graph 1 No. of incubation centers

Flexibility of Labour Market:

The analysis given in the figures for the indicator of Flexibility of Labour Market in the cities of Faisalabad, Multan, Lahore, and Islamabad is based on the number of businesses present in each city. This is a useful measure of the level of economic activity and the potential for job creation in each city.

According to the figures given, Lahore has the highest number of businesses with 2800, followed by Faisalabad with 1651, Multan with 1600, and Islamabad with 144. This suggests that Lahore has the most dynamic and flexible labor market among the four cities, with the highest potential for job opportunities and growth.



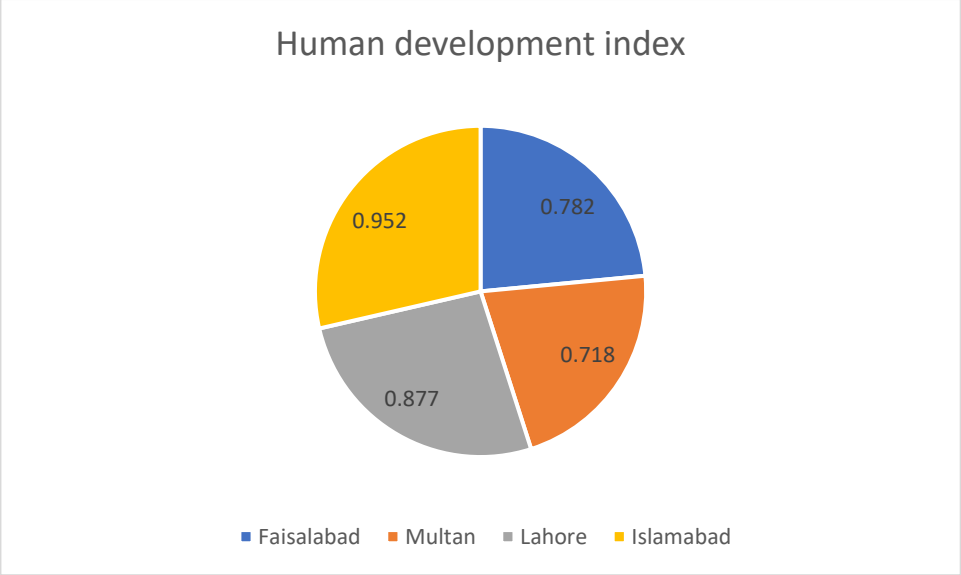
Graph 2 Number of businesses

Level of Human development:

The human development index (HDI) is a composite statistic used to measure the average level of human development within a city. It is calculated by taking into account three key dimensions of human development: health, education, and income.

The figures provided for the HDI of four cities in Pakistan - Faisalabad, Multan, Lahore, and Islamabad - show significant variations in human development levels across these cities. The highest HDI score is for Islamabad, with a score of 0.952, indicating a very high level of human development.

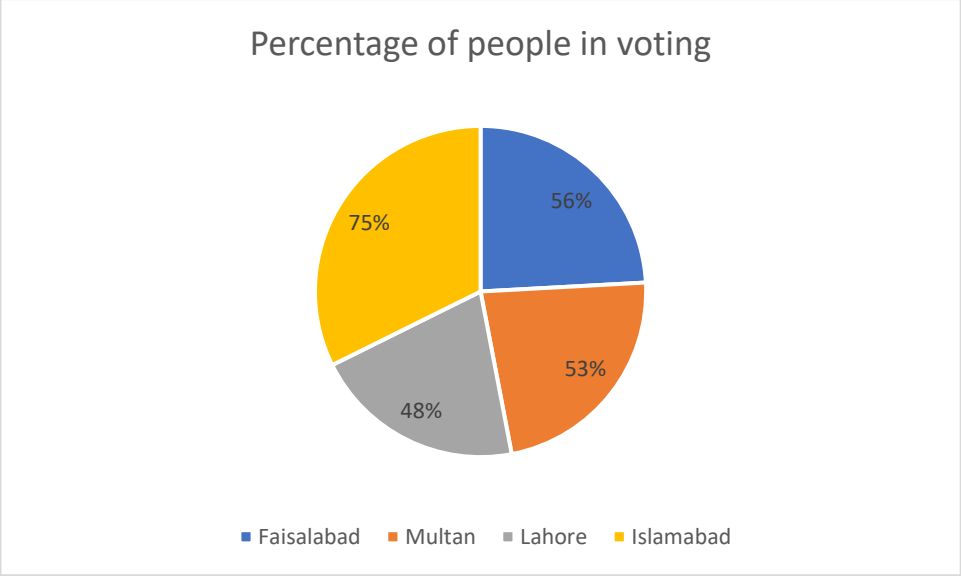
Lahore also has a high HDI score of 0.877, indicating a high level of human development. In contrast, Multan has an HDI score of 0.718, indicating a medium level of human development, and Faisalabad has an HDI score of 0.782, indicating a higher level of human development than Multan, but still lower than Lahore and Islamabad.



Graph 3 Human Development index

Participation in public events:

The given figures present the percentage of people's participation in public events, specifically voting, in four cities, namely Faisalabad, Multan, Lahore, and Islamabad. From the data, it can be observed that Islamabad has the highest percentage of voter turnout, with 75% of people participating in public events. This suggests that the people of Islamabad are more politically aware and active than the other three cities. On the other hand, Lahore has the lowest percentage of voter turnout, with only 48% of people participating in public events.



Graph 4 Percentage of people in voting

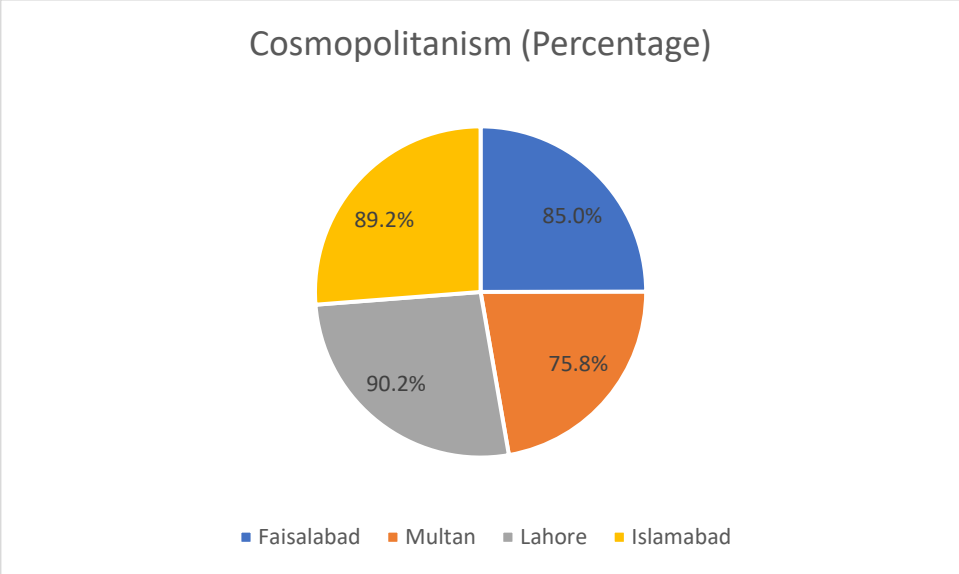
Cosmopolitanism

Cosmopolitanism is an important indicator of a smart city as it reflects the diversity and openness of a city towards different cultures, backgrounds, and perspectives. The analysis given in the figures of the four cities, Faisalabad, Multan, Lahore, and Islamabad, shows the percentage of their cosmopolitanism.

According to the analysis, Lahore has the highest percentage of cosmopolitanism among the four cities, with 90.2%. This suggests that Lahore is a diverse and inclusive city that welcomes people from different parts of the world and embraces their cultural differences.

Islamabad also has a high percentage of cosmopolitanism, with 89.2%. This indicates that the city is open to different cultures and has a diverse population. As the capital city of Pakistan, Islamabad attracts people from different regions of the country as well as from around the world due to its political, economic, and cultural significance.

Faisalabad has the highest percentage of cosmopolitanism among the three cities, with 85.0%. This shows that Faisalabad is a city that values diversity and is open to people from different cultures and backgrounds. Multan has a relatively lower percentage of cosmopolitanism, with 75.8%.



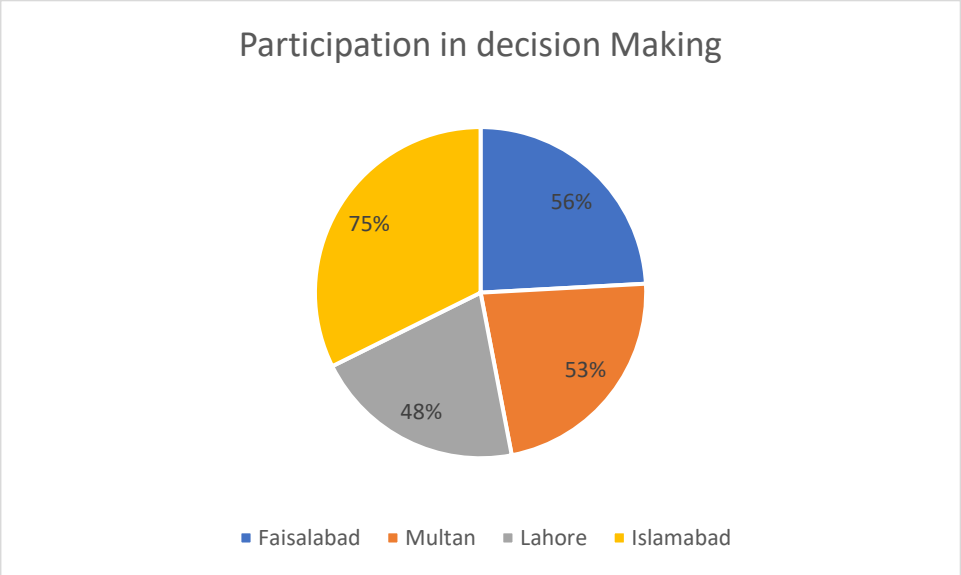
Graph 5 Cosmopolitanism (Percentage)

Participation in decision Making

The given figures present the analysis of the participation of citizens in decision-making processes in four cities, i.e., Faisalabad, Multan, Lahore, and Islamabad. The indicator,

"Participation in decision Making," reflects the extent to which the citizens of these cities are involved in the decision-making process, either directly or indirectly.

According to the figures, Islamabad has the highest percentage of citizen participation in decision-making at 75%. Faisalabad and Multan have moderate levels of citizen participation in decision-making, with 56% and 53%, respectively. In contrast, Lahore has the lowest percentage of citizen participation in decision-making at 48%.

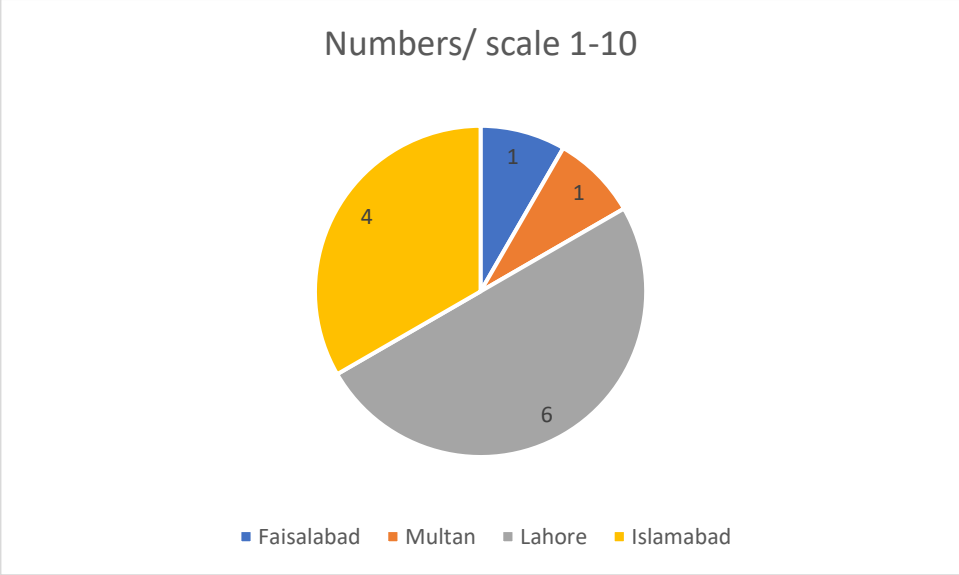


Graph 6 Participation in decision Making

Public and Social services

The figures given in the indicator of Public and Social services for the cities of Faisalabad, Multan, Lahore, and Islamabad are on a scale of 1-10. The analysis of these figures suggests that Lahore has the highest score of 6, indicating that the city provides relatively better public and social services than the other cities in the list.

On the other hand, Faisalabad and Multan both have a score of 1, indicating that these cities have poor public and social services. Islamabad has a score of 4, which suggests that it falls in between Lahore and the other two cities in terms of the quality of public and social services provided.



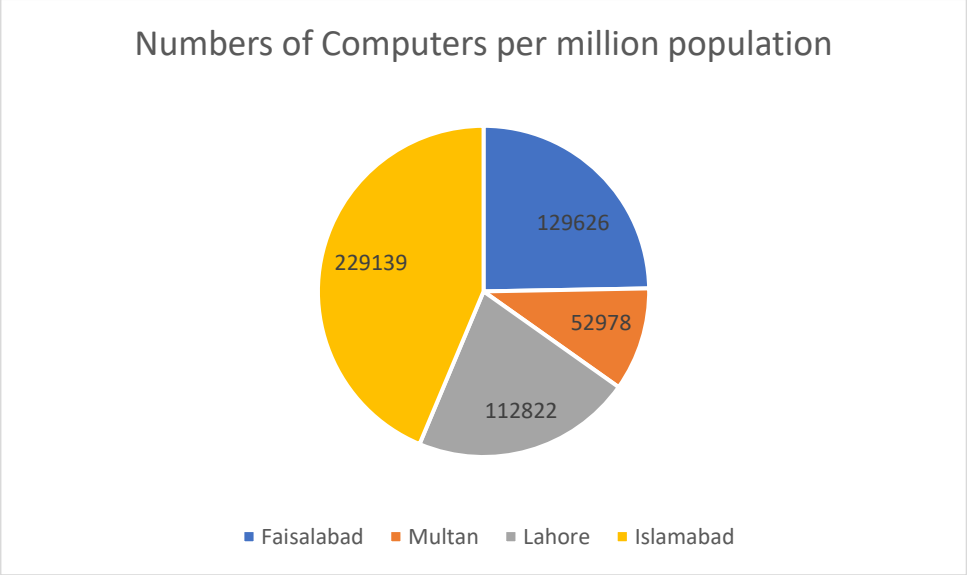
Graph 7 Public and social services

ICT:

Number of computers per million population:

The given figures represent the number of computers per million population in four cities of Pakistan, namely Faisalabad, Multan, Lahore, and Islamabad. This indicator falls under the category of Information and Communication Technology (ICT), which is an important aspect of smart cities.

Looking at the numbers, we can see that Islamabad has the highest number of computers per million population, with 229,139 computers. This could be due to Islamabad being the capital city of Pakistan and home to a large number of government offices, businesses, and institutions. On the other hand, Multan has the lowest number of computers per million population, with only 52,978 computers. While Islamabad has more than four times the number of computers per million population as Multan, Lahore and Faisalabad also show relatively high numbers of computers per million population, with 112,822 and 129,626 respectively.

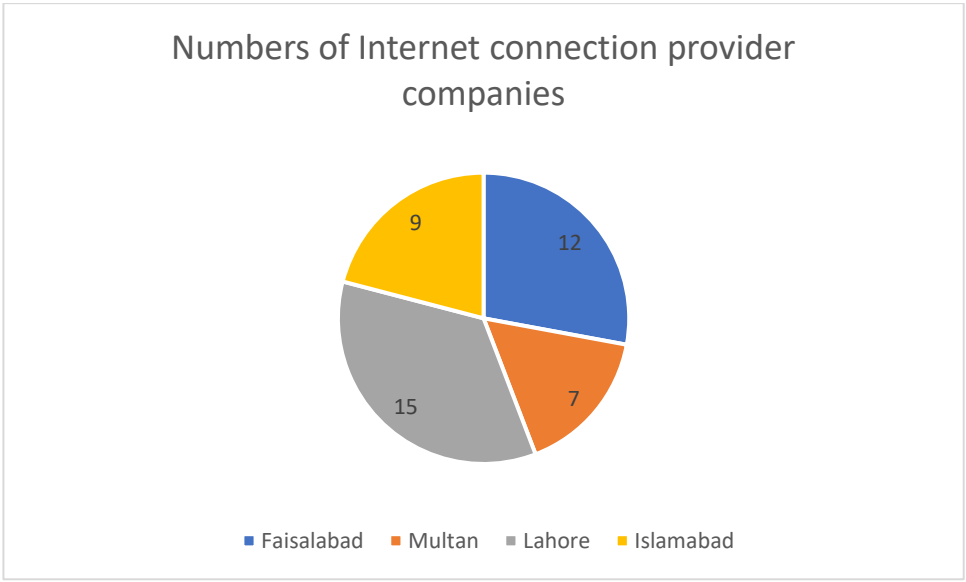


Graph 8 Numbers of Computers per million population

Number of Internet connection provider companies:

The given figures represent the number of internet connections in four cities of Pakistan: Faisalabad, Multan, Lahore, and Islamabad. These cities are often considered as emerging smart cities due to their rapid urbanization, increasing population, and adoption of advanced technologies in different aspects of urban life.

The analysis of the figures shows that Lahore has the highest number of internet connections among these four cities, with a total of 15. Faisalabad comes in second with 12 internet connections, followed by Islamabad with 9, and Multan with 7.

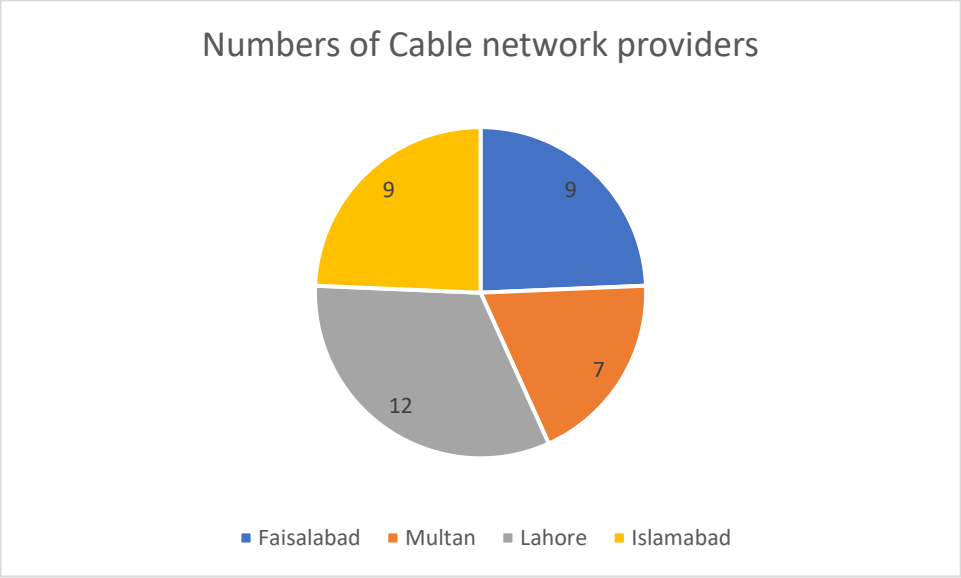


Graph 9 Numbers of Internet connection provider companies

Number of Cable network providers:

The given figures represent the number of cable network providers in four different cities of Pakistan: Faisalabad, Multan, Lahore, and Islamabad. This indicator, ICT (Information and Communication Technology), is an essential component of smart cities that aims to improve the quality of life and enhance the efficiency of various urban services by leveraging digital technologies.

From the given data, we can observe that Lahore has the highest number of cable network providers (12) compared to the other three cities. Islamabad and Faisalabad have the same number of cable network providers (9), which suggests that both cities have almost similar ICT infrastructure and services. Multan has the lowest number of cable network providers (7) compared to the other three cities.



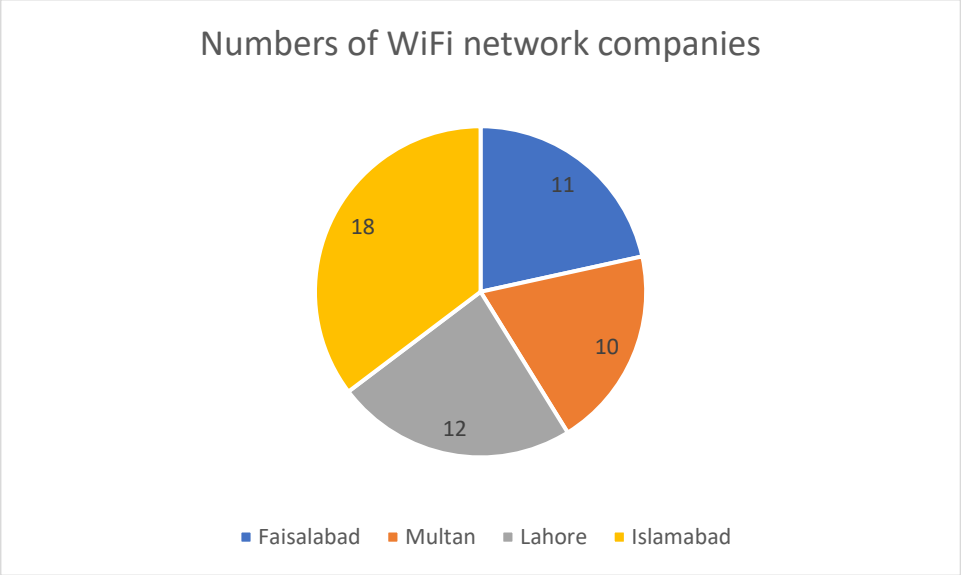
Graph 10 Numbers of Cable network providers

Numbers of WiFi network companies:

The given figures represent the number of WiFi network companies operating in four cities of Pakistan - Faisalabad, Multan, Lahore, and Islamabad. The data is related to the Information and Communication Technology (ICT) aspect of smart cities, which is a critical component in building and maintaining a smart city infrastructure.

From the given figures, we can observe that Islamabad has the highest number of WiFi network companies, with 18 operating in the city. This indicates that Islamabad has a robust and well-developed ICT infrastructure, which is essential for a city to be considered 'smart.' Lahore follows closely with 12 WiFi network companies, which suggests that the city has a reasonably advanced ICT infrastructure, although not as

much as Islamabad. Faisalabad and Multan have 11 and 10 WiFi network companies, respectively.



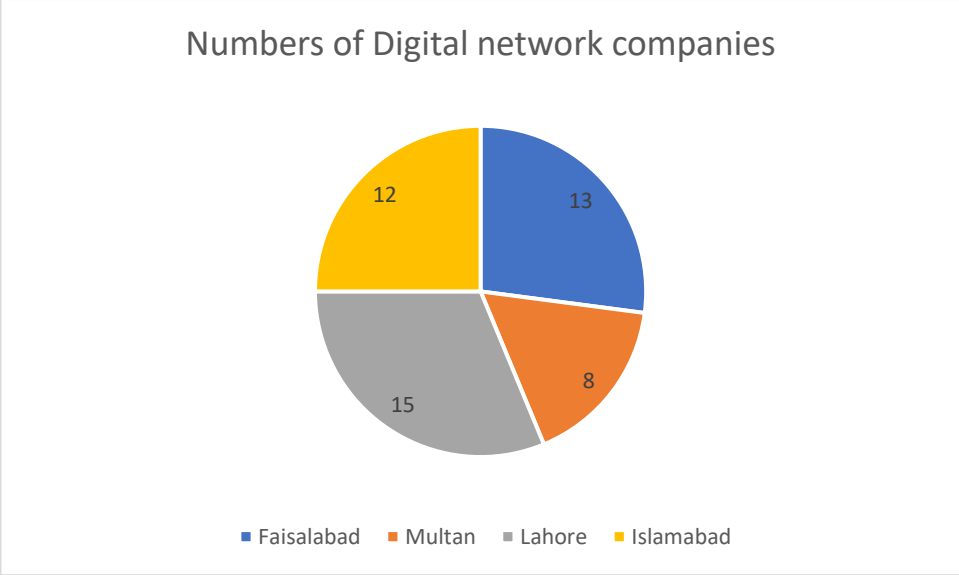
Graph 11 Numbers of WiFi network companies

Numbers of Digital network companies:

The figures given in the indicator of smart cities, specifically regarding the ICT aspect, provide some useful insights into the digital network companies' presence in the four Pakistani cities: Faisalabad, Multan, Lahore, and Islamabad.

Firstly, the data reveals that Lahore has the highest number of digital network companies, with a count of 15. This indicates that Lahore is a more developed city in terms of ICT infrastructure and has a thriving digital economy. On the other hand, Multan has the lowest number of digital network companies with only 8, which indicates that it may be lagging behind other cities in this aspect.

Secondly, Faisalabad and Islamabad have almost similar numbers of digital network companies, with 13 and 12 respectively.

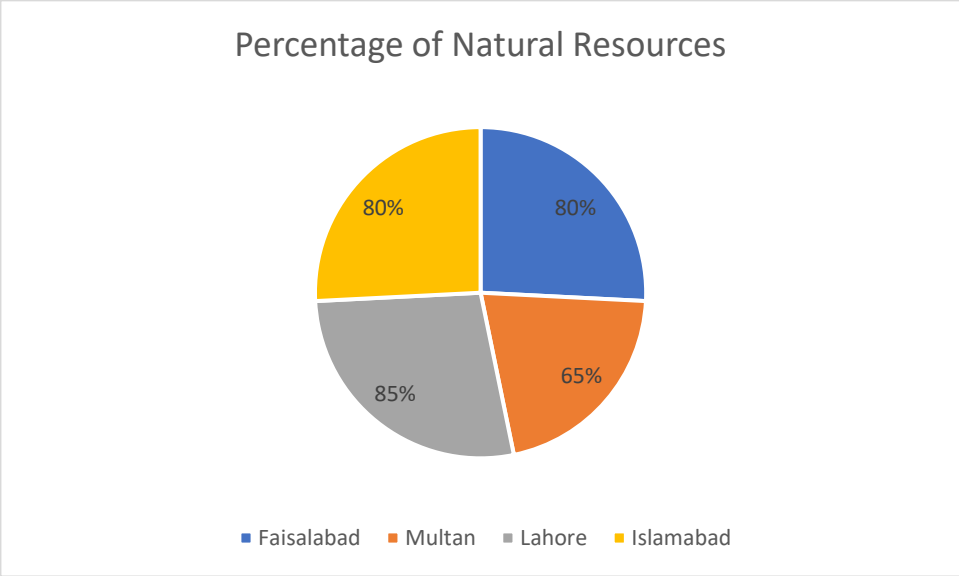


Graph 12 Numbers of Digital network companies

Natural condition:

The figures provided in this indicator of smart cities represent the level of natural resources available in the cities of Faisalabad, Multan, Lahore, and Islamabad. The data shows the percentage of natural resources present in each city, which can have a significant impact on their sustainability and overall quality of life for residents.

According to the figures, Lahore has the highest percentage of natural resources among the cities listed, with 85%. Similarly, Faisalabad and Islamabad both have an 80% percentage of natural resources, Multan has a slightly lower percentage of natural resources, with 65%.



Graph 13 Percentage of Natural Resources

4.3 Summary of the Chapter

The assessment of a smart city's capabilities involves evaluating its ability to use technology and data to improve efficiency, sustainability, safety, and quality of life. Smart cities have upgraded or innovative infrastructure, prioritize sustainable and accessible mobility options, use technology to collect and analyze data for decision-making, promote environmental sustainability, and prioritize residents' quality of life through initiatives such as smart healthcare and public safety programs. Ultimately, a smart city leverages technology, data, and innovation to create a sustainable, efficient, and livable urban environment for its residents. Urban resilience is the ability of a city or urban area to adapt, respond and recover from the challenges and shocks that it may face. The concept of urban resilience is increasingly important as cities are facing a growing number of challenges, such as climate change, natural disasters, economic crises, and social and political upheavals. In this context, the resilience of a city is critical to its ability to maintain its functions, services and quality of life for its inhabitants.

In the context of Pakistan, a study has observed that Islamabad has demonstrated more urban resilience than Lahore, Faisalabad, and Multan, in four key dimensions of resilience: infrastructure, environmental, physical, and economic resilience. The observation that Islamabad has demonstrated more urban resilience than Lahore, Faisalabad, and Multan can be attributed to its relatively well-designed and maintained infrastructure, green and clean environment, low risk of natural disasters, and diverse and growing economy.

CHAPTER 5

URBAN RESILIANCE ASSESSMENT

5.1. Introduction

Assessing urban resilience involves evaluating a city's ability to withstand and recover from shocks and stressors, such as natural disasters, climate change, economic crises, and social disruptions. Here are some key aspects to consider when assessing urban resilience:

1. Physical Infrastructure: A resilient city must have robust and adaptable physical infrastructure that can withstand and recover from shocks and stressors. This includes infrastructure such as buildings, transportation systems, water and sewage systems, and power grids.
2. Environmental Sustainability: A resilient city must be sustainable and able to adapt to changing environmental conditions. This includes initiatives such as reducing greenhouse gas emissions, promoting renewable energy sources, and adopting green infrastructure.
3. Social Equity: A resilient city must prioritize social equity and ensure that all residents have access to the resources and support they need to withstand and recover from shocks and stressors. This includes addressing issues such as income inequality, affordable housing, and access to healthcare and education.
4. Economic Stability: A resilient city must have a strong and diverse economy that can withstand economic shocks and provide residents with opportunities for employment and economic mobility.
5. Community Engagement: A resilient city must engage with and empower its residents to participate in resilience-building initiatives. This includes fostering community networks, promoting citizen-led initiatives, and ensuring that residents have access to information and resources.

Overall, assessing urban resilience involves evaluating a city's ability to withstand and recover from shocks and stressors, while also promoting sustainability, social equity,

and economic stability. A resilient city is one that is able to adapt and thrive in the face of challenges, while also ensuring the well-being and prosperity of its residents.

5.2. Data Analysis & Results

Urban Resilience:

Urban resilience is the capacity of a city to respond, adapt and recover from a wide range of shocks and stresses, such as natural disasters, climate change, economic downturns, and social crises. The analysis of urban resilience involves identifying vulnerabilities and strengths within the urban systems, evaluating the level of preparedness and response mechanisms, and developing strategies to enhance resilience. Following are the indicators taken for four cities i-e, Faisalabad, Multan, Lahore and Islamabad.

Water:

Urban resilience refers to the ability of a city to adapt and recover from various shocks and stresses, including natural disasters, economic downturns, and social upheavals. One critical factor that plays a significant role in urban resilience is the availability and management of water resources. In this comparative analysis, we will examine the water management practices of four Pakistani cities, Faisalabad, Multan, Lahore, and Islamabad, and their implications for urban resilience.

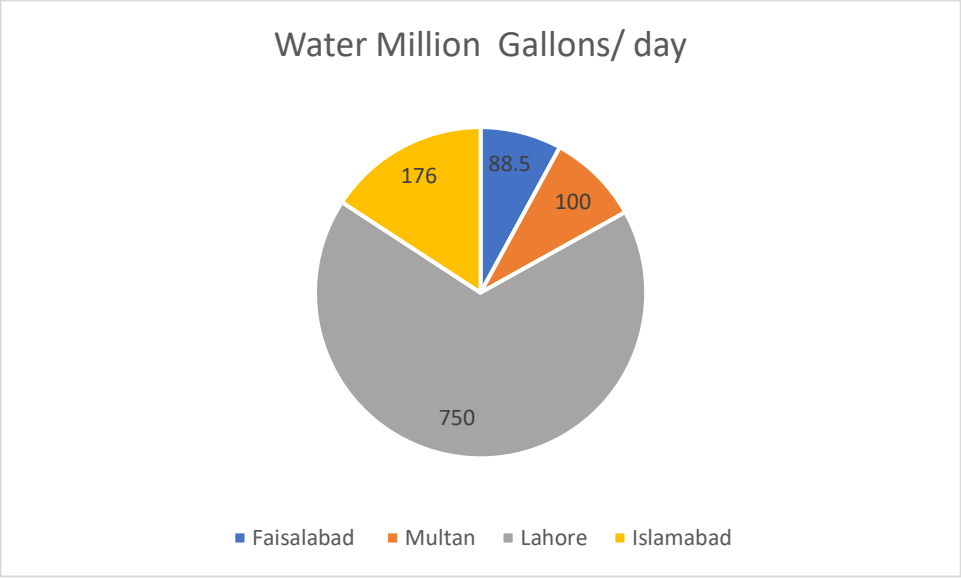
Faisalabad, with a population of over 3.2 million, has a water supply of 88.5 million gallons per day (MGD). The city primarily relies on the groundwater extracted from the Upper and Lower Bari Doab Canal and the Lower Chenab Canal. However, the groundwater is severely depleted due to over-extraction, which has resulted in declining water quality and quantity. The city is facing a severe water crisis, with residents receiving water for only a few hours a day.

Multan, with a population of over 1.8 million, has a water supply of 100 MGD. The city relies on the River Chenab as its primary source of water, but the river's water quality is compromised due to industrial and agricultural pollution. The city has taken several initiatives to address the issue, including constructing a water treatment plant and establishing a solid waste management system. However, the city still faces a water shortage, and many residents do not have access to clean drinking water.

Lahore, with a population of over 11 million, has a water supply of 750 MGD, making it the largest city in Pakistan in terms of water availability. The city sources its water

from the Indus River and the Upper Bari Doab Canal. However, like many other cities in Pakistan, Lahore is facing severe water management challenges, including groundwater depletion, water pollution, and inefficient water use practices. The city has taken several initiatives to address these challenges, such as building new water treatment plants and implementing a rainwater harvesting system.

Islamabad, with a population of over 1.2 million, has a water supply of 176 MGD, which is sourced from the Simly and Khanpur Dams. The city has invested heavily in water infrastructure, including constructing new water treatment plants, expanding the distribution network, and promoting water conservation practices. However, the city still faces challenges such as water pollution, leakages, and low water pressure in some areas.



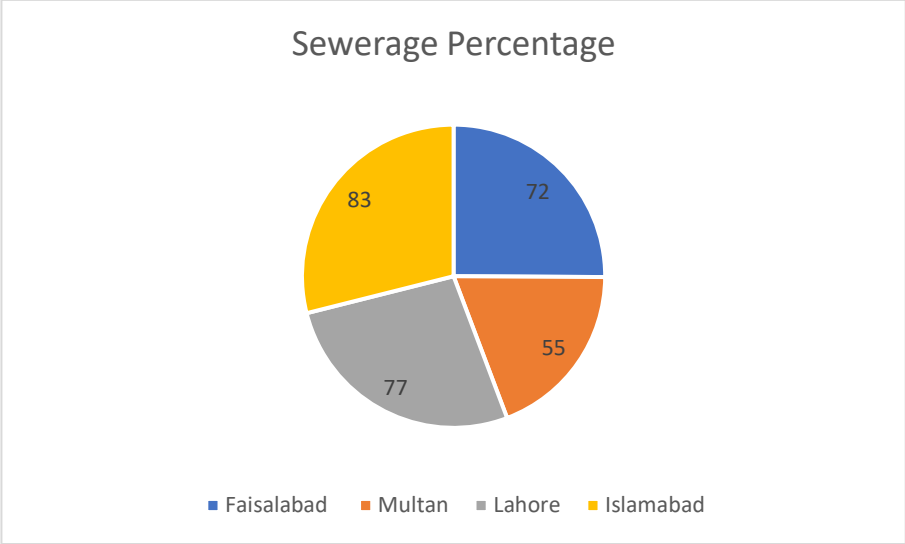
Graph 14 Water Million Gallons/ day

Sewerage:

Urban resilience is a crucial factor that determines a city's ability to withstand and recover from disruptive events such as natural disasters, pandemics, and other crises. Sewerage is one of the critical components of urban resilience as it plays a vital role in maintaining public health, sanitation, and environmental sustainability. In this comparative analysis, we will examine the sewerage system of four cities in Pakistan, namely Faisalabad, Multan, Lahore, and Islamabad, based on their percentage score.

According to the data provided, the sewerage system in Islamabad has the highest percentage score of 83, indicating a robust and efficient system. Lahore follows closely with a score of 77, while Faisalabad has a score of 72, and Multan has a score of 55.

The higher scores of Islamabad and Lahore could be attributed to their better urban planning and management, as well as their larger budgets for infrastructure development and maintenance. These cities also have a higher population density, which necessitates a more comprehensive and efficient sewerage system.

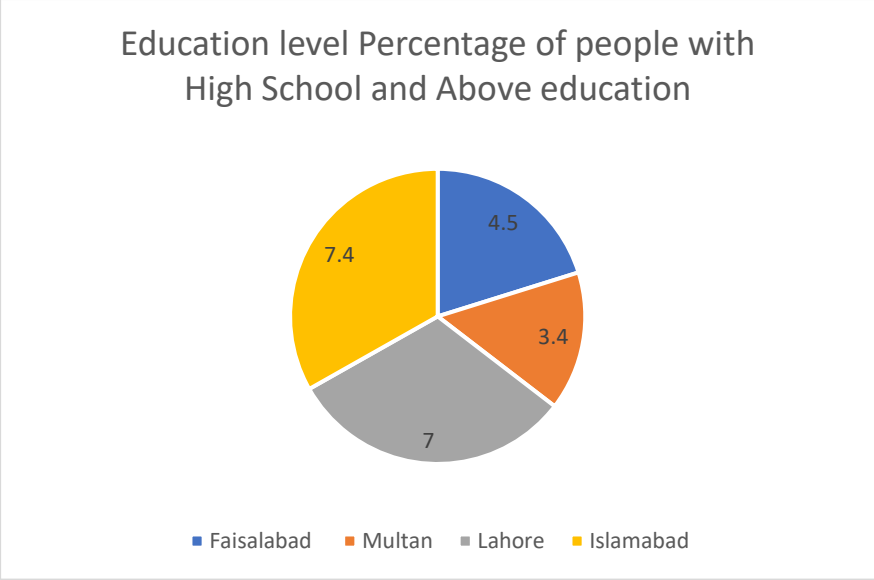


Graph 15 Sewerage Percentage

Education level

Higher education levels can lead to better employment opportunities, higher incomes, and improved access to resources, which can enhance a city's ability to withstand and recover from shocks. In this comparative analysis, we will look at the education levels in four major cities in Pakistan: Faisalabad, Multan, Lahore, and Islamabad. Specifically, we will examine the percentage of people with high school and above education in each city.

According to the data, Islamabad has the highest percentage of people with high school and above education, at 7.4%. Lahore follows closely behind with 7%, while Faisalabad and Multan have significantly lower percentages of 4.5% and 3.4%, respectively.

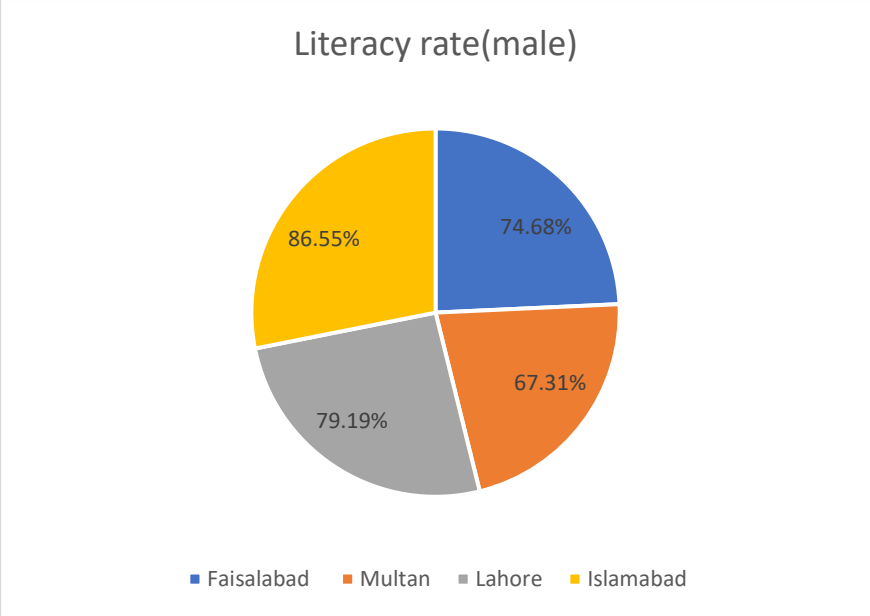


Graph 16 Education level Percentage of people with High School and Above education

Literacy rate (male)

A comparative analysis of the literacy rates of males in the cities of Faisalabad, Multan, Lahore, and Islamabad reveals significant differences between these cities. According to the data, the literacy rate among males is highest in Islamabad at 86.55%, followed by Lahore at 79.19%. Faisalabad has a literacy rate of 74.68%, and Multan has the lowest literacy rate among the four cities at 67.31%.

These differences in literacy rates can have a significant impact on a city's resilience. Higher literacy rates among males are typically associated with greater economic opportunities, as educated individuals are better equipped to enter and succeed in the workforce. Additionally, higher literacy rates can lead to improved health outcomes, as individuals are more likely to understand and follow health guidelines and access medical services.



Graph 17 Literacy rate(male)

Literacy rate (female)

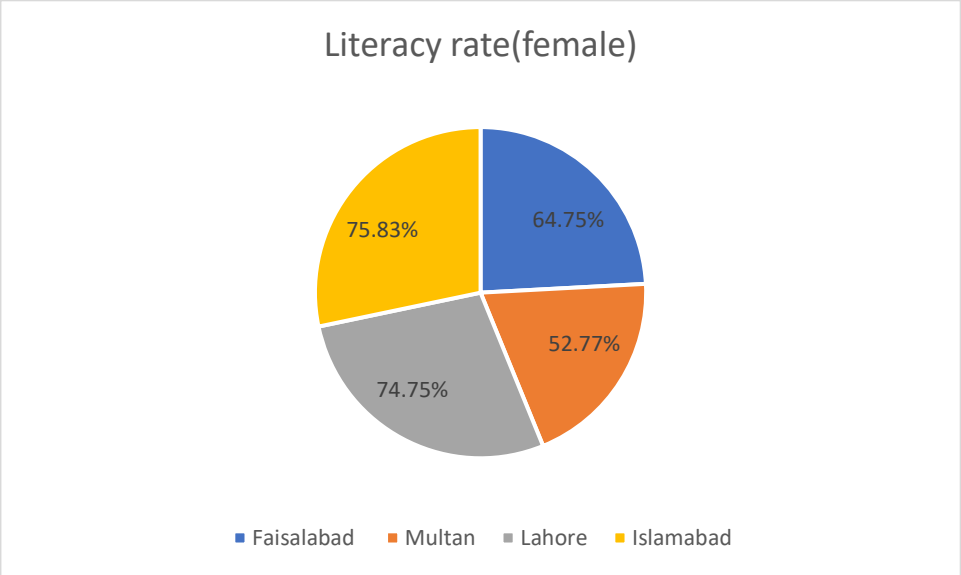
A comparative analysis of the literacy rate for females in four major cities of Punjab - Faisalabad, Multan, Lahore, and Islamabad - reveals significant variations in their levels of urban resilience.

Faisalabad, with a female literacy rate of 64.75%, has the lowest level of urban resilience among the four cities. This indicates that a significant proportion of women in the city may not have the necessary skills and knowledge to actively participate in the city's economic, social, and political activities. As a result, Faisalabad may face greater challenges in building a sustainable and inclusive urban ecosystem that can withstand and recover from various shocks and stresses.

Multan, with a female literacy rate of 52.77%, also faces significant challenges in building urban resilience. The low literacy rate among females in the city could limit their access to education, healthcare, and economic opportunities, which could further exacerbate their vulnerability to various shocks and stresses.

Lahore, with a female literacy rate of 74.75%, performs better than Faisalabad and Multan in terms of urban resilience. The relatively high literacy rate among females in the city indicates that they have greater access to education, healthcare, and economic opportunities, which could enhance their ability to contribute to the city's development and resilience.

Islamabad, with a female literacy rate of 75.83%, has the highest level of urban resilience among the four cities. The high literacy rate among females in the city suggests that they have better access to education, healthcare, and economic opportunities, which could enhance their ability to withstand and recover from various shocks and stresses. This could also contribute to building a more sustainable and inclusive urban ecosystem in the city.



Graph 18 Literacy rate(female)

Health Coverage:

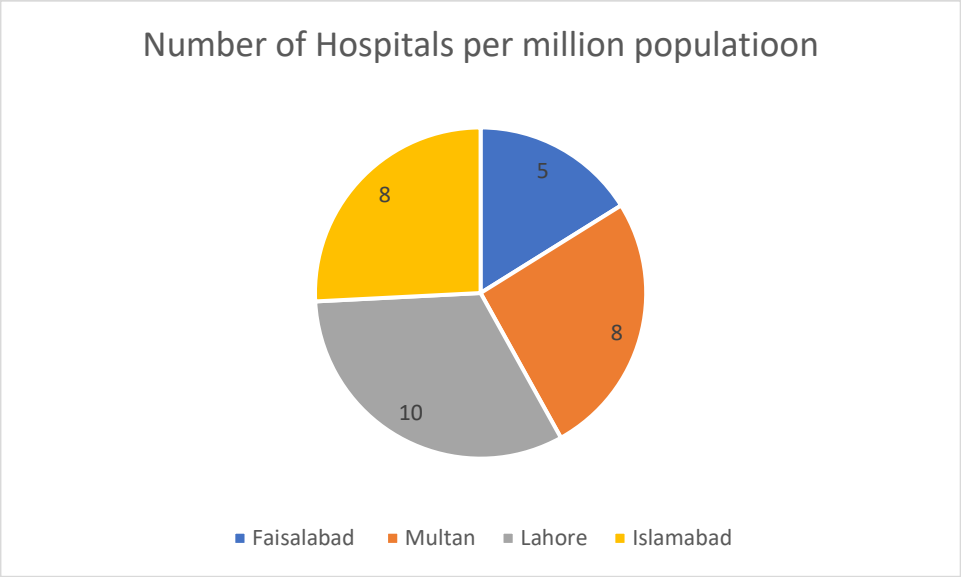
According to the data, Lahore has the highest number of hospitals per million populations with a ratio of 10 hospitals. Islamabad and Multan have an equal number of hospitals with 8 hospitals per million populations. Faisalabad, on the other hand, has the lowest number of hospitals with a ratio of 5 hospitals per million population.

This data shows that Lahore has a relatively better health coverage compared to the other three cities. The higher number of hospitals indicates that the city has more healthcare facilities available for its residents. This can lead to faster responses in emergencies, improved access to medical care, and overall better health outcomes.

Islamabad and Multan have a similar number of hospitals, indicating that their health coverage is relatively similar. However, both cities have lower numbers of hospitals than Lahore, which may result in some challenges in providing adequate healthcare services to their populations.

Faisalabad has the lowest number of hospitals per million populations, which may hinder the city's ability to respond to emergencies and provide timely medical care to

its residents. The lower health coverage in Faisalabad could be a potential cause of concern for the city's overall resilience, particularly in the event of a health crisis such as a pandemic.



Graph 19 Number of Hospitals per million populatioon

Pollution Index:

Urban resilience is the capacity of a city or a community to withstand and recover from shocks and stresses, including natural disasters, economic disruptions, and social unrest. Environmental sustainability is one of the key factors that contribute to urban resilience, as it ensures the long-term viability of a city's natural resources and ecosystems.

One of the most significant environmental challenges that cities face is air pollution, which can cause respiratory problems, cardiovascular diseases, and other health issues. To assess the level of air pollution in different cities in Pakistan, we can use the Air Quality Index (AQI), which measures the concentration of various pollutants, such as particulate matter (PM), nitrogen dioxide (NO2), and sulfur dioxide (SO2).

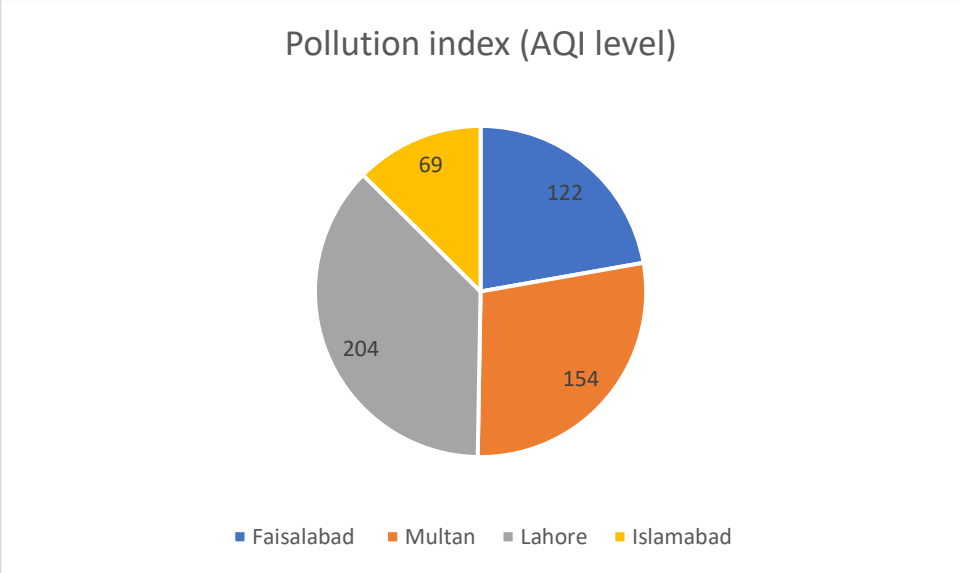
Based on the AQI data available for Faisalabad, Multan, Lahore, and Islamabad, a conducted comparative analysis has been conducted of these cities' environmental sustainability and their potential for urban resilience.

According to the data, Faisalabad has an AQI level of 122, indicating moderate air pollution. Multan has a higher AQI level of 154, indicating unhealthy air quality for sensitive groups, such as children and the elderly. Lahore has the highest AQI level among these cities, with a reading of 204, indicating very unhealthy air quality that can

cause significant health problems. On the other hand, Islamabad has the lowest AQI level of 69, indicating good air quality.

This analysis suggests that Islamabad is the most environmentally sustainable city among these four cities, as it has the lowest level of air pollution. This factor can contribute to Islamabad's resilience to environmental shocks and stresses, as the city's natural resources and ecosystems are less likely to be degraded by pollution.

In contrast, Lahore faces significant environmental challenges due to high levels of air pollution. This factor can pose a threat to the city's long-term viability and may negatively impact its capacity to withstand and recover from shocks and stresses.



Graph 20 Pollution index (AQI level)

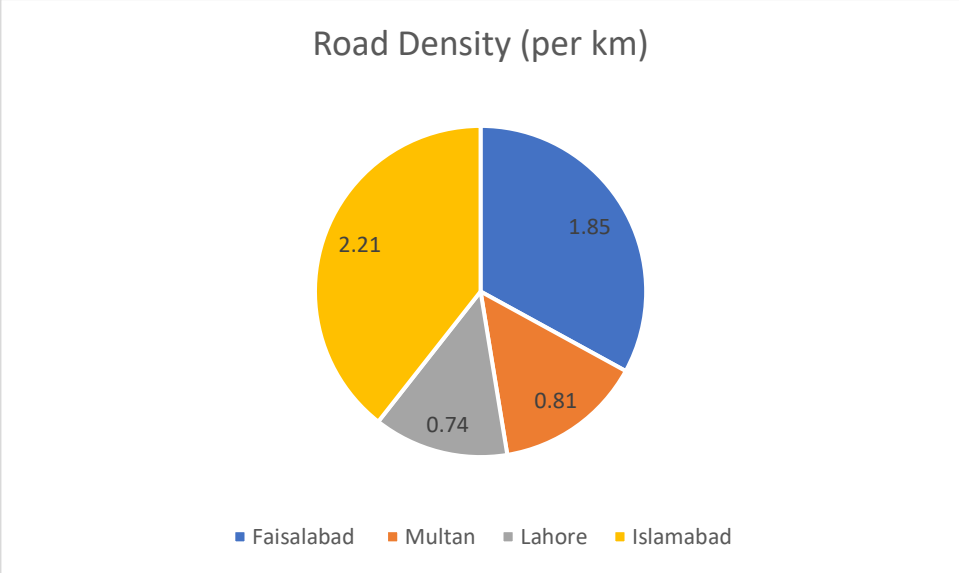
Road Density:

Urban resilience refers to the ability of a city to withstand and recover from shocks and stresses, such as natural disasters, economic downturns, and social crises. One factor that contributes to urban resilience is road density, which measures the length of roads per unit of area. In this context, a comparative analysis of road density in four Pakistani cities - Faisalabad, Multan, Lahore, and Islamabad - can shed light on their relative resilience.

According to the data provided, Islamabad has the highest road density of 2.21 km per km, followed by Faisalabad with 1.85 km per km. Multan has a road density of 0.81 km per km, while Lahore has the lowest road density of 0.74 km per km.

The high road density in Islamabad suggests that the city has invested heavily in transportation infrastructure, which could enhance its ability to respond to crises by facilitating the movement of people and goods. On the other hand, the low road density in Lahore could be a potential challenge for its resilience, as it may limit the city's capacity to mobilize resources and respond effectively in the face of shocks and stresses.

However, it is important to note that road density alone cannot determine a city's resilience. Other factors, such as the quality of road infrastructure, public transportation systems, and emergency response services, must also be taken into account.



Graph 21 Road Density (per km)

Housing units (per million population):

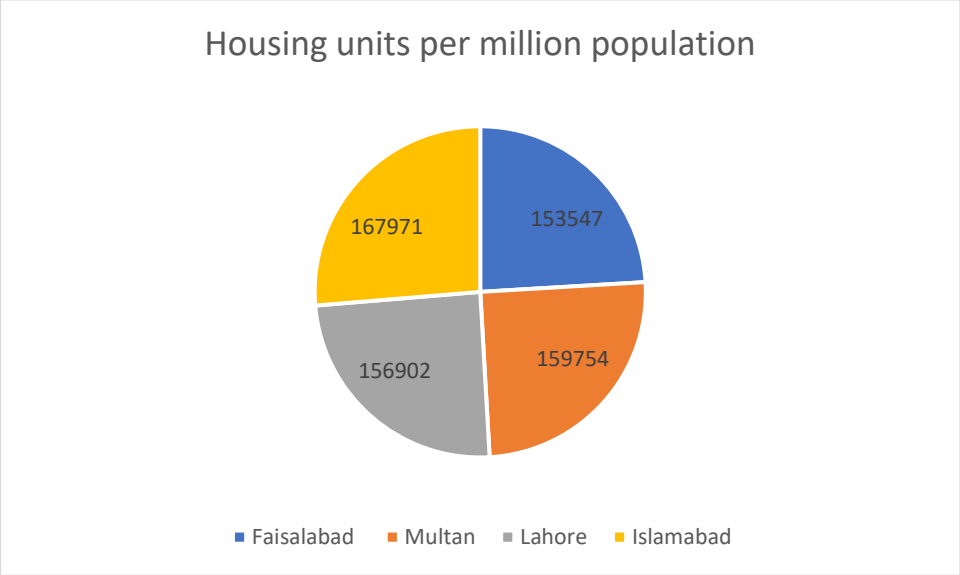
A comparative analysis of the housing units per million population in four cities in Pakistan - Faisalabad, Multan, Lahore, and Islamabad - reveals interesting insights into their urban resilience.

According to the data, Islamabad has the highest number of housing units per million population at 167971, followed by Multan at 159754, Lahore at 156902, and Faisalabad at 153547. These figures suggest that Islamabad is better prepared to handle shocks and stresses that may arise due to the availability of housing units.

Having a higher number of housing units per million population can lead to several benefits. For example, it can help to reduce the burden on existing housing stock, which can often become overcrowded and inadequate. It can also increase the availability of

affordable housing options, which can benefit low-income households and help to reduce homelessness.

In terms of urban resilience, having adequate housing units can also provide a stable living environment for residents. This can be particularly important during times of stress, such as natural disasters or economic downturns. Additionally, having enough housing units can help to attract and retain a skilled workforce, which can contribute to the overall economic resilience of a city.



Graph 22 Housing units per million population

Industrial units (per million population):

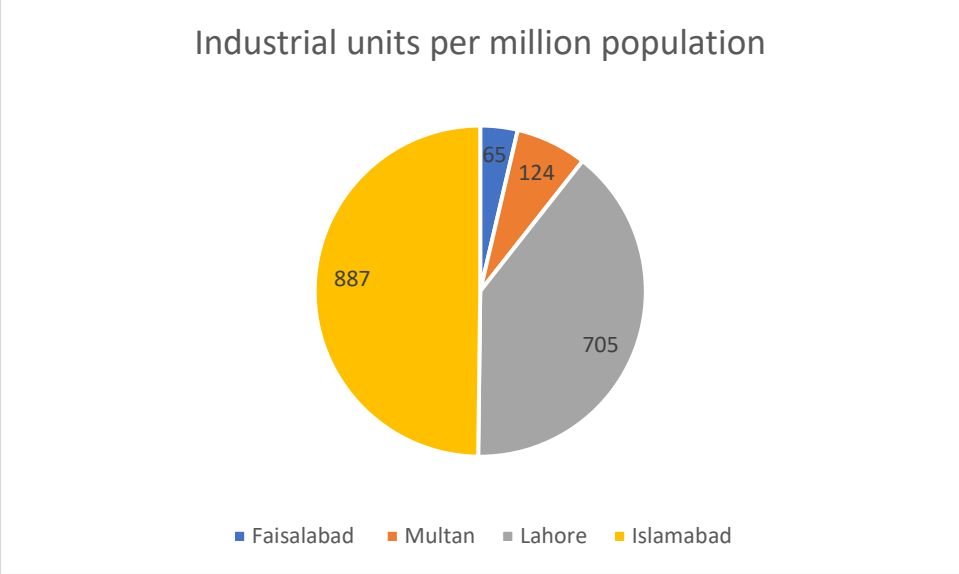
Urban resilience is the capacity of a city to withstand and recover from shocks and stresses such as natural disasters, economic downturns, and social unrest. One factor that can affect urban resilience is the number of industrial units per million population. A higher number of industrial units can provide more employment opportunities and generate more revenue for the city, which can help increase its resilience.

Let's compare the number of industrial units per million population in four cities of Pakistan: Faisalabad, Multan, Lahore, and Islamabad.

Faisalabad has 65 industrial units per million population, which is the lowest among the four cities. This may indicate that the city has a relatively weaker industrial base and fewer employment opportunities. However, it's worth noting that Faisalabad is known as the "Manchester of Pakistan" due to its textile industry, which contributes significantly to the country's exports.

Multan has 124 industrial units per million population, which is higher than Faisalabad but still lower than the other two cities. Multan is known for its agriculture and is a major producer of cotton, wheat, and mangoes. However, the city has been trying to attract more industries to diversify its economy and increase employment opportunities. Lahore has 705 industrial units per million population, which is significantly higher than Faisalabad and Multan. Lahore is the second-largest city in Pakistan and a major economic hub, with a diverse range of industries such as textiles, pharmaceuticals, and automobile manufacturing. The city's strong industrial base contributes significantly to its resilience, as it provides employment opportunities and generates revenue.

Islamabad has the highest number of industrial units per million population, with 887 units. Islamabad is the capital of Pakistan and is known for its high standard of living and modern infrastructure. However, the city's industrial sector is relatively small compared to other cities, and it mainly comprises construction and service industries.



Graph 23 Industrial units per million population

Employment status (percentage)

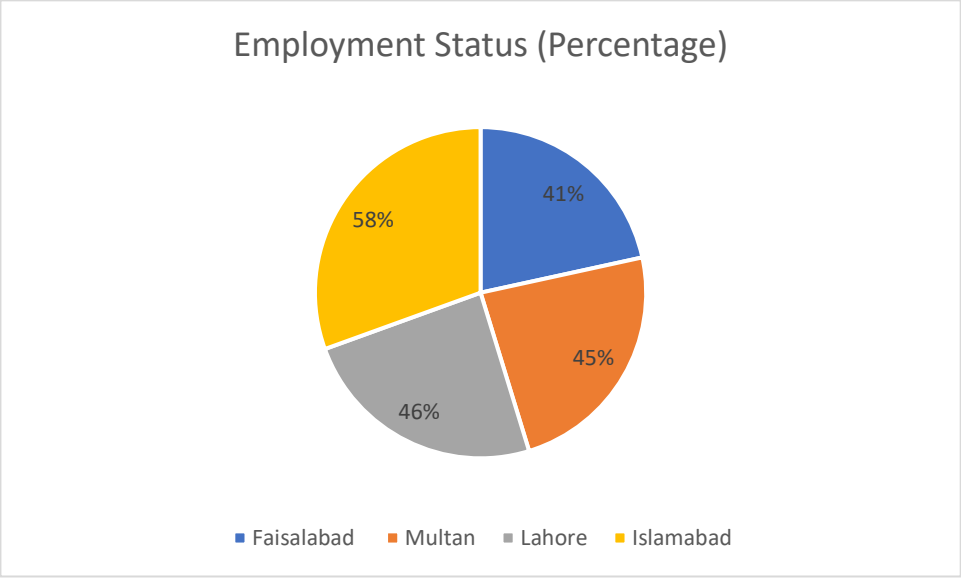
Urban resilience is a crucial factor for the sustainable development of cities. Employment status is an essential aspect of urban resilience as it affects the economic stability of individuals and the overall city's economic growth. In this comparative analysis, the percentage of employment status in four cities of Pakistan, namely Faisalabad, Multan, Lahore, and Islamabad has been analyzed.

According to the data provided, the city with the highest percentage of employment status is Islamabad, with 58%. This indicates that more than half of the population of

Islamabad is employed, which is a positive sign for the city's economic development. Lahore follows closely behind with 46% of its population being employed. Multan and Faisalabad have lower employment percentages with 45% and 41%, respectively.

A high percentage of employment status in a city is an indicator of economic stability, job opportunities, and a higher standard of living for individuals. In contrast, a low employment rate can result in poverty, unemployment, and social issues, such as crime and homelessness.

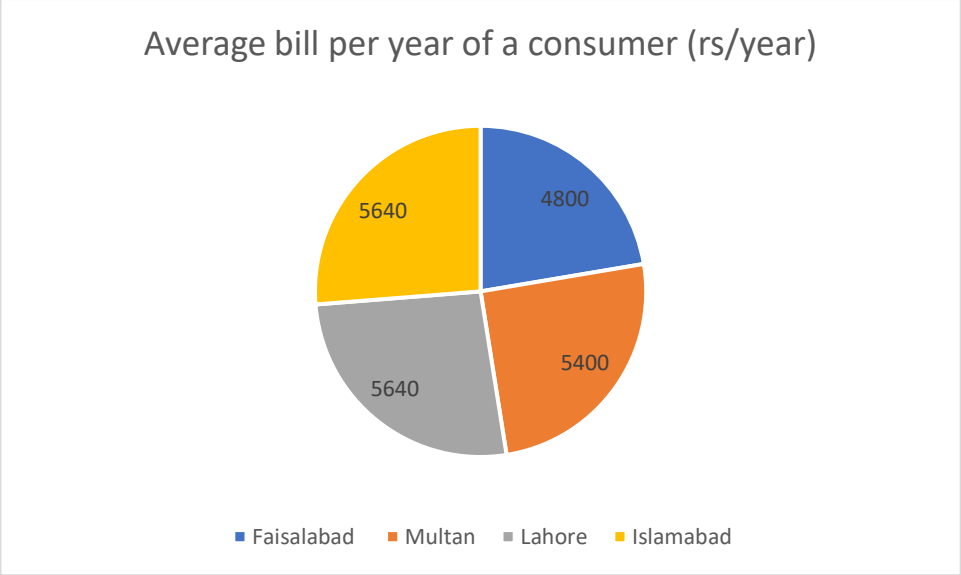
Therefore, it is crucial for cities to create and implement policies that promote job creation and employment opportunities. Such policies should be designed to attract and retain businesses, provide education and training opportunities for residents, and support entrepreneurship and innovation.



Graph 24 Employment Status (Percentage)

Gas:

According to the data provided, Faisalabad has the lowest average gas bill per year at Rs. 4800, while Multan, Lahore, and Islamabad have average bills of Rs. 5400, Rs. 5640, and Rs. 5640, respectively. This information can give us some insights into the affordability of gas for consumers in these cities and their potential resilience to gas-related disruptions.

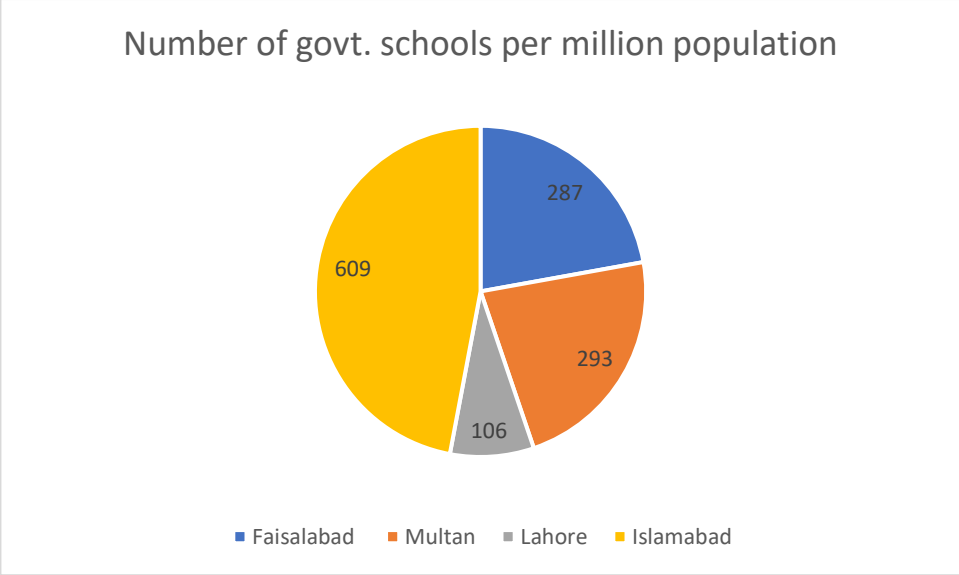


Graph 25 Average bill per year of a consumer (rs/year)

Schools:

According to the available data, Islamabad has the highest number of government schools per million population, with 609 schools. This indicates a strong commitment to providing public education in the city and a willingness to invest in the education sector. On the other hand, Lahore has the lowest number of government schools per million population, with only 106 schools. This suggests a significant gap in the availability of public education services, which could undermine the city's resilience in the face of various crises.

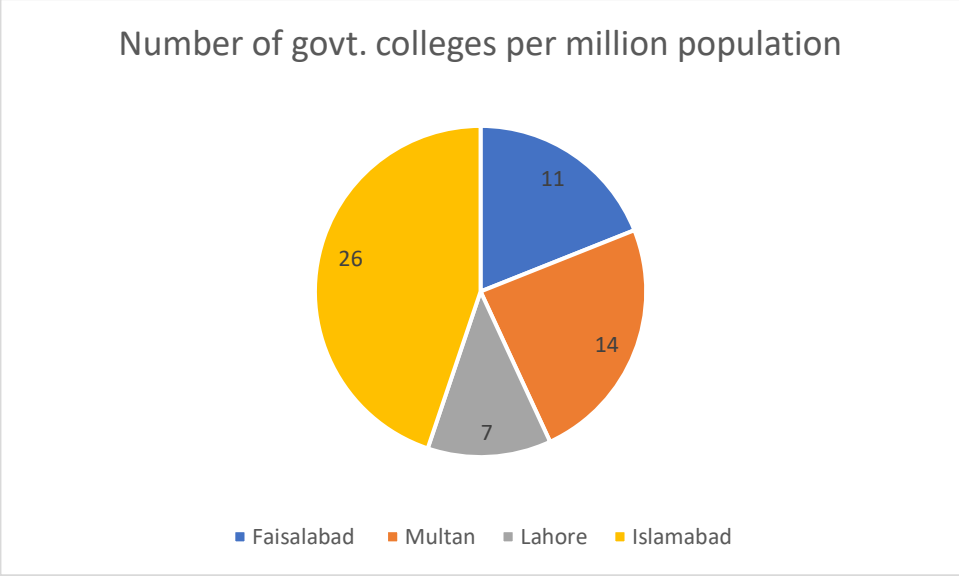
Faisalabad and Multan fall in the middle of the spectrum, with 287 and 293 government schools per million population, respectively. Although these numbers are lower than Islamabad's, they are still higher than Lahore's, indicating a comparatively better provision of public education services in these two cities.



Graph 26 Number of govt. schools per million population

Colleges:

Faisalabad has 11 government colleges per million population, which is lower than both Multan and Islamabad. Multan has 14 government colleges per million population, indicating a slightly better availability of educational opportunities than Faisalabad. Meanwhile, Islamabad has the highest number of government colleges per million population, with 26. This may be due to the fact that Islamabad is the capital city of Pakistan and is home to many government institutions, including universities and colleges.



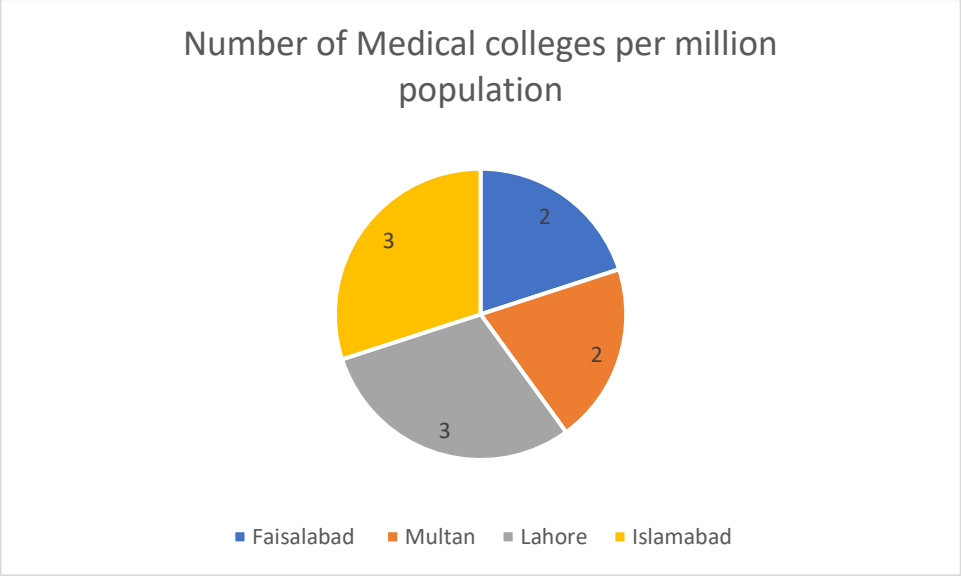
Graph 27 Number of govt. colleges per million population

Medical Colleges:

Medical colleges play a crucial role in preparing healthcare professionals to respond to emergencies and to provide quality healthcare services to the population. In this comparative analysis, we will examine the number of medical colleges per million population in four cities in Pakistan: Faisalabad, Multan, Lahore, and Islamabad.

Faisalabad and Multan have the same number of medical colleges per million population, which is 2. This means that for every million people living in these cities, there are two medical colleges. Lahore has the highest number of medical colleges per million population, with a ratio of 3. This means that for every million people living in Lahore, there are three medical colleges. This high number of medical colleges indicates that Lahore has a strong healthcare infrastructure and is well-prepared to respond to emergencies and provide quality healthcare services to its population.

Islamabad, like Lahore, also has a ratio of 3 medical colleges per million population. This is not surprising, given that Islamabad is the capital city of Pakistan and has a relatively high population density compared to Faisalabad and Multan.

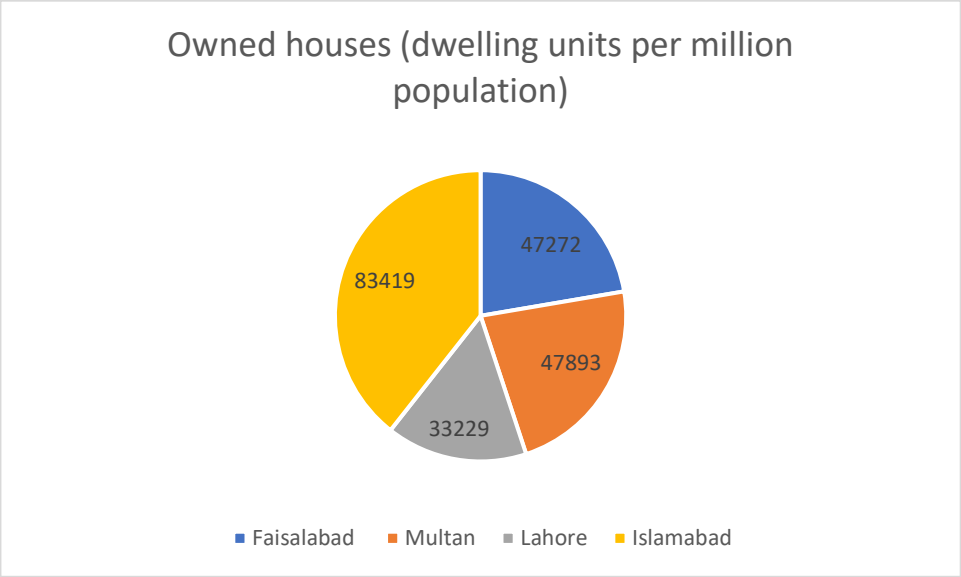


Graph 28 Number of Medical colleges per million population

Ownership of dwelling:

To compare the ownership of dwelling in four major cities in Pakistan - Faisalabad, Multan, Lahore, and Islamabad - we can look at the number of owned houses per million population in each city. According to the data provided, Faisalabad has the highest number of owned houses per million population, with 47,272 owned dwelling units, followed closely by Multan with 47,893 owned dwelling units. Lahore has a

significantly lower number of owned houses per million population, with only 33,229 units, while Islamabad has the highest number of owned houses among these cities with 83,419 owned dwelling units per million population.



Graph 29 Owned houses (dwelling units per million population)

5.3. Summary of the Chapter

Assessing urban resilience requires evaluating a city's capacity to withstand and recover from shocks and stressors such as natural disasters, climate change, economic crises, and social disruptions. The key aspects to consider when assessing urban resilience include robust and adaptable physical infrastructure, environmental sustainability, social equity, economic stability, and community engagement. A resilient city prioritizes the well-being and prosperity of its residents by promoting sustainability, social equity, and economic stability, while also empowering them to participate in resilience-building initiatives. Ultimately, a resilient city is one that can adapt and thrive in the face of challenges.

Lahore and Islamabad are two cities in Pakistan that have taken the lead in implementing smart city initiatives across six dimensions. These dimensions include Smart Economy, Smart People, Smart Mobility, Smart Governance, ICT, and Smart Environment. Overall, Lahore and Islamabad have taken significant steps to implement smart city initiatives across various dimensions to promote sustainable development, enhance citizen engagement, and drive economic growth and development.

CHAPTER 6

EXPERTS OPINION ASSESSMENT

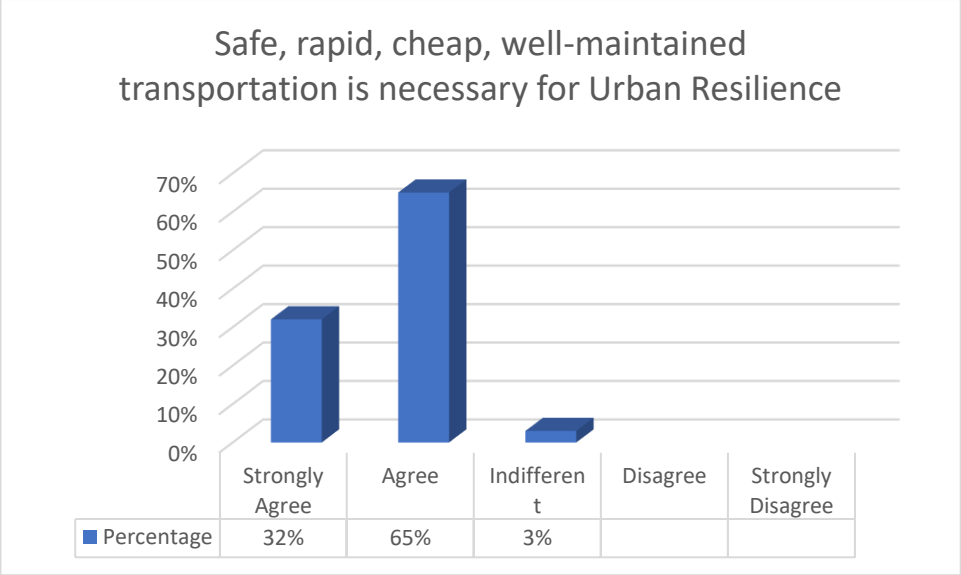
The objective iii of this study is regarding the readiness of Experts for adopting smart cities. To evaluate this aspect a questionnaire has been designed and conducted through online surveys. The results obtained from surveys revealed that experts are on the opinion that resilience of a city can be increased thorough smart city techniques. The presence of smart city techniques can contribute significantly to increasing city resilience. Smart city techniques leverage technology, data, and innovation to optimize city services, improve sustainability, and enhance the quality of life for residents.

6.1. Data Analysis

Safe, rapid, cheap, well-maintained transportation is necessary for Urban Resilience

Transportation plays a critical role in the development of smart cities and urban resilience. As per the feedback received from professional town planners through a questionnaire, it is evident that safe, rapid, cheap, and well-maintained transportation is crucial for urban resilience.

Around 97% of the respondents either strongly agreed or agreed with the statement that safe, rapid, cheap, and well-maintained transportation is necessary for urban resilience. This indicates that town planners acknowledge the importance of transportation in ensuring a resilient urban environment.

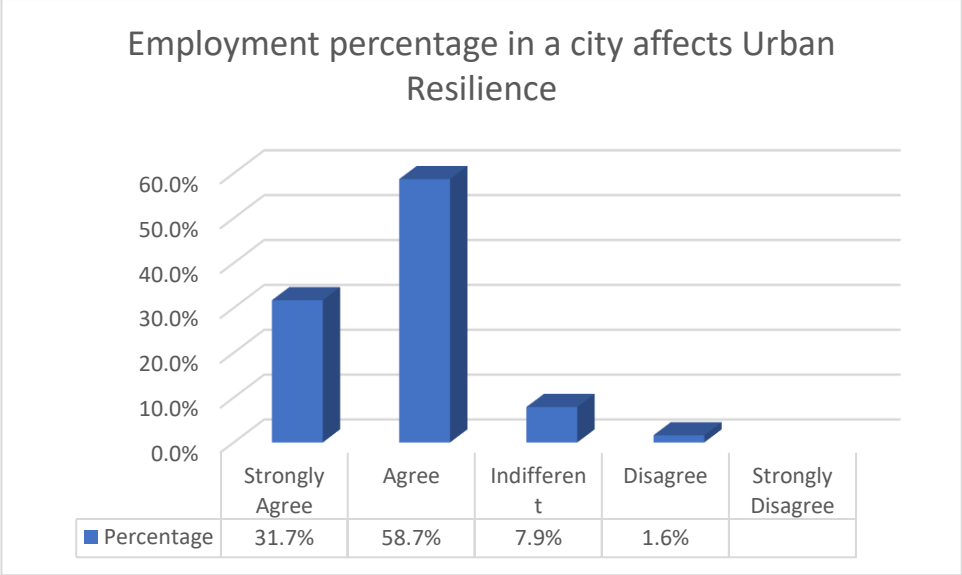


Graph 30 Safe, rapid, cheap, well-maintained transportation is necessary for Urban Resilience

Employment percentage in a city affects Urban Resilience

According to the responses of professional town planners surveyed through a questionnaire, the employment percentage in a city is perceived to have a significant impact on urban resilience. The majority of respondents, comprising 31.7% who strongly agree and 58.7% who agree, support this view.

Employment percentage refers to the proportion of working-age individuals who are employed within a city. A high employment percentage indicates a strong and diverse economy, with a wide range of job opportunities across various sectors. Additionally, a strong and diverse economy can attract investments and spur innovation, leading to increased resilience and adaptability.

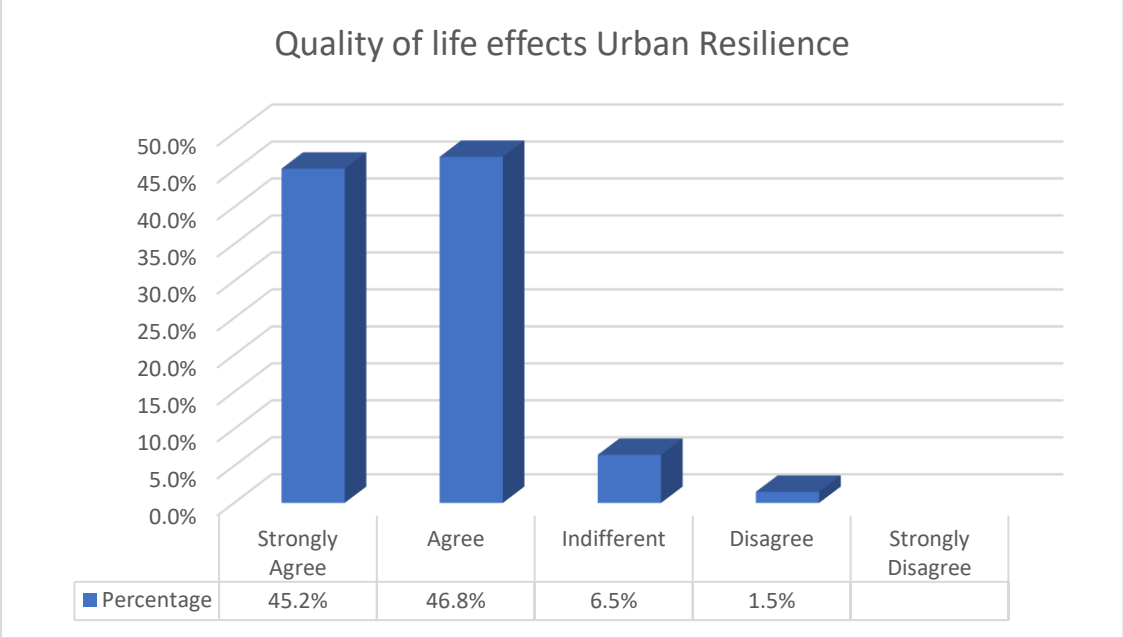


Graph 31 Employment percentage in a city affects Urban Resilience

Quality of life effects Urban Resilience:

The quality of life factor has a significant impact on the concept of smart cities and urban resilience, according to professional town planners who were asked through a questionnaire. The results indicate that a majority of the respondents, around 92% (45.2% strongly agree and 46.8% agree), believe that quality of life has a positive effect on urban resilience. This implies that cities that prioritize quality of life initiatives such as parks, green spaces, and pedestrian-friendly infrastructure are more likely to be resilient in the face of unexpected shocks.

Furthermore, the results also show that only a small percentage of the respondents (1.5%) disagreed with the idea that quality of life affects urban resilience, while an even smaller percentage (6.5%) were indifferent. This suggests that there is a broad consensus among professional town planners that quality of life is an essential factor in creating resilient and sustainable cities.

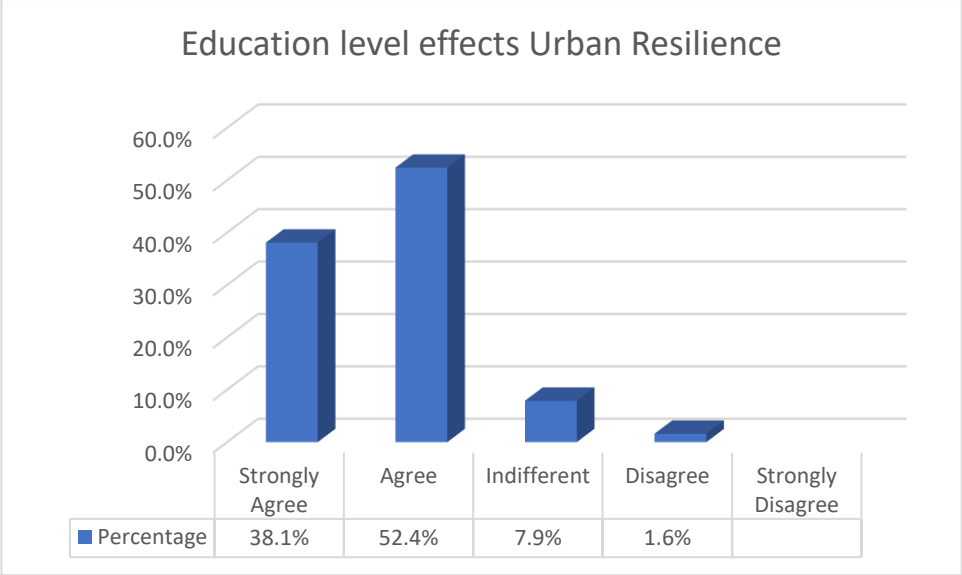


Graph 32 Quality of life effects Urban Resilience

Education level effects Urban Resilience

According to the responses of professional town planners in the questionnaire, education level has a significant impact on the smart city concept and urban resilience. A large majority of the planners either strongly agreed or agreed with this statement, representing 90.5% of the total responses.

A higher level of education among urban residents and policymakers can positively impact the development and implementation of smart city solutions. Education helps to raise awareness about the benefits of smart city technologies and their potential to improve urban resilience. It also helps to build a skilled workforce that can design, deploy and maintain smart city systems.

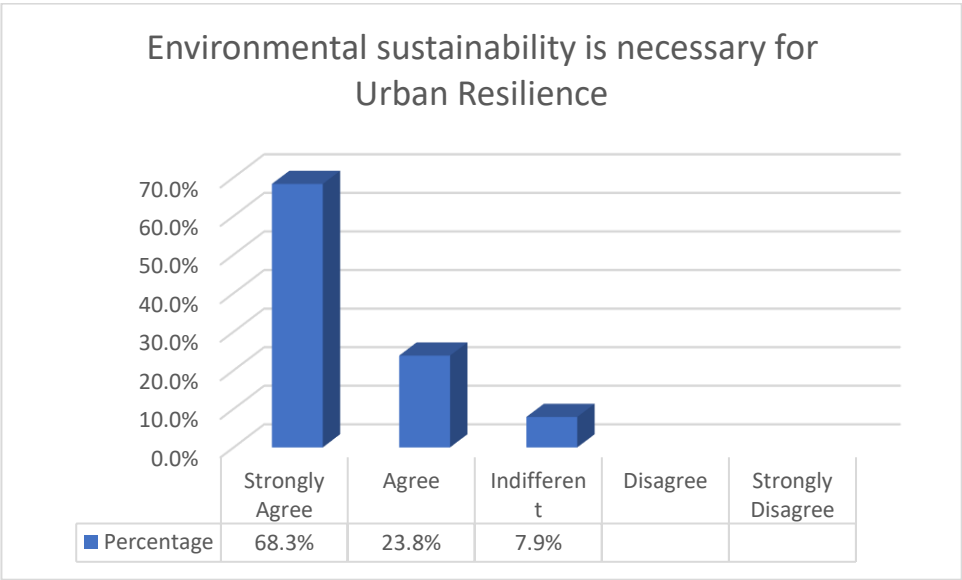


Graph 33 Education level effects Urban Resilience

Environmental sustainability is necessary for Urban Resilience

According to the responses from professional town planners through a questionnaire, it is evident that the factor of environmental sustainability is critical for urban resilience. A significant majority of 68.3% strongly agreed with the statement, while 23.8% agreed with it. This reinforces the idea that urban resilience cannot be achieved without taking into account the environmental sustainability of a city.

The responses from town planners indicate that they recognize the critical role of environmental sustainability in building urban resilience. The high percentage of those who strongly agreed with the statement suggests that this factor is widely considered to be essential in the planning and design of smart cities.

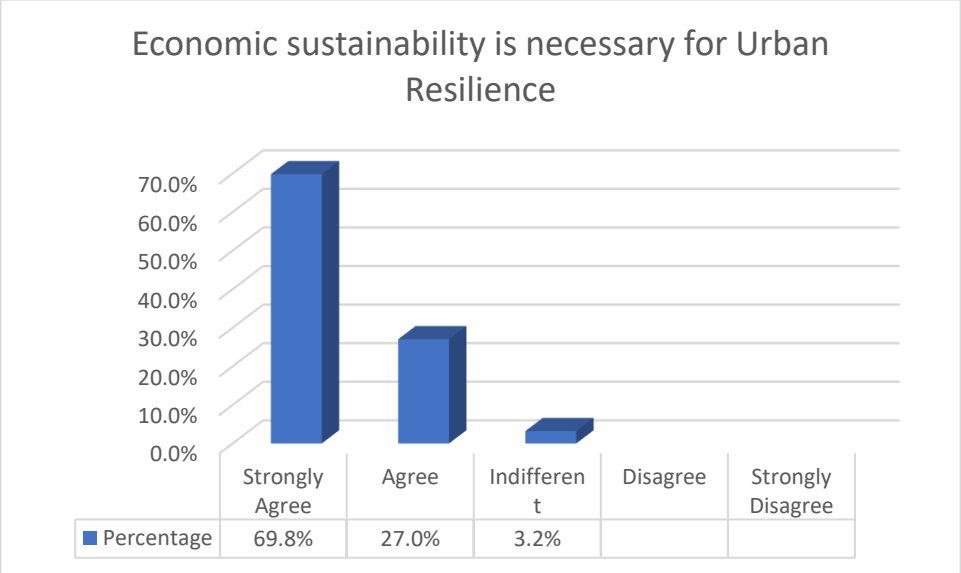


Graph 34 Environmental sustainability is necessary for Urban Resilience

Economic sustainability is necessary for Urban Resilience

According to a questionnaire asked from professional town planners, economic sustainability is considered a crucial factor for achieving urban resilience in the context of smart cities. The majority of the respondents strongly agreed (69.8%) with this statement, while 27.0% agreed with it. Only a small fraction of respondents (3.2%) expressed indifference towards the role of economic sustainability in urban resilience, and no one disagreed or strongly disagreed with the statement.

Economic sustainability is particularly crucial because it enables cities to generate the necessary resources to maintain and enhance their resilience. A financially healthy city can invest in critical infrastructure, such as resilient buildings and transportation systems, as well as social safety nets that can support vulnerable populations during times of crisis.



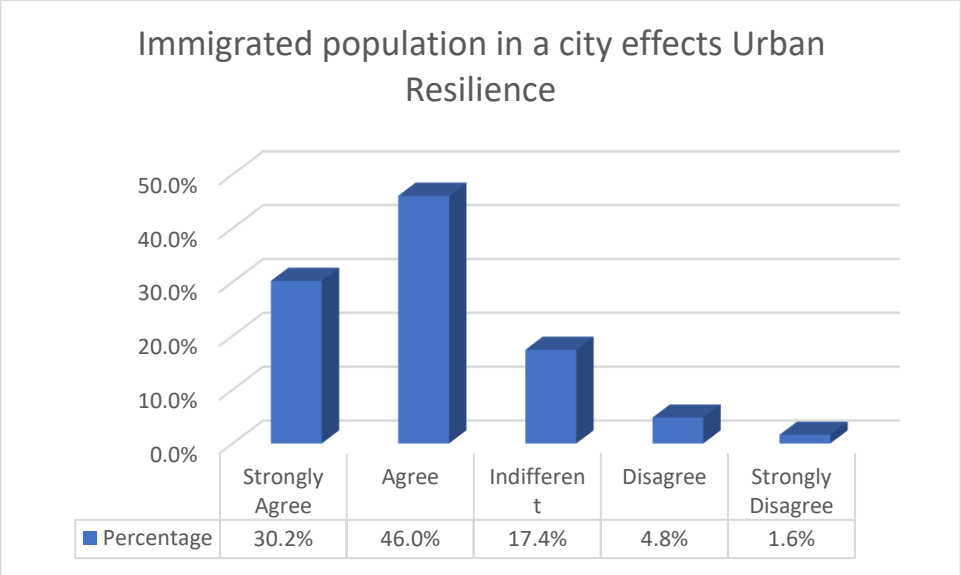
Graph 35 Economic sustainability is necessary for Urban Resilience

Immigrated population in a city effects Urban Resilience

According to the responses received from the professional town planners through a questionnaire, the factor of an immigrant population in a city has a significant impact on the concept of smart cities and urban resilience. A significant percentage of 76.2% of the respondents agreed or strongly agreed that an immigrant population affects urban resilience.

The high percentage of agreement suggests that there is a consensus among town planners that an immigrant population can have a substantial impact on a city's resilience. Immigrants may bring diverse skills, cultural knowledge, and social

networks that can contribute positively to a city's economic growth, social cohesion, and community resilience. However, they may also face challenges related to language barriers, access to healthcare and education, and discrimination, which can undermine their well-being and the city's overall resilience.

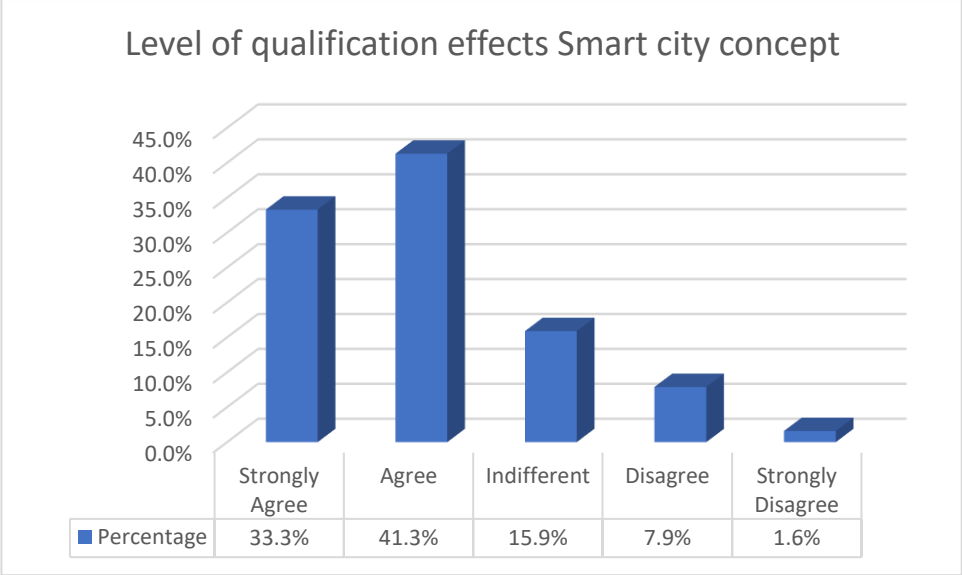


Graph 36 Immigrated population in a city effects Urban Resilience

Level of qualification effects Smart city concept:

The level of qualification is an important factor that impacts the smart city concept and urban resilience. According to a questionnaire asked from professional town planners, 74.6% of them agreed or strongly agreed that the level of qualification affects the smart city concept.

However, it is also worth noting that a significant percentage of town planners (15.9%) responded as indifferent. This suggests that there may be some town planners who do not see the link between the level of qualification and the smart city concept. The role of town planners in designing and implementing smart cities is critical. The level of education and expertise can influence the success of a smart city project. With the rapid advancement in technology and the increasing complexity of urban challenges, it is important for town planners to stay up-to-date with the latest knowledge and skills.

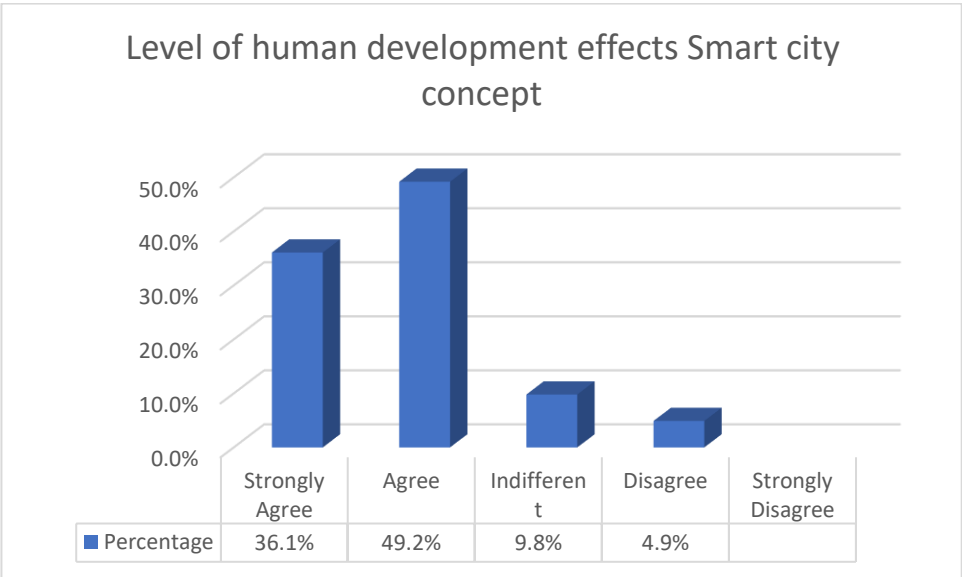


Graph 37 Level of qualification effects Smart city concept

Level of human development effects Smart city concept

The level of human development has a significant impact on the Smart city concept and urban resilience. According to a questionnaire conducted among professional town planners, 85.3% of them either strongly agree or agree that the level of human development affects the Smart city concept.

Smart cities rely heavily on technology and innovation to create sustainable, efficient, and livable urban environments. However, technology alone cannot guarantee the success of a smart city. The level of human development plays a crucial role in ensuring that the benefits of smart city initiatives are accessible to all members of the community.



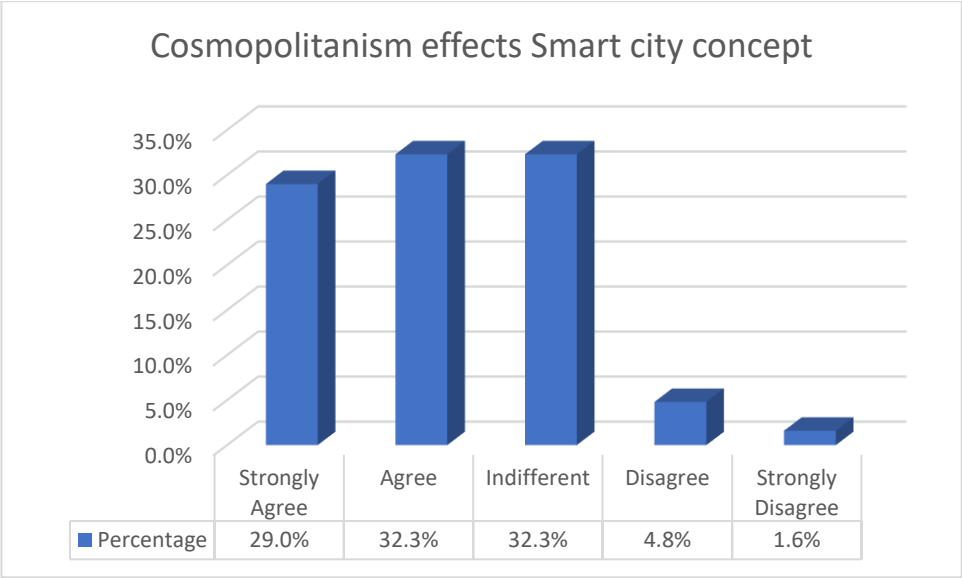
Graph 38 Level of human development effects Smart city concept

Cosmopolitanism effects Smart city concept:

According to the results of the questionnaire given to professional town planners, the factor of cosmopolitanism has a significant impact on the smart city concept and urban resilience. Out of the total respondents, 29.0% strongly agree and 32.3% agree that cosmopolitanism has a positive impact on the smart city concept.

However, it is worth noting that 32.3% of the respondents were indifferent to the impact of cosmopolitanism on the smart city concept. Only 6.4% of the respondents disagreed or strongly disagreed with the positive impact of cosmopolitanism on smart cities. This suggests that the majority of town planners recognize the importance of building inclusive and diverse communities in creating resilient and sustainable cities.

The fact that over 60% of the respondents either strongly agree or agree with the positive impact of cosmopolitanism on smart cities indicates that town planners recognize the value of embracing diversity in urban planning. By promoting a cosmopolitan mindset, cities can attract talent from different backgrounds and cultures, leading to a more vibrant and diverse workforce.

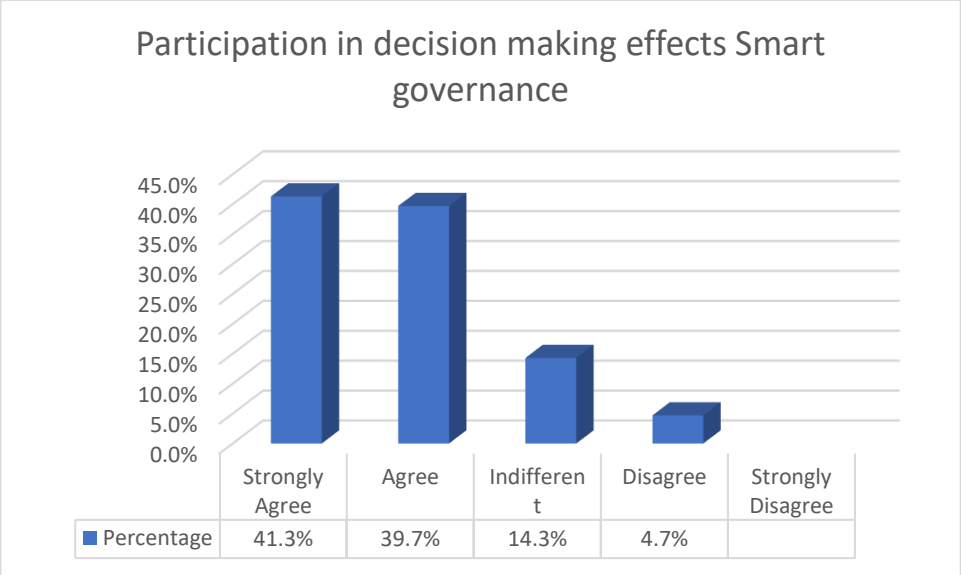


Graph 39 Cosmopolitanism effects Smart city concept

Participation in decision making effects Smart governance:

The factor of participation in decision making has a significant impact on the concept of smart cities and urban resilience. According to a questionnaire sent to professional town planners, 41.3% strongly agreed and 39.7% agreed that participation in decision making has a positive effect on smart governance.

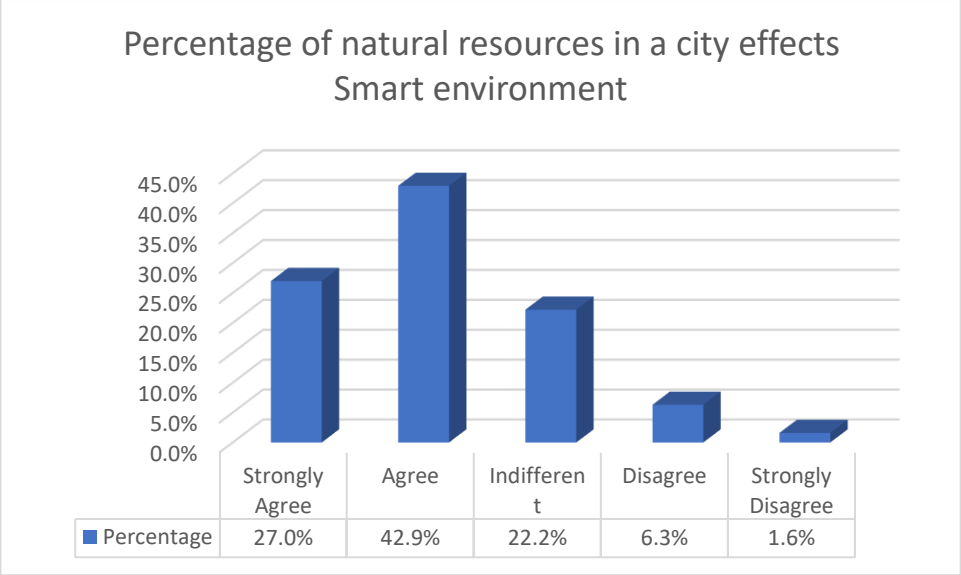
Smart governance refers to the use of technology and data-driven decision making to improve the delivery of public services and enhance the quality of life for citizens. This requires collaboration and participation from all stakeholders, including the government, private sector, and citizens.



Graph 40 Participation in decision making effects Smart governance

Percentage of natural resources in a city effects Smart environment

According to the responses from professional town planners in the questionnaire, the percentage of natural resources in a city has a significant impact on the smart city concept and urban resilience. The majority of the respondents agreed or strongly agreed (69.9%) with this statement, indicating that natural resources play a crucial role in building a sustainable and resilient city. the percentage of natural resources in a city is a crucial factor that impacts the smart city concept and urban resilience. City planners need to prioritize the conservation and management of natural resources to build sustainable and resilient cities.

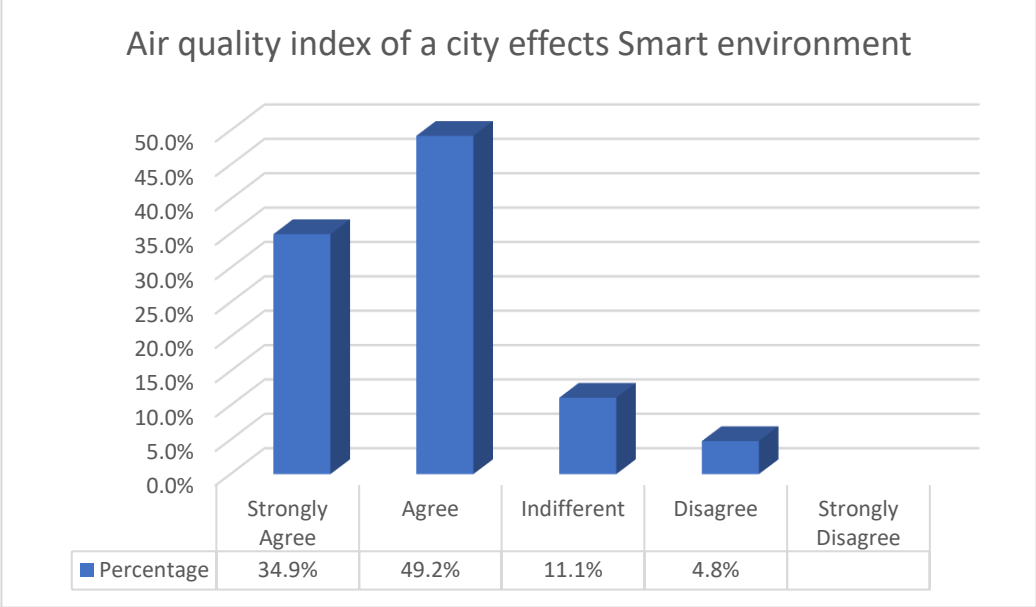


Graph 41 Percentage of natural resources in a city effects Smart environment

Air quality index of a city effects Smart environment

The air quality index of a city is a critical factor that impacts the concept of a smart city and its overall urban resilience. According to a survey of professional town planners through a questionnaire, a significant percentage of respondents (34.9%) strongly agreed that air quality is a crucial factor for a smart environment.

From the responses, nearly half (49.2%) of the respondents agreed that air quality is an essential factor for a smart environment, further emphasizing the importance of this issue. However, it is worth noting that a small percentage of respondents (4.8%) disagreed with the significance of air quality for a smart environment, and a minority (11.1%) were indifferent.

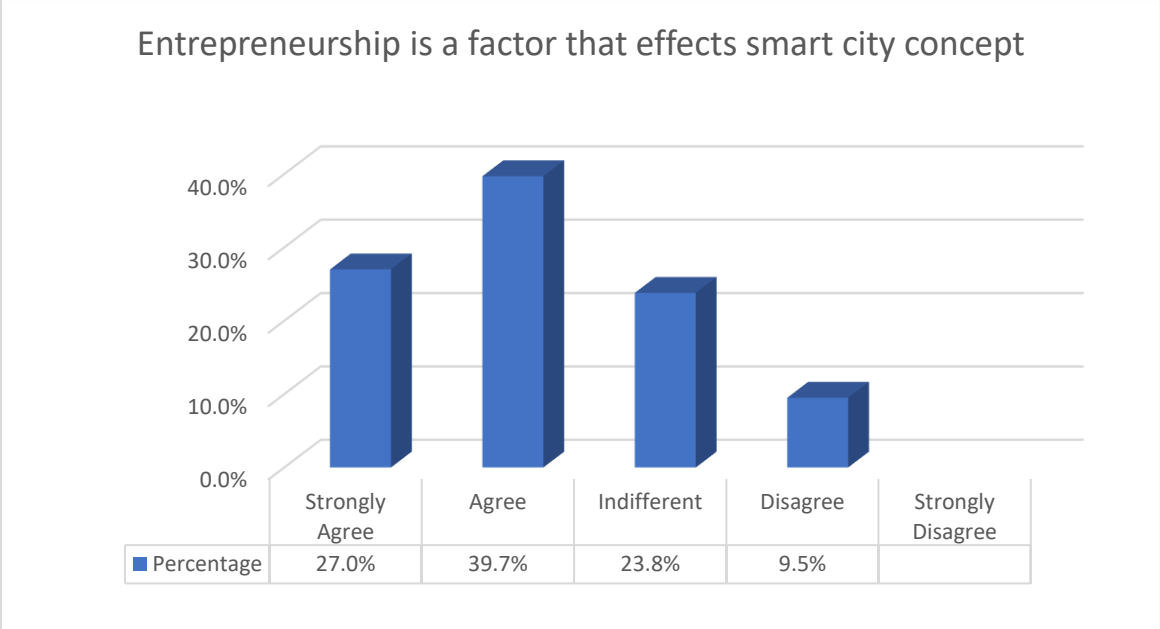


Graph 42 Air quality index of a city effects Smart environment

Entrepreneurship is a factor that effects smart city concept

According to the responses from professional town planners through the questionnaire, entrepreneurship is perceived to be a significant factor impacting the smart city concept and urban resilience. A majority of the respondents either strongly agreed or agreed (a total of 66.7%) that entrepreneurship plays a vital role in the development of smart cities. The remaining respondents were either indifferent (23.8%) or disagreed (9.5%) with the statement. None of the respondents strongly disagreed with the statement.

The role of entrepreneurship in the development of smart cities is multi-faceted. Entrepreneurial activities can drive innovation, create job opportunities, and foster economic growth. In smart cities, entrepreneurship can also help to facilitate the adoption and implementation of new technologies and sustainable practices.

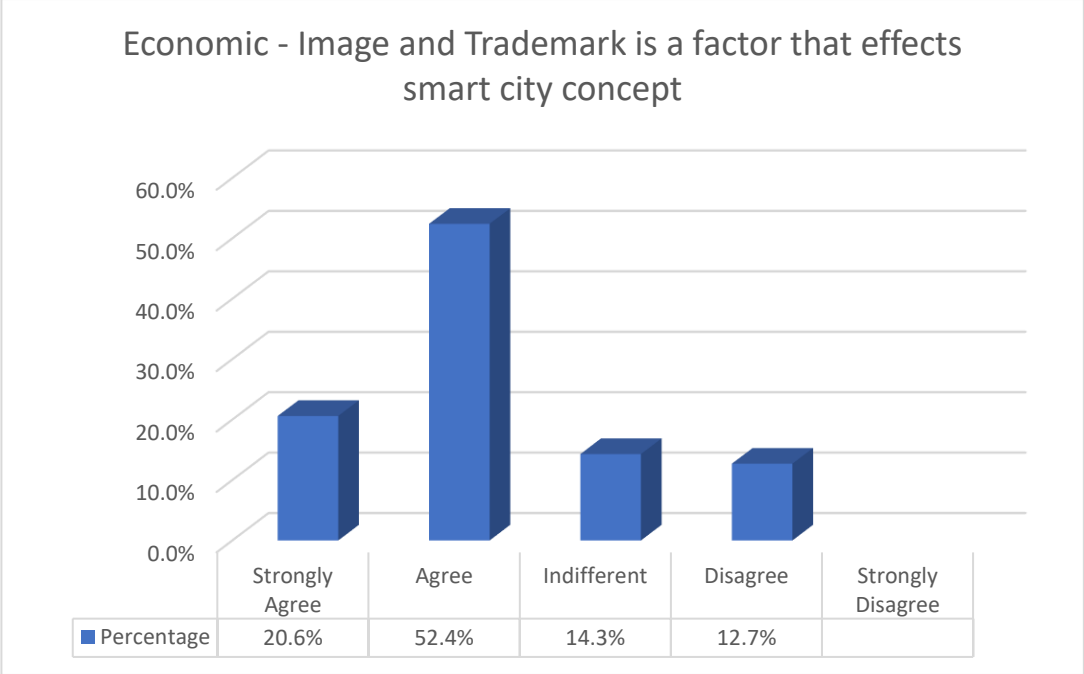


Graph 43 Entrepreneurship is a factor that effects smart city concept

Economic - Image and Trademark is a factor that effects smart city concept

The economic factor of image and trademark is a crucial element that impacts the smart city concept and urban resilience. This factor was identified as significant in a recent survey conducted among professional town planners.

The results of the questionnaire indicate that a significant proportion of the respondents agreed or strongly agreed that the economic factor of image and trademark impacts the smart city concept. Specifically, 20.6% of the respondents strongly agreed, while 52.4% agreed with this statement. Only a small proportion of respondents (12.7%) disagreed with the statement, while 14.3% were indifferent.

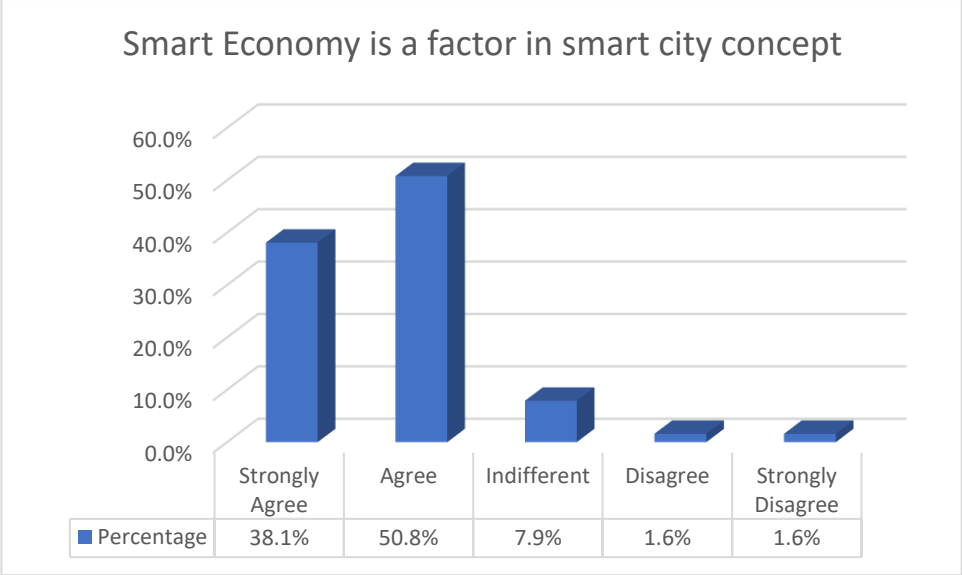


Graph 44 Economic - Image and Trademark is a factor that effects smart city concept

Smart Economy is a factor in smart city concept

Smart Economy is a crucial factor that impacts both the smart city concept and urban resilience. The concept of a smart city involves the integration of technology, data, and communication to improve the quality of life for its residents. A smart economy, in this context, refers to the use of technology and innovation to enhance economic growth and create new opportunities for employment.

According to a questionnaire conducted among professional town planners, a significant percentage of respondents (38.1%) strongly agreed that a smart economy is a vital factor in the smart city concept. An additional 50.8% agreed with this statement, indicating that the vast majority of planners recognize the importance of a smart economy in shaping the future of cities.



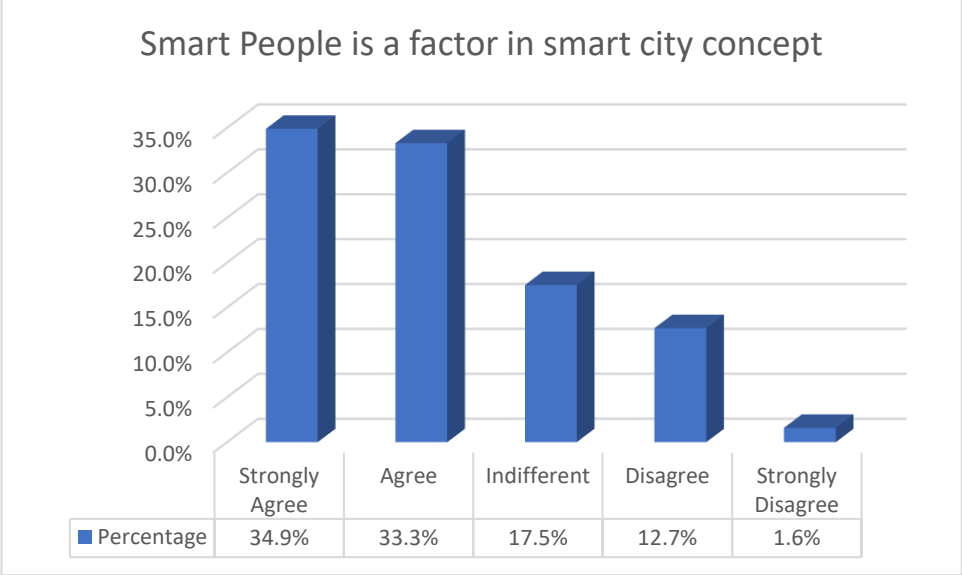
Graph 45 Smart Economy is a factor in smart city concept

Smart People is a factor in smart city concept

The factor of "Smart People" in the smart city concept has been identified as a crucial element that impacts urban resilience. According to a questionnaire administered to professional town planners, 68.2% of the respondents either strongly agreed or agreed that this factor is essential.

The concept of smart cities involves using advanced technologies to improve the quality of life, sustainability, and efficiency of urban areas. However, technology alone is not enough to create a smart city. The people who live, work, and visit these cities are essential to their success.

The responses of the professional town planners to the questionnaire indicate that they recognize the importance of smart people in building resilient cities. However, it is worth noting that 17.5% of the respondents were indifferent, while 14.3% either disagreed or strongly disagreed.

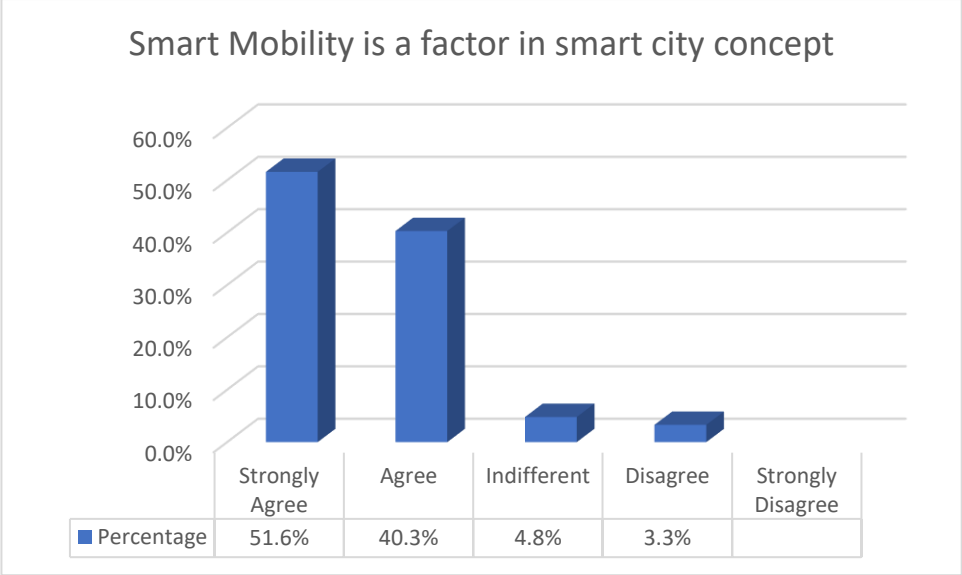


Graph 46 Smart People is a factor in smart city concept

Smart Mobility is a factor in smart city concept

According to the responses of professional town planners through a questionnaire, smart mobility is considered a crucial factor in the smart city concept, with 51.6% strongly agreeing and 40.3% agreeing. This suggests that there is a broad consensus among urban planners that smart mobility is essential for creating sustainable, resilient, and livable cities.

Smart mobility refers to the integration of technology into transportation systems to improve efficiency, accessibility, and safety. This can include a range of innovations, such as electric vehicles, autonomous vehicles, ride-sharing services, smart traffic management systems, and public transportation systems that are connected to the Internet of Things.

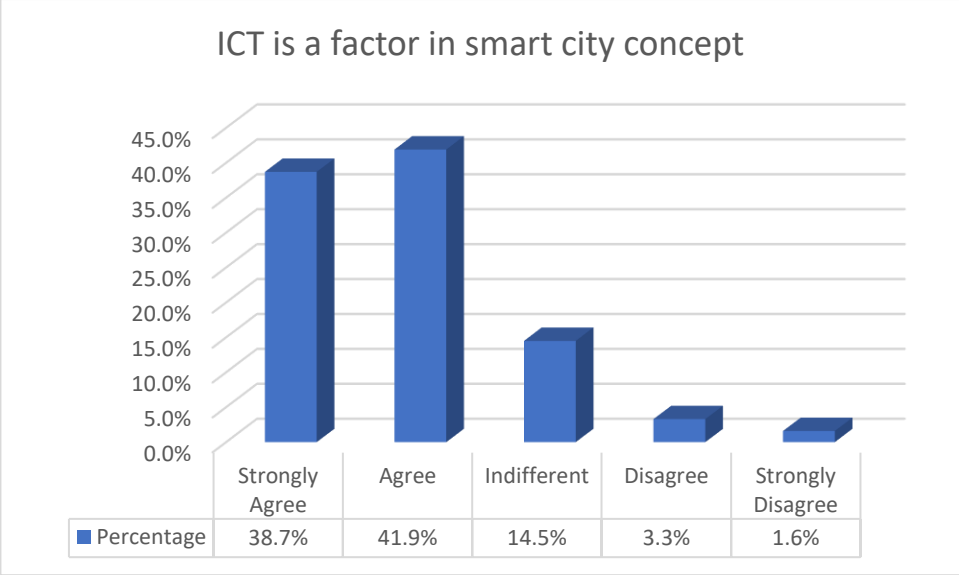


Graph 47 Smart Mobility is a factor in smart city concept

ICT is a factor in smart city concept

ICT (Information and Communication Technology) is an essential factor in the development and implementation of smart city concepts. According to a survey conducted among professional town planners, a significant majority (80.6%) of respondents agreed that ICT plays a crucial role in building smart cities.

The survey results revealed that 38.7% of respondents strongly agreed that ICT is an essential factor in smart city development. 41.9% of respondents agreed that ICT is a factor in the smart city concept. Only 14.5% of respondents were indifferent to the role of ICT in smart city development and a small percentage of respondents (3.3%) disagreed with the idea that ICT is a factor in the smart city concept.



Graph 48 ICT is a factor in smart city concept

6.2.2 Summary of the Chapter

The objective of this study is to evaluate the readiness of experts to adopt smart cities. Smart cities refer to the use of technology, data, and innovation to improve the quality of life for residents, enhance sustainability, and optimize city services. The study aimed to understand whether experts are ready to embrace the concept of smart cities and to what extent they believe that the resilience of a city can be increased through the use of smart city techniques.

To evaluate this aspect, a questionnaire was designed, and online surveys were conducted. The surveys were targeted at experts who have knowledge and experience in the fields of urban planning, infrastructure development, and smart city technologies. The questionnaire consisted of questions related to the experts' views on the effectiveness of smart city techniques in enhancing city resilience and their willingness to embrace the concept of smart cities.

The results obtained from the surveys showed that experts are of the opinion that smart city techniques can significantly contribute to increasing city resilience. The presence of smart city techniques can improve the sustainability of cities, optimize city services, and enhance the quality of life for residents. The findings suggest that experts are ready to embrace the concept of smart cities and believe that it can positively impact the resilience of cities. All professional town planners believe in the importance of smart cities as this can lead to sustainable and resilient cities of the future.

CHAPTER 7

CONCLUSION

7.1. Conclusion

The current study revolves around the objectives of identifying the characteristics / indicators that are impeding in development of SC in Pakistan followed by suggesting a suitable framework for guidance and implementation in developing smart and resilient cities. In the realm of modern era, developing SC is imperative in context of Pakistan as cities like Lahore and Faisalabad are expanding and exhausting the natural resources at a pace that natural cycle cannot replenish the effects of rapid urbanization. Pakistan is far behind in the race of achieving Smartness in cities. So there is a dire need to improve infrastructure which is strong and resilient and essential for a smart city. This includes reliable and efficient transportation systems, high-speed internet connectivity, and clean and reliable energy sources. Infrastructure improvements should be made with long-term sustainability in mind.

Perception of professionals and various stakeholders, in achieving smartness and resilience, helped in investigating in the major barriers in local context extracted through intensive literature review, questionnaire survey and interviews in the current study. The acquired data was analysed using various statistical techniques. For better understanding, these techniques are used, on barriers that are logical and need to keep an eye open in mitigating those unexplored barriers that are hindering in achieving.

Various barriers were examined in the current study i.e. 1) Regulatory & Policy Barriers, 2) Lack of Social Capital and Sustainable Urban Infrastructure, 3) Inexperienced Professionals and Lack of Public Participation and 4) Weak Industry / Professional – Academia Linkage. Results from survey highlighted insufficiency of institutions and weak mechanism for rules implementation and evaluation, secondly Lack of supporting Policy resulting in unsustainable planning practices. Moreover, lack of public participation and their coordination among various stakeholder are also highlighted in the result. Beside that a lot of respondents have suggested that people should be educated and make them realize / aware regarding the very concept of sustainability. Also their participation should be ensured in planning process as it's done in developed countries. Citizen engagement is critical to the success of a smart

and resilient city. City officials should encourage participation from residents in decision-making processes and provide opportunities for feedback and input. Finding of this study would contribute in understanding the barrier that need attention of our policy makers and professionals. So that addressing them in proper manner would result in desired scenarios and help achieving desired goals.

7.2. Recommendations

There is a dire need to focus on Multan and Faisalabad in terms of Urban Resilience and Smart City.It is recommended that Planners, Engineers, Architects, Developers, Environmentalist and other stakeholders should sit together and comprehensive plan that addresses various aspects of urban life, including transportation, housing, energy, and public safety. The plan should involve input from a diverse group of stakeholders, including city officials, community leaders, and residents. We should encourage the use of technology that can improve the efficiency and effectiveness of city services. For example, smart traffic management systems can reduce congestion, while smart streetlights can save energy and improve safety. Smart waste management systems can also help reduce waste and improve sustainability. As technology continues to shape the future of work, it is important to invest in education and workforce development programs that prepare residents for the jobs of the future. This includes training programs in areas such as coding, data analysis, and artificial intelligence. Moreover, Planning Authorities should amend their rules and include sustainability related clauses in them and enforce them.

7.3. Limitations

There are some lagging and limitation in current study that requires attention form future researches. Though the sample size is fulfilling the minimum requirement for carrying various statistical analysis but future research need to employ a greater sample to have large dataset to get explicit results and observe whether the outcome from large dataset differs from the results of current study. The current study is limited to only four metropolitans of Pakistan, the future study should go beyond these cities.

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ANNEXURE – 1

NIT, SCEE, NUST

National University of Sciences & Technology (NUST), Islamabad

The information provided by the interviewees would be used only for academic purpose and their names would be kept confidential.

Name of Respondent: _____

Urban Resilience:

Q1. Please comment on the following statements related to Urban Resilience:

Statements	Opinion (Scale)				
	Strongly Agree	**Agree**	**Indifferent**	**Disagree**	**Strongly Disagree**
i. Safe, rapid, cheap, well-maintained transportation is necessary for Urban Resilience.					
ii. Employment percentage in a city effects Urban Resilience.					
iii. Quality of life effects Urban Resilience.					
iv. Education level effects Urban Resilience.					
v. Environmental sustainability is necessary for Urban Resilience.					
vi. Economic stability is important factor of Urban Resilience.					
vii. Urban Resilience is affected by the water sufficiency in a city.					

viii.	Road network of a city effects Urban Resilience.					
ix.	Immigrated population in a city effects Urban Resilience.					
x.	Percentage of people with High School and Above education in a city effects Urban Resilience.					
xi.	Literacy rate of male in a city effects Urban Resilience.					
xii.	Literacy rate of female in a city effects Urban Resilience.					
xiii.	Number of hospitals in a city effects Urban Resilience.					
xiv.	Age cohort in a city effects Urban Resilience.					
xv.	Percentage of people with physical or mental disability in a city effects Urban Resilience.					
xvi.	Air quality index of a city effects Urban Resilience.					
xvii.	Open spaces in a city effects Urban Resilience.					
xviii.	Road density in a city effects Urban Resilience.					
xix.	Housing units per million population in a city effects Urban Resilience.					
xx.	Industrial units per million population in a					

	city effects Urban Resilience.					
xxi.	Ownership of dwelling effects Urban Resilience.					

Smart City:

Q2. Please comment on the following statements related to Smart City:

Statements		**Opinion (Scale)**				
		Strongly Agree	**Agree**	**Indifferent**	**Disagree**	**Strongly Disagree**
i.	Level of qualification effects Smart city concept.					
ii.	Level of human development effects Smart city concept.					
iii.	Cosmopolitanism effects Smart city concept.					
iv.	Participation in decision making effects Smart governance.					
v.	Percentage of natural resources in a city effects Smart environment.					
vi.	Air quality index of a city effects Smart environment.					
vii.	Entrepreneurship is a factor that effects smart city concept.					
viii.	Economic - Image and Trademark is a factor that effects smart city concept.					
ix.	Smart Economy is a factor in smart city concept.					
x.	Smart people effect smart city concept.					

xi.	Smart Mobility in a city is a factor in smart city concept.					
xii.	Smart Governance is a factor in smart city concept.					
xiii.	ICT is a factor in smart city concept.					
xiv.	Smart Environment is a factor in smart city concept.					