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Title:

To Assess the Potential of Smart City Concept for New Housing Developments: A Case Study of Lahore

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To Assess the Potential of Smart City Concept for New Housing Developments

A CASE STUDY OF LAHORE

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DEPARTMENT OF CITY AND REGIONAL PLANNING

UNIVERSITY OF MANAGEMENT AND TECHNOLOGY, LAHORE.

Declaration

We hereby declare that the project report is based on over work carried out during over study under the supervision of Planner Muhammed Mutahir Awan we aid the statements made or an outcome of our project work and have not been published anywhere else before

We further clarify that

- The work content in the report is original and has been done by us under the general supervision of our supervisor.
- The work has not been submitted to any other institution for any other certificate.
- Whenever we have used materials (data, theoretical analysis, and text) from other sources we have given due credit to them in the text of the report giving their details in the references.

Acknowledgment

All the praise belongs to Allah Almighty who is the most compassionate and the most merciful and who blessed us with the knowledge that enabled the US to successfully finish this task. In moments of distress, He Guided us and removed all obstacles from the lighted path. All respect and regards to over Holly prophet Hazrat Muhammad (Peace Be Upon Him) who drives us to our creator and who is the educator of all mankind.

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DEDICATION

"To remove an obstruction from the pathway is equal to giving charity"

(Sadqa) "[Prophet Muhammad PBUH, Bukhari 2989]

We dedicate our project

To Last and Ever Last, Prophet of Allah Almighty,

Hazrat Muhammad (Peace Be Upon Him)

And

To the persons who are the causes of our success.

These are our parents and friends whose prayers have made us something out of nothing and our advisor for his guidance and encouragement throughout this research work.

Contents

Chapter No: 1: Introduction to Research

1.1 Introduction

Due to the rapid changes in cities around the world caused by the urbanization process, the smart cities' approach has engaged a lot of attention from city planners and policy makers. Data-driven solutions and advanced technology is used by smart cities to improve the infrastructure of the urban area, enhance the standard of life, and promote sustainable development. The study aims to explore the suitability of implementing concepts of smart cities in the context of new housing developments in Lahore, Pakistan. In this case study, the literature is reviewed to understand the smart city's concept, examine its feasibility with regard to Lahore, and propose the development of a smart city. In addition, a comprehensive review of academic and economic literature will be conducted to attain a comprehensive knowledge of the principles, components, and advantages of Smart Cities. By reviewing existing research, theoretical frameworks, and case studies, we will develop a solid basis for assessing the potential of smart city concepts in the context of Lahore, Pakistan.Analysis of specific challenges and opportunities that may impact the application of smart city introduction in new housing developments in Lahore, Pakistan. We will examine the suitability and adaptability of smart city concepts in the region, taking into account factors such as existing urban infrastructure, technological readiness, governance framework, and socio-economic dynamics. The proposal will integrate key components of a smart city, including intelligent transport systems, sustainable energy solutions, digital connectivity, and citizen-centric services. It aims to address the specific needs and goals of new housing developments in Lahore and to highlight the potential advantages and impact of implementing concepts of smart cities in the region.

1.2 Problem Statement

The rapid urbanization and increasing population in Lahore, Pakistan, present significant challenges for housing development and urban planning. As cities strive to accommodate the growing population, there is a pressing need to explore innovative approaches that foster sustainable advancement, better the life of residents, and ensure efficient urban management. In this context, the potential of smart city concepts for new housing development in Lahore remains largely unexplored. The problem lies in the lack of understanding about the applicability and benefits of smart city concepts in the specific context of Lahore, Pakistan. While the concept of

smart cities has gained global recognition, its successful implementation requires careful consideration of local factors, such as the existing urban infrastructure, technological readiness, socio-economic dynamics, and governance frameworks. Without a thorough assessment of these factors, it is challenging to determine the potential of smart city initiatives for new housing development in Lahore. Furthermore, there is a gap in the literature concerning the integration of smart city concepts into the housing development process in Lahore, Pakistan.

The existing literature primarily focuses on smart city applications in larger urban settings or specific domains such as transportation, energy, or governance. Limited research addresses the specific needs and challenges of new housing development projects and their potential alignment with smart city principles in the context of Lahore. Addressing this problem is crucial to inform urban planners, policymakers, and stakeholders involved in shaping the future of housing development in Lahore. By assessing the potential of smart city concepts, understanding their applicability, and proposing a hypothetical smart city development, this study aims to bridge the existing gap and provide valuable insights into the feasibility and benefits of incorporating smart city principles into new housing development projects in Lahore, Pakistan. Ultimately, by addressing this problem, we have the potential to facilitate the advancement of sustainable and inclusive urban development in Lahore, fostering smarter, more livable, and resilient communities for the growing population.

1.3 Research Questions

- How can we assess the potential of the smart cities concept in Lahore?
- How can we understand the applicability of the smart city approach?
- "What is the potential of integrating smart city concepts into new housing development in Lahore, Pakistan, and how can it contribute to sustainable and inclusive urban development?"

1.4 Research Objectives

1. To conceptualize a smart city approach through a literature review
2. To draw a perception and assess the understanding of private society owners and residents about the smart city.

3. To understand and assess the potential of the smart city concept for new housing developments
4. To develop a smart city proposal; a design tool for new housing developments, and give recommendations to adopt the concept of a smart city for residential developments

1.5 Research Limitations

- People have a lack of awareness of the smart city concept
- There is no proper data on smart cities in the case of Lahore
- There is no smart city in Lahore which is fulfilling the international standards of smart city concept
- While collecting the data from societies we face many difficulties because the authority of the societies is not corporative.

1.6 Research Overview

1.6.1 Chapter 1: Introduction

In this chapter we give the overview of our research in which we give the introduction to the smart city concept after that we discuss the problem statement of our research after that we discuss the research question after that we discuss the research objectives of our research and at the end, we discuss the Limitation of the research.

1.6.2 Chapter 2: Literature Review

In this chapter we give the literature review of our research after that we discuss the Background of the smart city concept and then we discuss the Concept of **the** smart city after that**,** we discuss the initial form of the concept of smart cities and then we discuss the early influences on the smart city concept and after that**,** we discuss the evolution of the smart city concept decade wise and after that**,** we discuss the improvements of **the** smart city over the decades and after that**,** we discuss the summary of the articles and after that**,** we discuss the case studies related to smart city and after that we discuss the smart city concept in **the** context of Pakistan and at the end we find the elements of **a** smart city from the case studies and articles.

1.6.3 Chapter 3: Research Methodology

In this chapter, we adopt the methodology and in the methodology, we find the objectives after that we collect data from the literature review, article assessments, and questionnaires and also collect the data through the assessment of societies and the surveys. After the data, we do data analysis and then we find the results after that we give the proposal based on the results we get through the analysis and we make the study area map in which we work for data collection & data analysis. 9 private housing schemes are used for data collection & data analysis.

1.6.4 Chapter 4: Findings and Evaluation

In this chapter, we give the overview of data collection in which primary and secondary data and selection of the study area and data analysis. We collect the data from the literature in which we find the elements of a smart city from the literature and then we assess these elements in our study area with the help of questionnaires and surveys in which we ask questions about the smart city concept and the features which are used in the area from different society authorities and the residents. after that, we analyze them and select the study area which develops after the LDA rule 2009. the questionnaire, we make a questionnaire with which assessment base and the questionnaire base includes what we asked from the authorities and residents. after that, we make a triangular analysis and then we compare the societies based on assessments and at the end, we do a rank analysis.

1.6.5 Chapter 5: Proposal and Recommendations

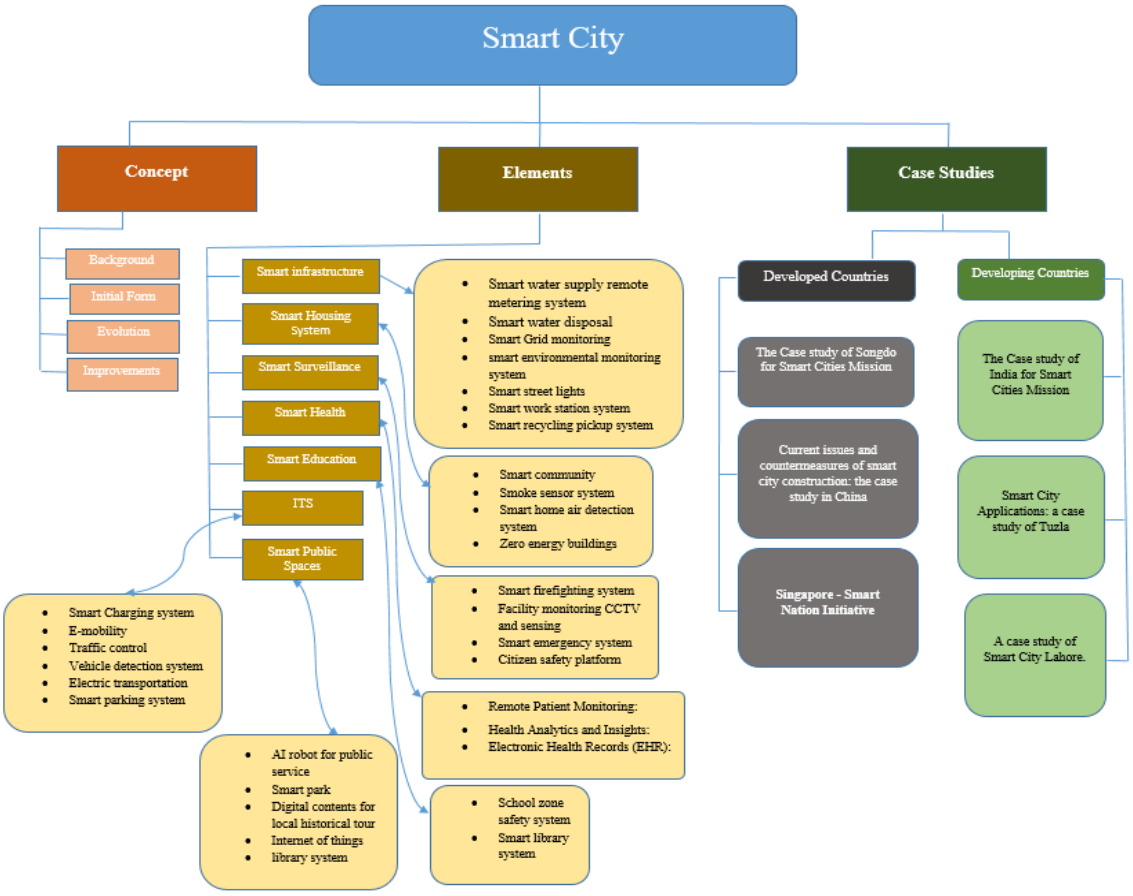
After the study which starts with literature & data collection, data analysis & results. Now based on these things a proposal is given as the solutions & assessment of the potential of smart city concept for the housing schemes in Lahore which was launched & approved after the 2009 Land use rules. Also recommendations on the basis on research.

Chapter 2: Literature Review

2.1 Introduction

In this chapter we give the literature review of our research after that we discuss the Background of the smart city concept and then we discuss the Concept of the smart city after that, we discuss the initial form of the concept of smart cities and then we discuss the early influences on the smart city concept and after that, we discuss the evolution of the smart city concept decade wise and after that, we discuss the improvements of the smart city over the decades and after that, we discuss the summary of the articles and after that we discuss the case studies related to the smart city in the context of devolving and developed countries and at the end we find the elements of a smart city from the case studies and articles.

2.2 Literature map



2.3 Background

To understand the context of the smart cities concept, it is helpful to acknowledge the broader context of urbanization, technological advances, and the challenges cities face. In the last century, the global urbanization process took place rapidly and a large part of the population of the globe lived in cities. Urban areas face many challenges such as population growth, congestion, inadequate infrastructure, environmental concerns, and social inequality. The advancement in communication and information technologies has played a significant role in shaping the concept of smart cities. Advances in areas such as sensors, data analytics, connectivity, and artificial intelligence are presenting new options to improve city systems and services. Cities face many complex problems, including inefficiency in transportation, energy use, waste

management, inadequate healthcare, crime, and environmental sustainability. These challenges require innovative approaches to urban planning and governance. The concept of smart city is to address the challenges of urban areas and the opportunities offered by technological advances It has evolved. The information and communication technologies' integration into the infrastructure of urban areas and services is seen as a way to address these problems and boost people's standard of life. (Vishnivetskaya, 2019).

2.4 Concept

The smart city's concept has been around for several decades, but its modern form began to emerge in the early 2000s. The term "smart city" is defined as the application of technology and data-driven solutions to make improvements in various aspects of urban life, including, safety of the public, citizen involvement, transportation, energy efficiency, and waste management. The idea of using technology to enhance urban environments can be traced back to the 1970s and 1980s when technologists and researchers started to identify the likelihood of utilising computer systems to manage city infrastructure. However, it was in the late 1990s and early 2000s that the concept gained more prominence with advancements in digital technologies and the internet. In 2004, IBM launched its "Smarter Cities" initiative, which aimed to leverage technology and data to address urban challenges. This initiative helped popularize the term "smart city" and sparked further interest in the concept. Since then, the idea has gained momentum worldwide, with cities implementing various smart solutions to enhance their operations and services.

Overall, while the roots of the smart city concept can be traced back several decades, its modern incarnation and widespread adoption started to take shape in the early 2000s.In the 1980s, researchers at the Massachusetts Institute of Technology (MIT) started exploring the concept of "smart cities" as they investigated the adoption of technological devices to monitor and manage urban environments. Projects such as the MIT Building Environmental Management Systems and the Smart Cities Group contributed to the early development of ideas and technologies related to smart cities. Additionally, the emergence of the internet in the 1990s provided a new platform for innovation and connectivity, further fueling the smart cities' concept. The increasing availability of digital technologies and the ability to collect and analyze data opened up new possibilities for improving urban systems and services. While these early initiatives and experiments laid the groundwork for the concept, it was in the early 2000s that the term "smart city" gained more widespread recognition and began to be used to describe the comprehensive application of technology and data-driven solutions to enhance urban life. (Orlando, 2020).

2.5 The initial form

The initial form of the concept of smart cities can be traced back to the 1980s and 1990s when urban planners and researchers began exploring the idea of employing technology to foster city functions and make the standard of life better for residents. During this time, the focus was primarily on using information technology and data management systems to streamline city operations and improve service delivery. In the 1980s, projects like the Masdar City in the United Arab Emirates and the MIT Media Lab's "Changing Places" research initiative explored the integration of technology into urban environments. These early efforts laid the foundation for the smart cities' concept by emphasizing the utilization of sensors, data analysis, and connectivity to produce more sustainable and effective urban systems. Another significant milestone was the development of the "Digital City" concept by Bill Mitchell at MIT in the 1990s.

Mitchell's research focused on leveraging digital technologies and communication networks to create intelligent urban environments that could adapt to the needs of residents. While these early efforts laid the groundwork for the smart cities' concept, it was in the 2000s that the term gained wider recognition and started to be more extensively discussed and implemented. The advancements in ICT, the proliferation of smartphones, and the rise of the IoT were crucial drivers that accelerated the development of the introduction of smart cities globally. Overall, the initial

form of the concept of a smart city can be seen as a gradual evolution from the 1980s and 1990s, when researchers and urban planners began exploring the potential of technology in improving urban life, to the late 2000s when the term "smart city" gained prominence and became a focal point for urban development strategies. (Maria, 2015).

As mentioned earlier, early influences on the smart city concept can be traced back to the 1980s and 1990s, with initiatives like Masdar City and MIT's "Changing Places" research. These projects laid the groundwork by exploring technological usage in urban environments and emphasizing the importance of data and connectivity. The term "smart city" gained popularity in the late 2000s, particularly through IBM's "Smarter Cities" initiative launched in 2008. This initiative brought attention to the concept and stimulated discussions and collaborations among governments, urban planners, and technology companies. In the following years, numerous cities around the world started adopting smart city strategies and implementing projects to leverage technology for urban development. These initiatives encompassed various aspects like energy management, smart transportation, waste management, public safety, and citizen engagement. Overall, the smart city concept appeared as a defense to the issues faced by urban areas and the opportunities presented by technological advancements. It continues to shape urban development strategies and offers the potential to generate more sustainable, livable, and efficient (Vishnivetskaya, 2019).

2.6 The evolution

The concept of smart cities has evolved significantly over the years, driven by technological advancements and the need to address various urban challenges. Here's a brief overview of the evolution of the smart city concept:

2.6.1 Early Urban Planning (1900s - 1960s):

At the turn of the 20th century, urban planners focused on improving public health and sanitation, leading to the development of infrastructure like sewage systems, water supply networks, and

waste management. This laid the foundation for modern urbanization but did not involve advanced technologies.

2.6.2 Rise of Information Technology (1970s - 1990s):

With the advent of computers and the Internet, cities began to adopt technology in their infrastructure management and administration. This phase focused on digitizing data, enabling more efficient communication, and automating some processes.

2.6.3 Sustainable Development (2000s - Early 2010s):

During this period, the emphasis shifted towards sustainable development and environmental considerations. The idea of eco-friendly cities gained prominence, aiming to reduce carbon footprints, enhance energy efficiency, and incorporate renewable energy sources.

2.6.4 Internet of Things (IoT) and Connectivity (The mid-2010s):

As the Internet of Things (IoT) gained traction, smart cities began leveraging interconnected devices to gather real-time data and optimize urban services. IoT enabled smarter transportation systems, efficient energy management, and improved citizen engagement through connected devices and sensors.

2.6.5 Data Analytics and Artificial Intelligence (Late 2010s):

The proliferation of data generated by various sensors and devices led to the rise of data analytics and artificial intelligence (AI) in smart cities. Advanced analytics allowed cities to make data-driven decisions, optimize resource allocation, and predict trends for better planning.

2.6.6 Citizen-Centric Approach (Late 2010s - Early 2020s):

Smart cities started to shift their focus towards a citizen-centric approach, considering the needs and preferences of residents. This involved initiatives to enhance public participation, improve digital services, and create more inclusive urban environments.

2.6.7 Integration of Mobility Solutions (Late 2010s - Early 2020s):

Smart cities integrated mobility solutions to address traffic congestion and promote sustainable transportation. This involved the implementation of intelligent transportation systems, electric vehicle charging infrastructure, and promoting alternative transportation options.

2.6.8 Resilience and Crisis Management (2020s):

Recent challenges, such as the COVID-19 pandemic and the increasing frequency of natural disasters, highlighted the importance of building resilient cities. Smart cities integrated crisis management technologies to respond effectively to emergencies, ensure the continuity of essential services, and protect citizens' well-being.

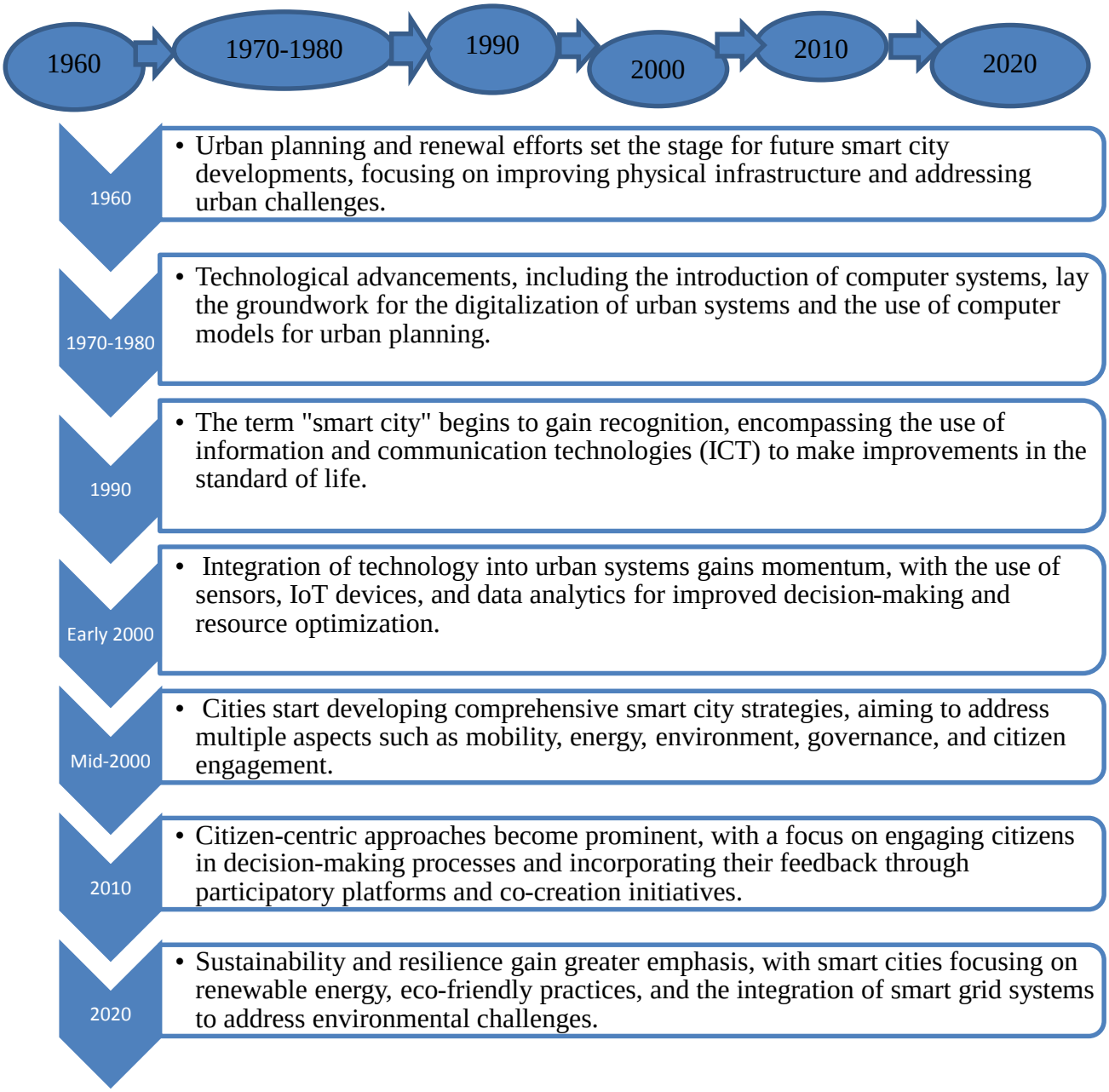
2.6.9 Hyper-connectivity and 5G (2020s - Ongoing):

The rollout of 5G technology enabled faster and more reliable connectivity, paving the way for innovative applications like augmented reality, autonomous vehicles, and immersive experiences. Smart cities continue to explore the potential of hyper-connectivity to revolutionize urban living further.

2.6.10 Sustainable and Circular Economy (Ongoing):

Current smart city efforts prioritize sustainability and the circular economy, aiming to reduce waste, promote recycling, and create more self-sufficient urban ecosystems. Concepts like urban farming, green infrastructure, and circular supply chains are gaining traction. (Ilieva, 2018).

Figure 1: Evolution of Smart Cities



2.7 Improvements

The smart cities' approach has undergone significant improvements over the decades. Here are some notable advancements and improvements made in the smart cities' approach in different decades:

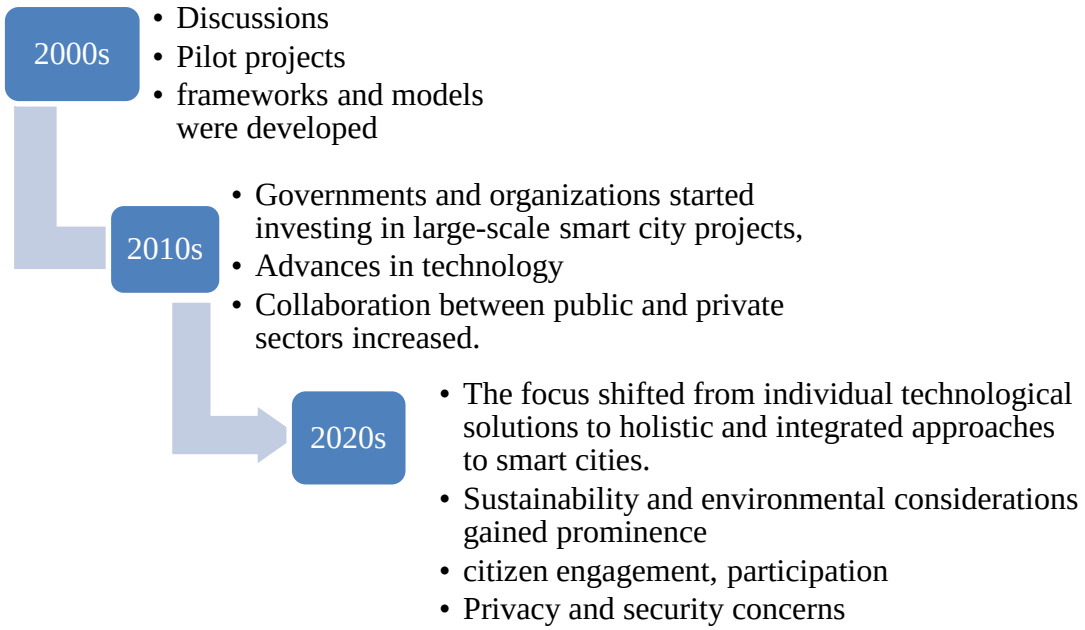


Figure 2:Improvements of Smart City In Different Decades

2.8 Elements of a smart city

A comprehensive review of the key elements of smart cities and evaluates their impact on smart city performance. The authors examine various dimensions of smart cities, including technology infrastructure, governance, sustainability, mobility, and citizen engagement. They analyze the implementation of these elements in real-world smart city projects and assess their effectiveness in improving urban life. Overall, it offers valuable insights into the elements and performances of smart cities, guiding future developments and policy decisions.(Rozman et al., 2022) Yakubu explores the concept of smart cities and their potential as the cities of the future. It discusses how advancements in technology, connectivity, and data analytics are transforming urban environments, making them more efficient, sustainable, and livable. The various aspects of smart cities, including smart infrastructure, energy management, transportation systems, digital governance, and citizen participation. It emphasizes the role of technology in optimizing resource allocation, improving service delivery, and enhancing the quality of life for residents. Yakubu Yusuf concludes by highlighting the challenges and opportunities of implementing smart city initiatives and the need for collaboration among stakeholders to realize the full potential of smart cities.(Yakubu Yusuf et al., 2023)

The study explores the link between smart cities and urban sustainability by conducting a comparative analysis of smart city services in Japan and Korea. The researchers examine how smart city initiatives in both countries address sustainability challenges such as energy consumption, transportation efficiency, waste management, and environmental preservation. The study evaluates the effectiveness of various smart city services implemented in Japan and Korea, considering factors like technological innovation, citizen engagement, and policy frameworks. By comparing the approaches and outcomes of smart city services in the two countries, the study provides insights into best practices and lessons learned for promoting urban sustainability through smart city initiatives. (Ryu & Lim, 2023) The study focuses on assessing the initiatives and progress of Mashhad Smart City in Iran. Mashhad has been implementing various smart city projects and initiatives aimed at enhancing urban services, improving quality of life, and promoting sustainable development. The article evaluates key aspects such as digital infrastructure, smart transportation, energy efficiency, citizen engagement, and e-governance. It examines the impact of these initiatives on urban sustainability, economic growth, and the overall well-being of

residents. The assessment provides insights into the strengths, challenges, and future prospects of Mashhad's smart city journey.(Mirsarraf * et al., 2022)

The research paper introduces a multi-contextual smart city model that focuses on facilitating service interconnections within smart cities. The model aims to enhance the integration and interoperability of various smart city services across different domains and sectors. It addresses the challenges of fragmented and siloed services by providing a framework for seamless interconnections and collaboration among service providers. The paper discusses the components of the multi-contextual model, including data-sharing mechanisms, standardized interfaces, and contextual awareness. It emphasizes the importance of interconnections in improving efficiency, innovation, and overall service delivery within smart cities.(Walletzký et al., 2023) A framework for the development of smart city architecture. It offers a systematic approach to designing and implementing smart city initiatives by considering various aspects such as technology integration, data management, interoperability, scalability, and security. The framework provides guidance for city planners, policymakers, and stakeholders in identifying the requirements, defining the architecture layers, and selecting appropriate technologies for smart city projects. It emphasizes the importance of an adaptable and flexible architecture that can evolve with emerging technologies and changing needs. The researcher highlights the benefits of adopting a structured framework in ensuring the successful implementation of smart city initiatives.(Prasetyo & Habibie, 2022)

The study focuses on identifying the barriers to the adoption of the smart housing concept in African smart city projects, with a specific case study of Akwa Millennium City. The research examines the challenges and constraints faced by developers, policymakers, and residents in implementing smart housing initiatives. It analyzes factors such as limited infrastructure, lack of awareness and education, affordability issues, cultural considerations, and regulatory hurdles. The study provides insights into the specific barriers encountered in the context of Akwa Millennium City and offers recommendations for overcoming these challenges to foster the successful adoption of smart housing concepts in African smart city projects. (Akinwamide et al., 2022) The research study explores the media storylines and societal frames surrounding the energy actions of housing cooperatives, examining how smart and conventional energy initiatives are portrayed. The study investigates the narratives and public perceptions surrounding the energy actions taken by housing

cooperatives, analyzing media coverage and societal framing. It delves into the discourses, values, and ideologies embedded in these narratives, shedding light on the interaction between smart energy technologies and traditional energy practices. The research provides insights into how media portrayals and societal frames influence the acceptance and adoption of smart energy initiatives within housing cooperatives.(Lukkarinen et al., 2022)

The crucial role that clean energy and technology play in the development of smart cities. It discusses how the integration of clean energy sources and advanced technologies is essential for achieving sustainability, efficiency, and resilience in urban environments. The study explores the benefits of clean energy solutions, such as renewable power generation, energy-efficient infrastructure, and smart grids, in reducing carbon emissions and promoting environmental conservation. It also emphasizes the importance of technology in enabling data-driven decision-making, improving resource management, and enhancing the quality of life for citizens. The study underscores the synergistic relationship between clean energy, technology, and smart cities, emphasizing the need for their integration for successful urban development.(Razmjoo et al., 2022) The systematic review examines sustainability-oriented innovations in smart cities and identifies emerging themes within this field. The study analyzes a wide range of research articles, reports, and case studies to identify the key sustainability-oriented innovations implemented in smart cities. It explores themes such as energy management, transportation, waste management, urban planning, and citizen engagement. The review highlights the importance of integrating sustainability principles into smart city initiatives and identifies promising trends and practices that contribute to creating sustainable and resilient urban environments.(Tura & Ojanen, 2022a)

The research paper focuses on the design principles for achieving strategic alignment in Smart City Enterprise Architectures (SCEA). The study emphasizes the importance of aligning smart city initiatives with the broader strategic goals and objectives of the city. It explores the key design principles that enable effective strategic alignments, such as modularity, interoperability, scalability, and adaptability. The paper discusses how these principles can guide the design and implementation of SCEAs to ensure the cohesive integration of smart city solutions and maximize their value in supporting the city's strategic direction.(Bastidas et al., 2023)The study explores the latest developments and advancements in the built environment, focusing on innovations, trends, and practices that shape the design, construction, and management of buildings and urban spaces.

It examines various aspects of the built environment, including sustainable architecture, smart building technologies, energy-efficient design, urban planning, and construction methods. The article discusses the implications of these developments for environmental sustainability, human well-being, and the future of cities. It provides insights into the evolving nature of the built environment and its impact on the way we live, work, and interact with our surroundings. (Chen, 2023)

The systematic review explores sustainability-oriented innovations in smart cities. The study identifies emerging themes within this context. The review provides insights into the current state of sustainability-oriented innovations in smart cities, highlighting key trends and developments. The findings contribute to a better understanding of how smart cities can leverage technology and innovation to promote sustainable practices and enhance urban living.(Tura & Ojanen, 2022b) The study focuses on the implementation of urban computing in smart cities, specifically within the context of Saudi cities. The research proposes a framework that outlines the process of transforming Saudi cities into smart cities through the application of urban computing. The framework provides a comprehensive understanding of the necessary steps, strategies, and considerations involved in this transformation. The analysis aims to support policymakers, urban planners, and stakeholders in effectively implementing smart city initiatives in Saudi Arabia.(Alshuwaikhat et al., 2022)

The research focuses on housing accessibility in densifying cities, with a specific focus on the case of Oslo. The study examines the complex relationship between housing and land use policies and their impact on housing accessibility. It identifies limitations within the existing policies and provides insights into potential strategies to address these limitations. The findings aim to contribute to a better understanding of the challenges and opportunities associated with housing accessibility in cities experiencing densification.(Lukkarinen et al., 2022) The study focuses on the contextualization of smart city technologies through an international comparison. It examines how smart city technologies are adapted and implemented in different contexts worldwide. The research aims to identify the factors that influence the successful deployment of smart city technologies and understand the challenges and opportunities associated with their contextualization. The study provides valuable insights for policymakers, urban planners, and

stakeholders in effectively adopting and integrating smart city technologies within diverse global contexts. (Jiang et al., 2023)

This research focuses on the digitalization of planning culture, specifically in Finland, and the shift toward information model-based planning. The study explores how digital technologies and information modeling are transforming traditional planning practices in Finland. It examines the benefits, challenges, and implications of this change for urban planning processes. The findings contribute to a better understanding of the role of digitalization in planning culture and provide insights into the transition towards information model-based planning in Finland. (Nummi et al., 2023) This study employs a text-mining approach to understand the linkages between smart city technologies and applications. It extracts key lessons from existing literature and identifies areas that require further research in the field of smart cities. The research highlights the importance of exploring the interconnections between different smart city technologies and their applications to maximize their potential benefits. It calls for future research to delve deeper into this topic and develop a comprehensive understanding of the complex relationships and dynamics within smart city ecosystems. (Lim et al., 2021)

This research focuses on business models for digital sustainability, specifically within the context of smart city services. The study develops a framework and explores the micro-foundations of value capture in these business models. It analyzes empirical evidence from 130 smart city services to provide insights into the relationship between digital sustainability and business models. The research contributes to a better understanding of how businesses can leverage digital technologies to create value while promoting sustainability in the context of smart cities.(Bencsik et al., 2023) This research focuses on smart cities and smart destination planning in Spain. It examines the instruments used in the planning process and explores the perceived impacts of these initiatives. The study analyzes the implementation of smart technologies and strategies in urban and tourist destinations in Spain, highlighting their effects on various aspects such as transportation, infrastructure, sustainability, and visitor experience. The findings contribute to a better understanding of the planning instruments used in smart city and smart destination initiatives and shed light on their perceived impacts in the Spanish context.(Ivars-Baidal et al., 2023)

This research explores the re-imagination of smart cities through the integration of city planning and Geo AI (Geospatial Artificial Intelligence) in the era of big data. The study focuses on how

big data and Geo AI technologies can revolutionize city planning processes, enabling more informed decision-making and efficient resource allocation. It examines the potential applications of Geo AI in various aspects of smart city planning, such as transportation, energy management, infrastructure development, and urban design. The findings contribute to a better understanding of the transformative power of big data and Geo AI in shaping the future of smart cities.(Mortaheb & Jankowski, 2023) This evaluation study focuses on assessing new first-tier smart cities in China using the entropy method and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) technique. The research aims to provide a comprehensive evaluation of these smart cities based on multiple criteria and identify their strengths and weaknesses. The study utilizes the entropy method to determine the weights of the evaluation criteria and applies the TOPSIS method to rank the smart cities. The findings contribute to a better understanding of the development and performance of new first-tier smart cities in China. (Zhang et al., 2022)

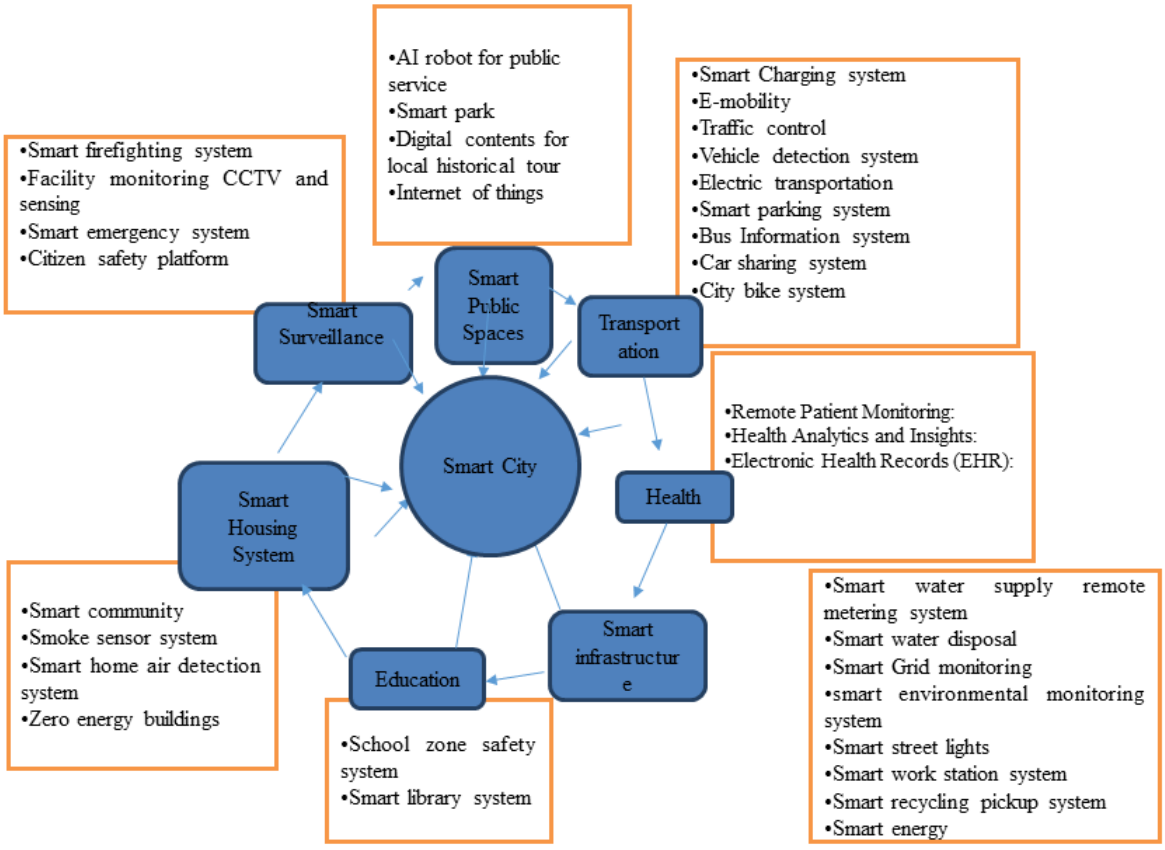


Figure 3: Elements from Literature

Table 1: Elements From Literature for Smart City

Elements	Description	References
Zero energy buildings	Zero-energy buildings in a smart city context are energy-efficient structures designed to generate and consume an equal amount of energy, contributing to the city's sustainability objectives while utilizing advanced technologies for efficient energy management	(Razmjoo, 2022)
Intelligent transportation service	refer to technology-driven solutions and systems that enhance transportation efficiency, safety, and sustainability through data integration, real-time monitoring, and intelligent management, ultimately improving the overall mobility experience within the urban environment	(Zhang, 2022)
Bus Information system	A bus information system in the context of smart city urban design is a technology-based platform that provides real-time information on bus routes, schedules, and arrivals to enhance public transportation accessibility, convenience, and user experience, promoting sustainable and efficient mobility within the city	(Zhang, 2022)
Smart parking system	A smart parking system in the context of smart city urban design is a technology-enabled solution that utilizes sensors, data analytics, and real-time information to optimize parking space utilization, streamline parking operations, and enhance the overall parking experience, contributing to reduced congestion and improved urban mobility	(Tura, 2022)
Smart energy	refers to the integrated use of advanced technologies, data analytics, and renewable energy sources to optimize energy generation, distribution, and consumption, promoting energy efficiency, sustainability, and resilience within the urban environment.	(Tura, 2022)
E-mobility	refers to the use of electric vehicles (EVs) and supporting infrastructure, such as charging stations, to promote sustainable transportation options and reduce carbon emissions, enhancing the overall transportation system within the city.	(Lim, 2021)

Traffic control	Traffic control in the context of smart city urban design involves the use of advanced technologies and real-time data analysis to optimize traffic flow, improve safety, and reduce congestion, enhancing the efficiency and effectiveness of the urban transportation network	(Lim, 2021)
Smart Charging system	is an intelligent infrastructure that enables efficient and controlled charging of electric vehicles (EVs), utilizing advanced technologies and data integration to optimize energy management, promote renewable energy integration, and support the transition to sustainable transportation within the city.	(Lim, 2021)
Smart Grid monitoring	refers to the utilization of advanced technologies and data analytics to monitor and manage the electrical grid infrastructure, enabling real-time monitoring of energy consumption, optimizing distribution, and promoting efficient and reliable energy supply within the city.	(Lim, 2021)
Smart education system	refers to the incorporation of digital technologies, data analytics, and personalized learning approaches to create inclusive, interactive, and adaptive educational environments that support lifelong learning and empower residents within the city	(Bencsik, 2023)
Smart housing system	involves the integration of advanced technologies and data-driven solutions to create energy-efficient, connected, and sustainable living spaces that enhance residents' quality of life, promote resource conservation, and optimize housing operations within the city.	(Bencsik, 2023)
Smart security	refers to the implementation of intelligent surveillance systems, sensors, and data analytics to enhance public safety, emergency response, and crime prevention, creating a secure and resilient environment for residents and visitors within the city.	(Bencsik, 2023)
smart environmental monitoring system	involves the deployment of sensors, data analytics, and advanced technologies to monitor and assess various environmental factors such as air quality, noise levels, and waste management, enabling proactive measures to be taken toward sustainability, resource conservation, and the well-being of residents within the city	(Bencsik, 2023)

Internet of things	refers to a network of interconnected devices, sensors, and objects that collect and exchange data to enhance the efficiency, sustainability, and quality of urban services and infrastructure, enabling seamless connectivity and data-driven decision-making for improved urban living experiences.	(Ivars-Baidal, 2023)
Smart health system	encompasses the integration of digital health technologies, data analytics, and telemedicine to provide personalized and accessible healthcare services, promote preventive care, and enhance the overall well-being of residents within the city, fostering a healthy and inclusive urban environment.	(Cavicchia, 2023)
Smart water disposal	refers to the implementation of intelligent systems, sensors, and data analytics to optimize the collection, treatment, and management of wastewater and storm water, ensuring efficient water disposal, mitigating pollution risks, and promoting sustainable water resource management within the city.	(Ivars-Baidal, 2023)
Smart public spaces	refer to technologically enhanced and digitally connected communal areas that utilize sensors, smart lighting, interactive displays, and data analytics to create inclusive, engaging, and sustainable environments for residents and visitors, fostering social interaction, civic engagement, and improved quality of life within the city.	(Bastidas, 2023)
Smoke sensor system	refers to a network of smoke detectors and sensors deployed throughout the city to detect the presence of smoke or fire. By integrating with a central monitoring system, it enables prompt alerts, faster response times, and enhanced public safety measures, helping to prevent fire incidents and minimize potential damages within the urban environment.	(Lukkarinen, 2022)
Smart library system	refers to an advanced technology-driven platform that digitizes library resources, enhances accessibility through online catalogs and e-books, utilizes data analytics for personalized recommendations, and provides interactive spaces and services to promote lifelong learning, knowledge sharing, and community engagement within the city.	(Mortaheb, 2023)

Smart infrastructure	refers to the integration of advanced technologies, sensors, and data analytics into the physical infrastructure of a city, such as transportation networks, utilities, and buildings. This enables real-time monitoring, efficient resource management, and proactive maintenance, leading to enhanced sustainability, resilience, and improved quality of life for residents within the city.	(Bastidas, 2023)
Vehicle detection system	refers to a network of sensors, cameras, and data analytics that enables real-time monitoring and identification of vehicles within the urban environment. This system facilitates traffic management, and parking optimization, and enhances overall transportation efficiency and safety within the city.	(Bastidas, 2023)
Safe drop service	Refer t o a secure and convenient delivery system that utilizes smart lockers or designated drop-off points for package or item collection. This service enhances efficiency, reduces theft, and provides a seamless and contactless experience for residents and businesses within the city, promoting convenience and safety in the delivery process.	(Jiang, 2023)
Smart street lights	refer to intelligent lighting systems that utilize sensors, data analytics, and automated controls to optimize energy efficiency, enhance public safety, and reduce operational costs. These lights can adjust brightness based on real-time conditions, detect motion, and provide smart features such as remote monitoring and adaptive lighting, contributing to a sustainable and well-lit urban environment.	(Bastidas, 2023)
Smart park	refers to a technologically enhanced and digitally connected green space that utilizes sensors, data analytics, and interactive features to provide innovative services and experiences to park visitors. These parks may offer amenities like smart lighting, Wi-Fi connectivity, real-time environmental monitoring, and interactive displays, fostering sustainability, recreation, and community engagement within the urban landscape.	(Bastidas, 2023)

Smart home air detection system	refers to an integrated network of sensors and devices within residential buildings that monitor and analyze air quality parameters. By providing real-time data and alerts, this system promotes healthy indoor environments, enables efficient ventilation strategies, and contributes to overall environmental sustainability and well-being within urban living spaces.	(Lukkarinen, 2022)
Smart work station system	refers to a technologically advanced setup that incorporates digital tools, connectivity, and data-driven features to optimize productivity, collaboration, and flexibility in work environments. These systems provide intelligent workstations, integrated communication platforms, and personalized settings to enhance efficiency, creativity, and work-life balance for individuals within the urban landscape.	(Nummi, 2023)
Facility monitoring CCTV and sensing	refers to a comprehensive surveillance system that combines video monitoring and sensor technologies to monitor and analyze various aspects of urban facilities. This integrated system enhances security, safety, and operational efficiency by providing real-time data, alerts, and insights for effective facility management and decision-making within the city.	(Nummi, 2023)
Electric transportation	refers to the use of electric vehicles (EVs) and associated charging infrastructure to promote sustainable and efficient transportation options within the city. By reducing emissions and reliance on fossil fuels, electric transportation contributes to improved air quality, reduced noise pollution, and a more environmentally friendly urban transportation system.	(Alshuwaikhat, 2022)
Smart community	refers to a digitally connected and technologically empowered neighborhood or residential area that utilizes innovative technologies, data integration, and community engagement to enhance the quality of life, sustainability, and social well-being. Smart communities leverage smart infrastructure, smart services, and citizen participation to create a collaborative and inclusive urban environment that promotes connectivity, efficiency, and a sense of belonging among residents.	(Alshuwaikhat, 2022)

Smart emergency system	refers to an integrated network of advanced technologies, data analytics, and real-time communication channels that enable efficient emergency response and management. This system facilitates early detection, rapid alert dissemination, and coordinated actions to enhance public safety and resilience during emergencies or crisis situations within the urban environment.	(Chen, 2023)
Citizen safety platform	refers to a digital platform that empowers residents with tools and resources to ensure their personal safety and contribute to community security. It facilitates communication, emergency reporting, and access to real-time information, fostering collaboration between citizens and authorities for a safer and more secure urban environment.	(Yusuf, 2023)
Digital content for the local historical tour	refer to interactive and immersive multimedia materials, such as augmented reality (AR), virtual reality (VR), or mobile applications, that provide engaging and informative experiences for visitors exploring the historical sites and landmarks within the city. These digital contents enhance the understanding, preservation, and accessibility of local history, promoting cultural heritage appreciation and enriching the tourist experience within the urban environment.	(Yusuf, 2023)
Smart water supply remote metering system	refers to a technology-driven solution that utilizes remote sensors and data analytics to monitor and manage water consumption in real-time. This system enables accurate billing, leak detection, and efficient water management, promoting conservation, sustainability, and effective resource allocation within the urban water supply network.	(Rozman, 2022)
Smart firefighting system	refers to an advanced network of sensors, monitoring devices, and data analytics that enhance the detection, response, and management of fire incidents within the city. This system provides real-time alerts, intelligent routing, and coordination of firefighting resources, improving emergency response times and minimizing property damage, thereby ensuring the safety and resilience of the urban environment.	(Lim H. , 2023)

The smart recycling pickup system	refers to an advanced technological solution integrated into a smart city's infrastructure that optimizes the collection and management of recyclable materials. It leverages various sensors, connectivity, and data analytics to streamline the recycling process and enhance overall sustainability efforts within the urban environment.	(Mirsarraf, 2022)
City bike system	refers to a transportation infrastructure that provides bicycles for public use within an urban environment. It typically involves a network of docking stations strategically located throughout the city where individuals can rent and return bicycles for short-distance trips. These systems often incorporate smart technology, such as mobile apps and electronic locking mechanisms, to facilitate bike sharing, track usage, and optimize the overall user experience.	(Carrubbo, 2023)
School zone safety system	refers to an intelligent infrastructure solution implemented within a smart city context to enhance safety measures and protect pedestrians, particularly students, in the vicinity of schools. It employs advanced technologies such as sensors, cameras, and real-time data analysis to detect and respond to potential risks and hazards, creating a secure environment for students and other pedestrians in school zones.	(Prasetyo, 2022)
Car sharing system	refers to a transportation model that allows individuals to access and use vehicles on a short-term basis, typically by renting them for specific durations or trips. It operates on the principle of shared mobility, where multiple users have access to a fleet of vehicles stationed in various locations throughout the city. Car-sharing systems typically employ smart technology, such as mobile apps and GPS tracking, to facilitate vehicle reservations, payment processing, and fleet management	(Carrubbo, 2023)
AI robot for public service	refers to an intelligent robotic system deployed within a smart city context to assist with various public service tasks and enhance the overall efficiency and effectiveness of urban operations. These robots are equipped with artificial intelligence capabilities, sensors, and advanced algorithms that enable them to perform a wide range of functions, such as	(Nummi, 2023)

	information dissemination, public safety monitoring, waste management, and community engagement.	

2.9 CASE STUDIES

Smart City practices encompass a range of strategies and initiatives aimed at utilizing technology and data to improve urban sustainability, efficiency, and the quality of life for residents. The case studies of Songdo in South Korea and the India Smart Cities Mission provide insights into successful smart city practices:

2.10 Developed Countries

2.10.1 Current issues and Countermeasures of Smart City Construction: the case study in China

In the case study focused on smart city construction in China, several critical issues and corresponding countermeasures were identified. One of the primary challenges faced in China's smart city development is the fragmentation of technology, leading to disparate systems and limited data sharing. To address this, the study proposes adopting an integrated approach, encouraging better cooperation among various government departments to create a cohesive smart city ecosystem. Another major concern is data privacy and security, given the vast amount of information collected in smart cities. The suggested countermeasure involves implementing robust data protection measures, including encryption and access controls, to instill citizen confidence in data handling. Additionally, the lack of interoperability among different smart city applications poses hindrances to seamless data exchange. To overcome this, the study recommends promoting standardized protocols and communication systems to facilitate data sharing and integration. Engaging citizens and raising awareness about smart city initiatives emerged as another crucial aspect. Citizen-centric design, involving residents in decision-making, and addressing their concerns help build public acceptance and support. Financial sustainability is also vital for long-term smart city development. Public-private partnerships (PPP) can attract private investments and expertise, ensuring ongoing financial viability. Lastly, conducting pilot projects before scaling up implementations allows for testing and refining smart city applications. Overall, the case study

underscores the significance of comprehensive policies, citizen participation, and robust data governance in ensuring successful and sustainable smart city construction in China.

2.10.2 The Case Study of Songdo for Smart Cities Mission

Songdo is often hailed as a leading example of a smart city. The development of Songdo involved a comprehensive integration of smart technologies, including an extensive sensor network, to create an efficient and sustainable urban environment. Key practices include. Intelligent Transportation: Songdo incorporates a sophisticated transportation system with smart traffic management, real-time data analysis, and efficient public transportation options. This promotes smooth mobility, reduces congestion, and minimizes carbon emissions. Sustainable Energy Management: The city utilizes smart grid infrastructure, renewable energy sources, and energy-efficient buildings. These practices optimize energy consumption, promote conservation, and reduce environmental impact. Integrated Waste Management: Songdo employs an automated waste collection system that utilizes underground pneumatic tubes for waste disposal. This enhances efficiency, reduces the need for traditional waste collection methods, and improves cleanliness.

2.10.3 Singapore - Smart Nation Initiative

Singapore, a global leader in smart city development, implemented the Smart Nation initiative to enhance livability, sustainability, and economic competitiveness. As a small, densely populated city-state, Singapore faced challenges such as limited space, aging infrastructure, and increasing urbanization. The Smart Nation initiative aimed to leverage technology and data to address these challenges. The challenge was to integrate various systems and technologies to create a seamless, interconnected urban environment. The goal was to improve citizen services, optimize resource allocation, and enhance the quality of life. Singapore implemented a holistic approach to smart city development. It involved integrating data from various sources, deploying sensors and IoT devices, and leveraging advanced analytics. The city focused on initiatives such as smart transportation, intelligent infrastructure, digital governance, and sustainable energy management. The Smart Nation initiative led to significant improvements. Singapore established efficient and integrated public transportation systems, reduced traffic congestion, and enhanced urban planning through data-driven insights. The city also implemented smart grid technologies to optimize

energy usage and introduced digital services for citizens, such as online government transactions and personalized healthcare. The Singapore case emphasizes the importance of a comprehensive and integrated approach to smart city development. The success of the Smart Nation initiative underscores the value of data-driven decision-making, strong public-private partnerships, and a focus on citizen-centric services. The lessons learned include the need for long-term planning, continuous innovation, and a commitment to sustainability. (Esther, Singapore - Smart Nation Initiative, 2023).

2.11 Developing Countries

2.11.1 Smart City Applications: A Case Study of Tuzla

The case study explores the transformation of Tuzla, a city in [Country], into a smart city by leveraging various smart city applications. Tuzla, facing urban challenges such as population growth, infrastructure demands, and environmental concerns, recognizes the potential of smart city solutions to address these issues effectively. The proposed smart city framework for Tuzla includes key components such as infrastructure development, smart mobility, energy management, e-governance, smart health, public safety, and sustainability initiatives. These components form the foundation for Tuzla's smart city journey. The study highlights successful smart city applications from other cities that can be adapted to Tuzla's context. Examples include a smart parking management system using IoT sensors and mobile apps, a waste management system optimizing collection routes through sensor technology, and energy-efficient smart lighting for public safety and energy savings. Additionally, a citizen engagement platform promotes inclusivity and participatory governance by empowering citizens to access information and provide feedback.

The benefits of implementing these smart city applications are significant. They include improved quality of life for residents, enhanced economic growth, better environmental sustainability, and increased citizen satisfaction. However, the study acknowledges potential challenges, such as initial investment costs, interoperability concerns, and data privacy issues that must be addressed during implementation. The proposed implementation strategy outlines a comprehensive plan, including timelines, budget estimates, and the roles of relevant stakeholders. The local government, private sector partners, and the community must collaborate to ensure the successful realization of Tuzla's smart city vision. The case study emphasizes the transformative

potential of smart city applications in addressing Tuzla's urban challenges and positioning the city for sustainable growth. By embracing technology-driven solutions, Tuzla can create a more efficient, inclusive, and environmentally friendly urban environment, ultimately enhancing the overall city experience for its residents.

2.11.2 The Case Study of India for Smart Cities Mission.

The India Smart Cities Mission is a nationwide initiative launched by the Indian government to develop 100 smart cities across the country. The mission emphasizes citizen-centric development and includes several key practices Citizen Engagement The mission promotes citizen participation and engagement in decision-making processes. It encourages the use of technology platforms and mobile applications to gather feedback, address grievances, and ensure transparency in governance. Integrated Command and Control Centers: Each smart city under the mission has a Command and Control Center that integrates various services and utilities, such as traffic management, public safety, and emergency response systems. These centers enable real-time monitoring, data analytics, and prompt decision-making for efficient city operations. Sustainable Infrastructure: The mission prioritizes sustainable infrastructure development, including energy-efficient buildings, green spaces, and water management systems. This ensures resource optimization, environmental conservation, and enhanced livability. Smart Mobility The mission focuses on improving urban mobility by promoting public transportation, non-motorized transport options, and intelligent traffic management systems. It aims to reduce congestion, promote cleaner modes of transport, and enhance connectivity.

In summary, smart city practices encompass the integration of technology, data-driven decision-making, citizen engagement, and sustainable development. The case studies of Songdo and the India Smart Cities Mission highlight the successful implementation of various smart city practices, including intelligent transportation, sustainable energy management, citizen engagement, and integrated urban infrastructure. These practices contribute to creating more efficient, livable, and sustainable urban environments. (Studies (CRS), 2018)

2.11.3 A case study of smart city Lahore

Smart City Lahore is one of the best residential projects in Pakistan, ranking among all the large real estate projects. Apart from everything else, this will be the first Pakistani project that shocks everyone. Smart City Lahore is the fifth smart city project in Asia and the second in Pakistan. It is located on the Lahore By-Street and is accessible via GT Expressway and Lahore-Sialkot Expressway. The ring road is also connected. It has quickly become the most popular residential scheme due to its modern development and unique features. The developers envision it as an eco-friendly smart city in Lahore

Chapter 3: Research Methodology

3.1 Introduction

This is the methodology of our research in which first we select the topic and then find the problem statement then find the objectives after that, we find the research questions and then we collect the data which is primary or secondary through the literature and on the basis of surveys and questionnaires. Then we analyze the data and get the result and give a proposal based on the result. This chapter outlines the research methodology that has been adopted for thesis completion researchers have also deliberated on the tools and techniques for the analysis of data acquired from secondary resources. Moreover, the chapter includes a selection of research topics, a selection of case study areas, data collection methods, data analysis, and report writing. The "how" a particular piece of research is carried out in practice is what researchers call research methodology. More specifically, it discusses the methodical approaches that a researcher takes when planning a study to guarantee accurate results that are in line with the study.

3.2 Methodology

Methodology refers to the systematic and organized approach that researchers use to conduct and carry out scientific investigations and studies. It encompasses the overall design, methods, procedures, and techniques used to collect, analyze, and interpret data to answer specific research questions or test hypotheses. The chosen research methodology significantly influences the validity, reliability, and generalizability of the study's findings.

Figure 4: Research Methodology

3.3 Data collection techniques

Data collection is very significant for any researcher. It is the process of gathering and measuring information on variables of interest in an established systematic way. The data for research purposes is collected through appropriate methods and tools. The **secondary data** was objectively collected to analyze the existing situation. We are gathering from published reports, research papers, the internet, etc.

3.4 Secondary data Source

Secondary data in research refers to existing data collected by others for different purposes, which researchers use to conduct new analyses and gain insights without gathering data themselves.

3.4.1 Through literature review

we did literature from different articles & case studies which is in local & international contexts. Also case studies from developed & Developing countries. After all the literature we find smart city features from the literature which is based on main & sub Elements.

3.4.2 Land Use Rules 2009

In 2009, the Land Development Authority (LDA) implemented land use rules to govern land development and utilization. These rules focused on sustainable development, efficient land management, and environmental protection. They emphasized proper planning, zoning, and development control to regulate land use practices effectively. The LDA's land use rules aimed to preserve natural habitats, conserve land resources, and prevent unauthorized changes in land use. Public participation, transparency, and accountability were encouraged to ensure inclusive decision-making processes. The rules addressed various aspects such as land subdivision, infrastructure development, and land use conversions. They provided guidelines for residential, commercial, industrial, and agricultural land use. By striking a balance between development and conservation, the LDA's land use rules aimed to protect the well-being of communities and the environment. These rules played a crucial role in ensuring responsible and sustainable land use practices, contributing to the long-term development and preservation of land resources.

3.5 Primary data source

Primary data in research refers to original data that researchers collect firsthand for their specific research objectives and questions. This data is gathered directly from participants or sources through various methods, such as surveys, interviews, experiments, observations, or focus groups. Primary data is unique to the particular study and has not been previously published or used for other research purposes, making it fresh and tailored to address the specific research objectives of the study at hand.

3.5.1 Semi structure interviews with owners of society

We did a survey which is based on questioner form & some questions we asked open-ended from our side by the owner of the societies. These interviews are awareness & observational-based. We cover 9 societies owner's offices in which DHA phase 9, DHA Phase 7, Dream garden, Mid City, Damaan City, Bahria Orchard, Smart City, Park View City, and Al Kabir Town Phase 2.

3.5.2 Questioner design for resident perception

We did a survey which is based Simple random sampling technique in which we did a survey on a 1% sample size from the residents. The questioner which is awareness & observational based on the smart city concept. We cover 9 societies residents in which DHA phase 9, DHA Phase 7, Dream garden, Mid City, Damaan City, Bahria Orchard, Smart City, Park View City, and Al Kabir Town Phase 2.

3.5.3 Observation sheet

We did a survey as an observational sheet in which we observe the smart city elements from the different societies. We assess which elements are in current societies which we find from literature.

3.6 Simple random sampling technique

Simple random sampling is a type of probability sampling in which the researcher randomly selects a subset of participants from a population. Each member of the population has an equal chance of being selected.

3.6.1 Formula:

1 percent is the sample size on the base of the formula which is given below.

N = Population size

z = z-score

e = margin of error

p = standard of deviation

$$\text{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+\left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

$$P = 1 - \frac{N-1}{N} \cdot \frac{N-2}{N-1} \cdots \frac{N-n}{N-(n-1)}$$

$$\text{Cancelling} \quad = 1 - \frac{N-n}{N}$$

N=Population size

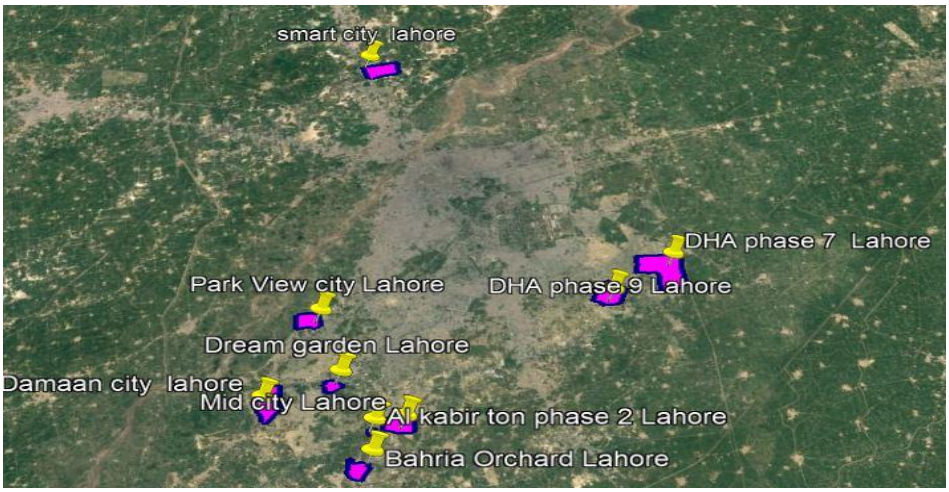
Z=z-score

e =Margin of Error

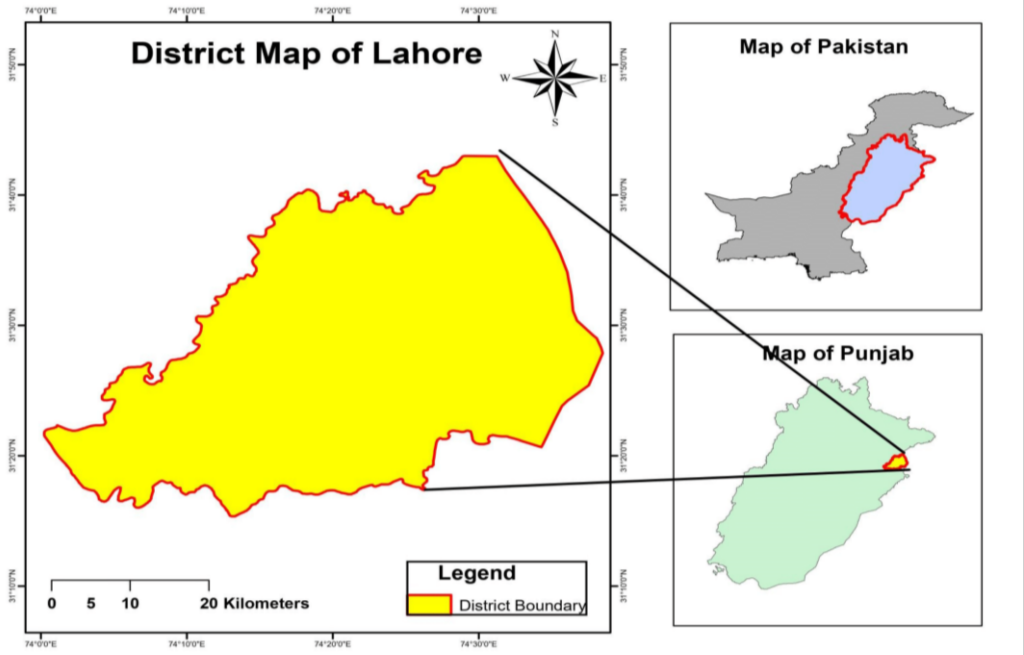
P=Standard of deviation

3.7 Selection of study area

This is the study area map in which we work for data collection & data analysis. 9 private housing schemes are used for data collection & data analysis. From these schemes, we did authorities & residential



base surveys & also assessments of smart elements which we collect from our literature.



3.8 Characteristics of Societies:

Dream Garden

The planned area is 500acres.An independent, gated & secure community with all the amenities of living. Lahore Dream Garden was launched in September 2011 and the first phase was completed 1.5 years ahead of schedule in June 2014.

DHA Phase 9

Prism offers a high standard of living to its residents. DHA phase 9 prism consists of over 30 commercial buildings. The planned road network connects it to all basic facilities, including health, transportation and education sectors, making daily life more convenient.

DHA Lahore Phase7

32,516 kanal land under development. Residential land, commercial land, institutional land and recreational facilities are all included.

Al Kabir Town It is located on 2,500 kanals. The well-designed community aesthetic can be seen on Thunder Wind Main Road in Lahore.

Lahore Smart City

Residential Concepts is a remarkable undertaking that redefines the concept of modern living. A total of 20,000 lands of the kanal lands have been reserved for the project on which this distinct residential area will be built

Park View City

The housing concept is an outstanding undertaking that redefines the idea of modern life. A total of 20,000 kanal of land has already been set aside for the project, on which this competent residential complex will be erected.

Mid-city

Phase 1 Consists Of 606 Kanal Area.

Damaan City

The project encompasses 1100 acres of land. A team of expert town planners plans, designs, and develops the Damaan City Lahore project plan. The project is designed to become Lahore's most appealing investment destination.

Bahria Orchard Lahore is a housing society in the Pakistani city of Lahore. It is a master-planned neighborhood constructed by the Bahria Town Group, one of Pakistan's leading real estate developers. The society covers about 25,000 acres and has over 200,000 people.

3.7 Housing Schemes in Lahore After LDA Land Use Rules 2009

Table 2: Housing Schemes in Lahore After LDA Land Use Rules 2009

Name	No Residents / Houses	Sample Size 1 %	Launch Year	Status
Dream Garden	480	5	2011	Approved
DHA Phase 9	190	2	2021	Approved
DHA Phase 7	311	3	2014	Approved
Bahria Orchard 3	800	8	2016	Approved
Al Kabir Town Phase 2	240	2	2017	Approved
Smart City	0	0	2020	Approved
Park View City	2200	22	2012	Approved
Damaan City	0	0	2020	Approved
Mid-City	0	0	2021	Approved

3.7.1 Reasons

Societies are taken on the basis of the evolution of smart cities which is starts in the 1960, s & implementing phase was started in 2010. These Are societies that were launched after the 2009 land use rules.in these Societies there are some societies that are only on the ground base means there are no residents in the society & some have some residents. which is described in the above table. The sample is 1 % because in the societies there are same-size plots in the rows if 1 house is surveyed for the 100 houses it can be the same for all the houses. Sample sizing on the basis of number of houses in the societies. All these societies are approved by different authorities.

Chapter 4: Data analysis & results

4.1 Introduction

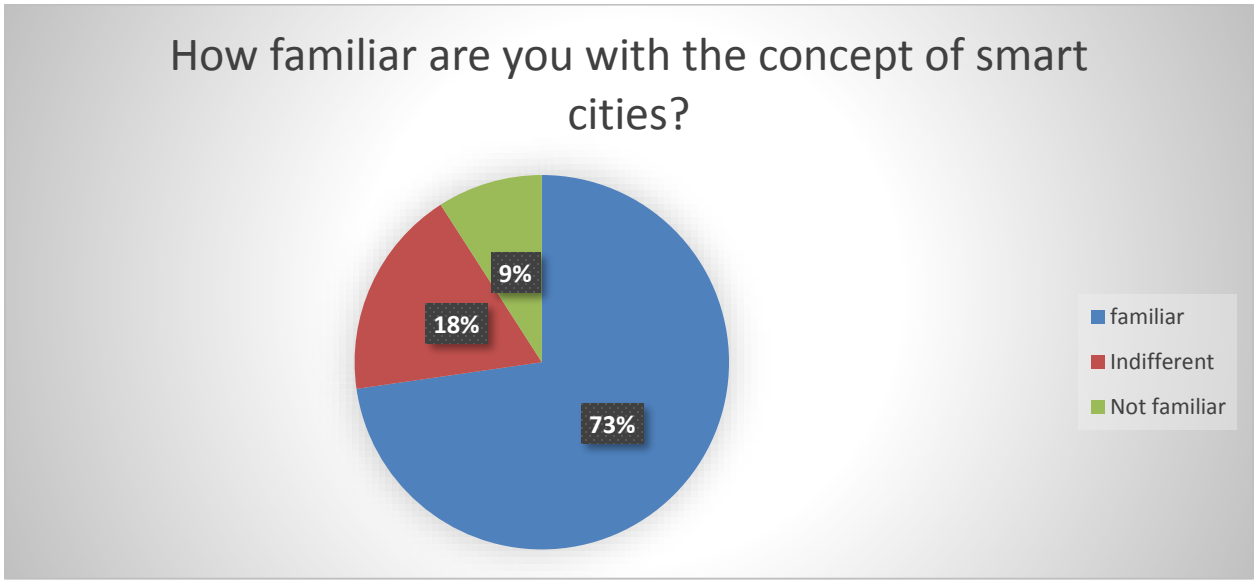
Following data collection based on various surveys (Residents, Owners, observational sheets, and awareness context) of smart city aspects. Now we examine our data collection in data analysis and findings. In this chapter, we complete Objective 3. In this chapter, we examine different societies' perceptions and awareness of the smart city concept. We conduct triangular analysis based on information gathered from residents and owners of the society concerning awareness and observational sheets of smart city features. In this chapter, we also conduct rank analysis.

4.2 Objective 3

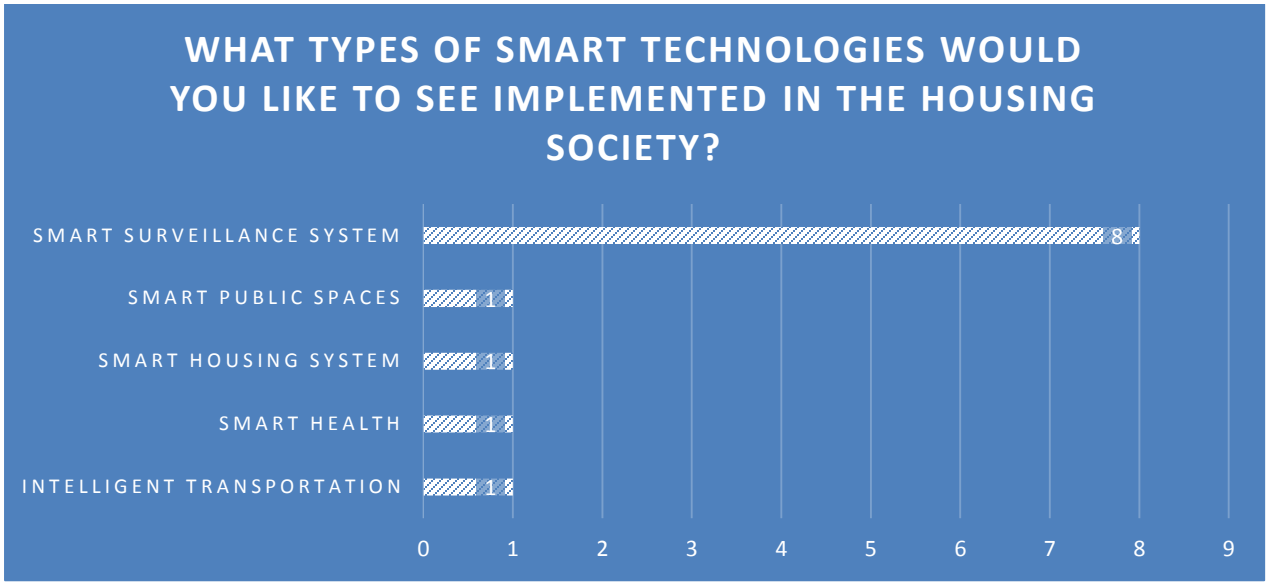
To draw a perception and assess the understanding of private society owners and residents about the smart city.

Result A: Semi structure interviews

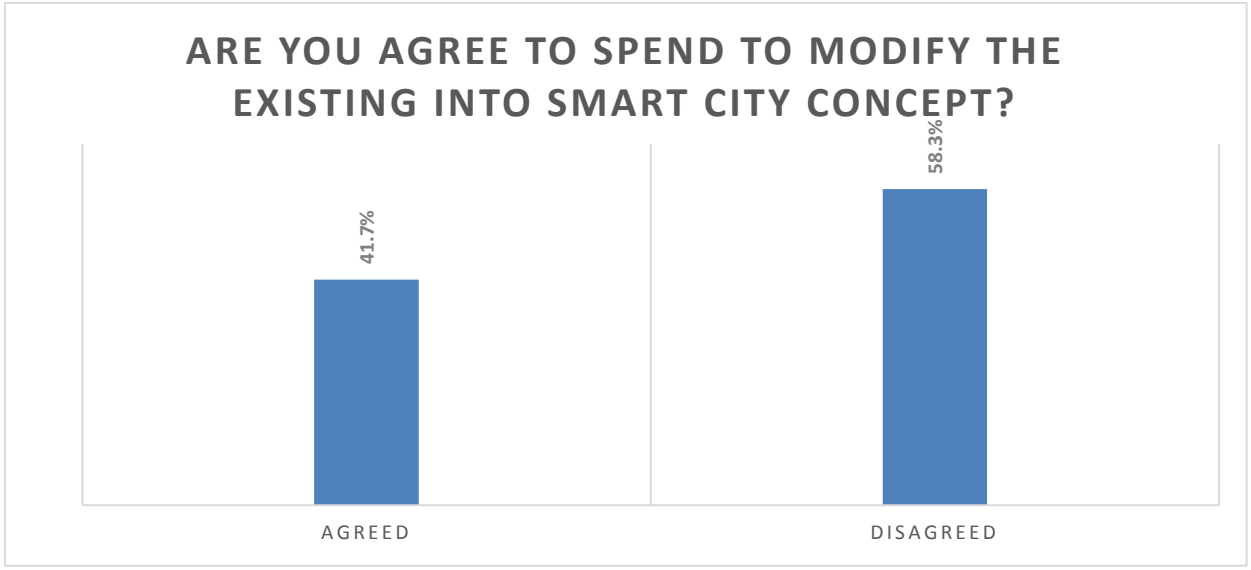
These are the results of the questions asked by the society's offices. This information provides by the society's offices.



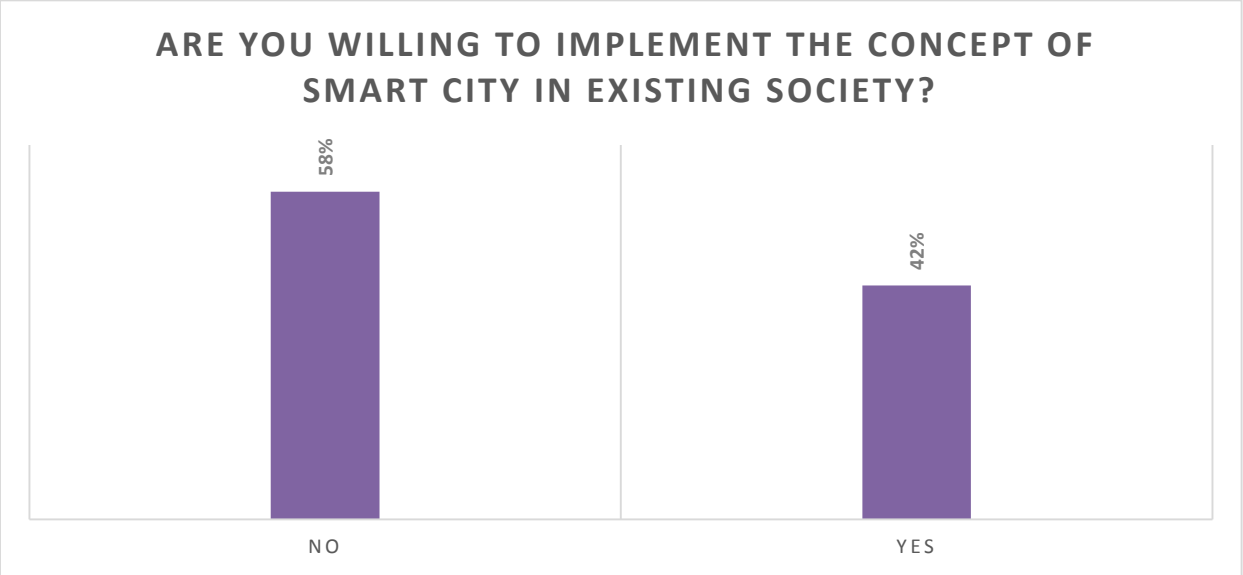
This is the questionnaire base analysis in which the graph shows the percentages of the familiar and not familiar with the concept of the smart city 73% represent the familiar persons and 9% are not familiar with the concept of smart cities the other and the remaining 18% are different.



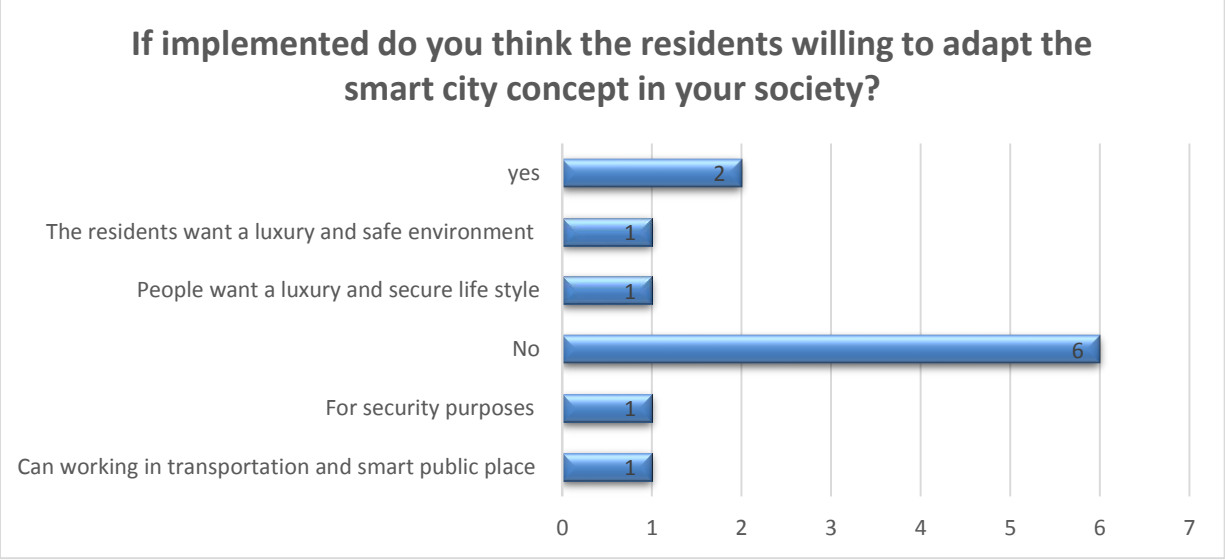
This graph shows the number of societies which are 0 to 9 which is the x side of the graph and the y side of the graph shows the technologies which are the peoples want to see implemented in the housing society in which the highest rate is 8% which is smart surveillance system prefer by peoples and others in which like smart public spaces, smart housing, smart health, and intelligent transportation just at 1.



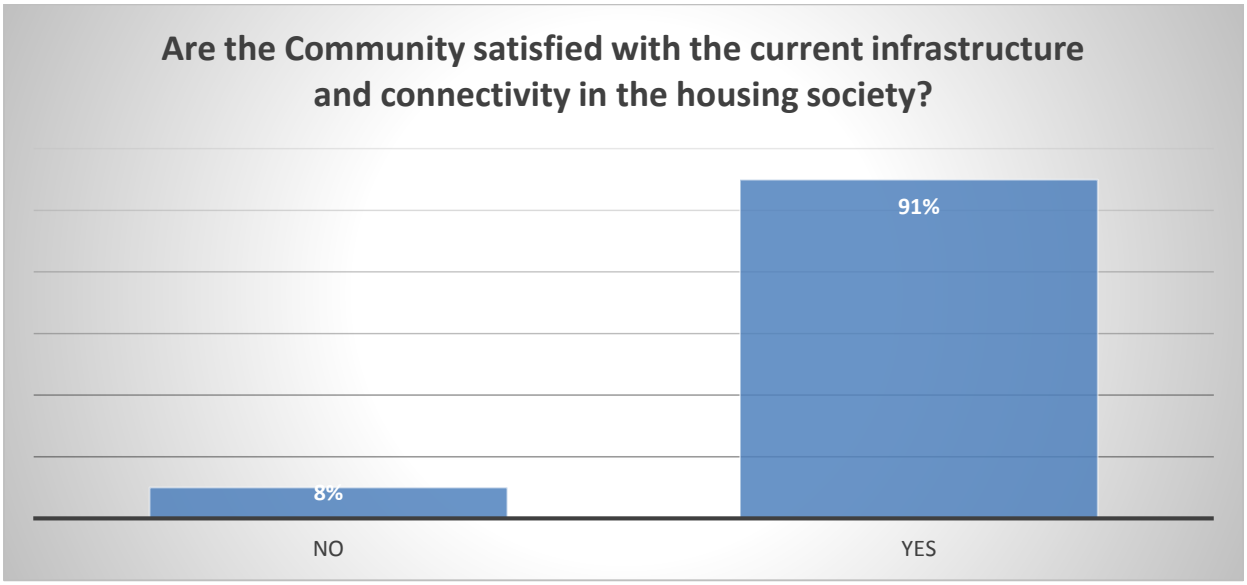
This graph shows the percentages of agreed and disagreed people who agree to spend to modify the existing smart city concept while 58.3% of people are not agreed and do not want to spend to modify the existing smart city concept on the other hand 41.7% agree to spend to modify the existing into smart city concept.



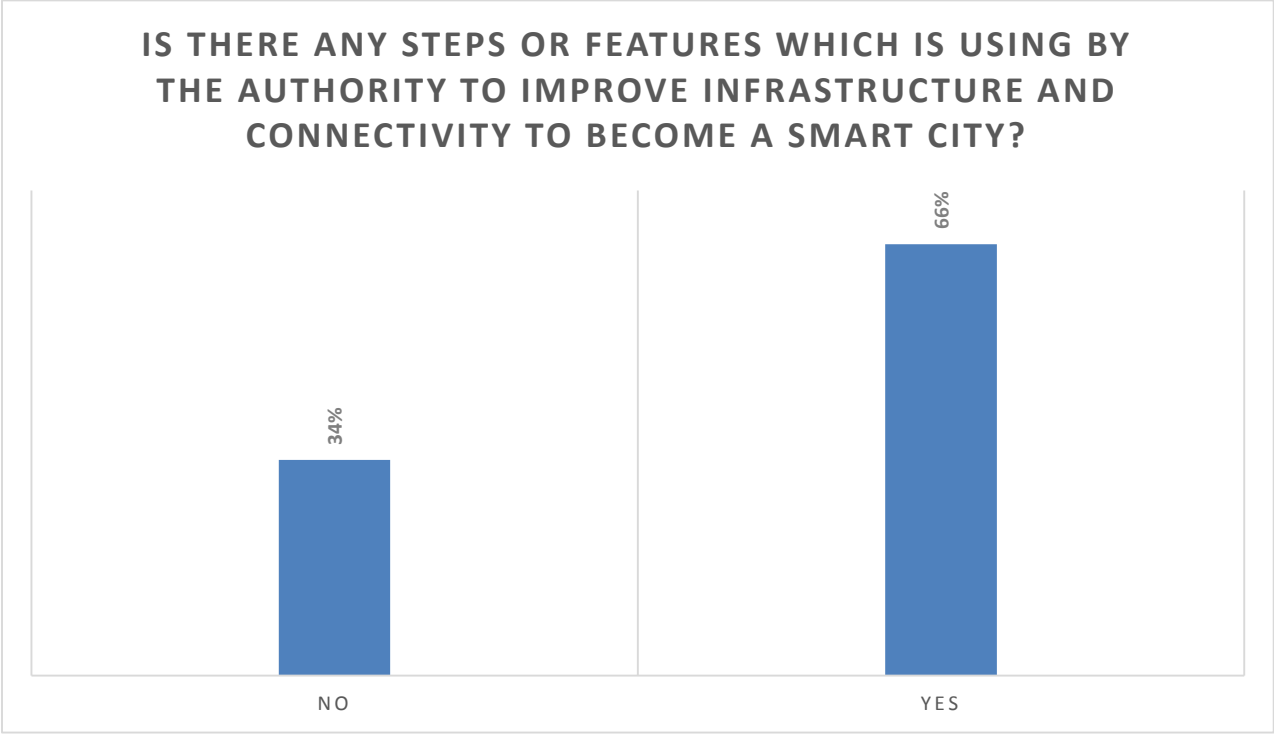
This graph shows the percentages of the people who are willing to implement the concept of a smart city existing society in which 58% said no they do not willing to implement the concept of a smart city in the existing society on the other hand 42% are willing to implement the concept of smart city in existing society.



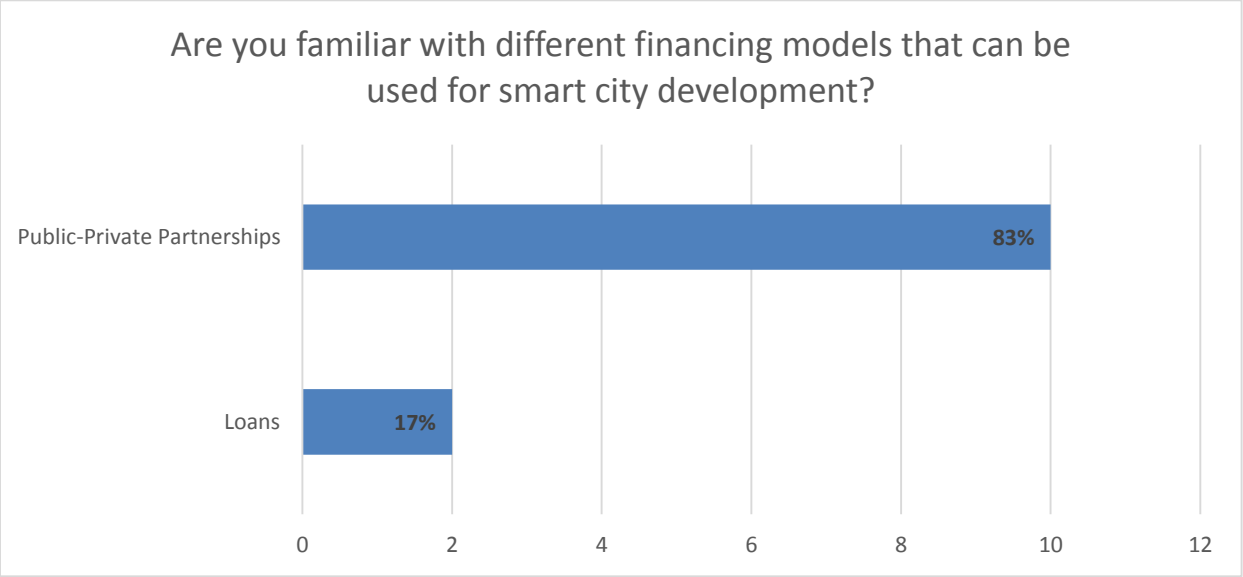
This graph displays the 2% of residents willing to adapt the smart city concept in their society and 1% of residents want a luxury and safe environment on the other hand 6% do not adapt the smart city concept in their society



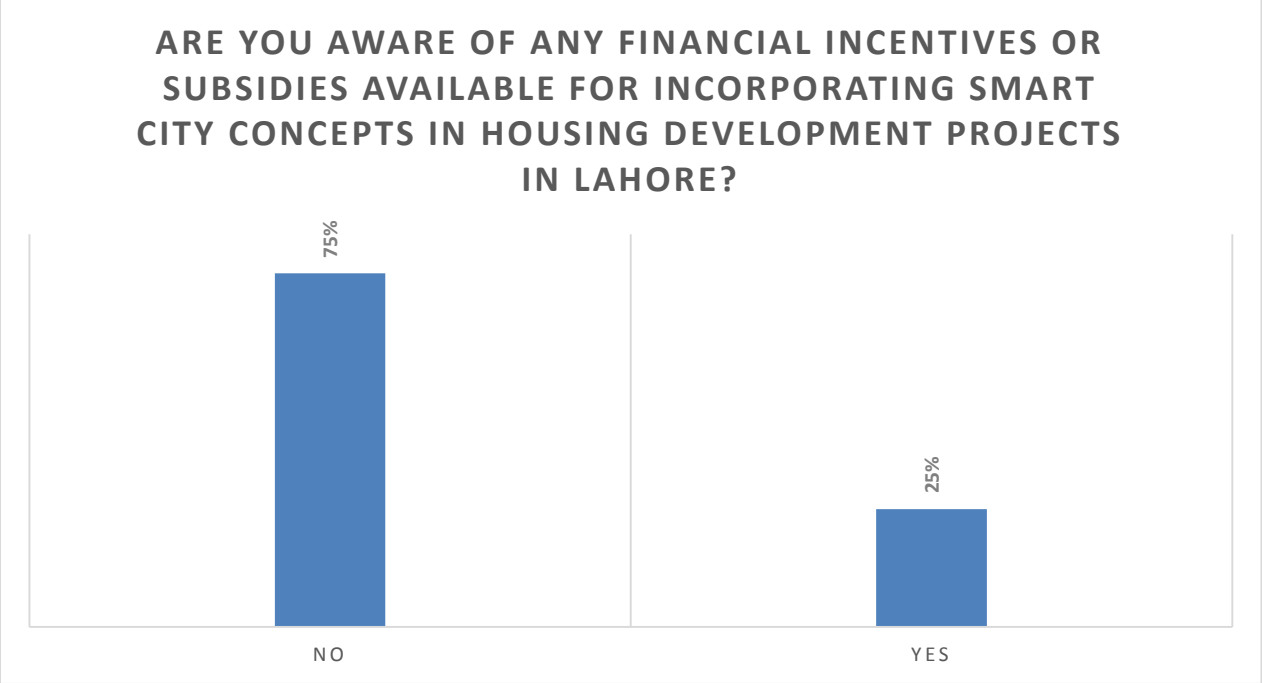
This graph displays that 91% community satisfied with the current infrastructure and connectivity in their housing society and 8% are not satisfied.



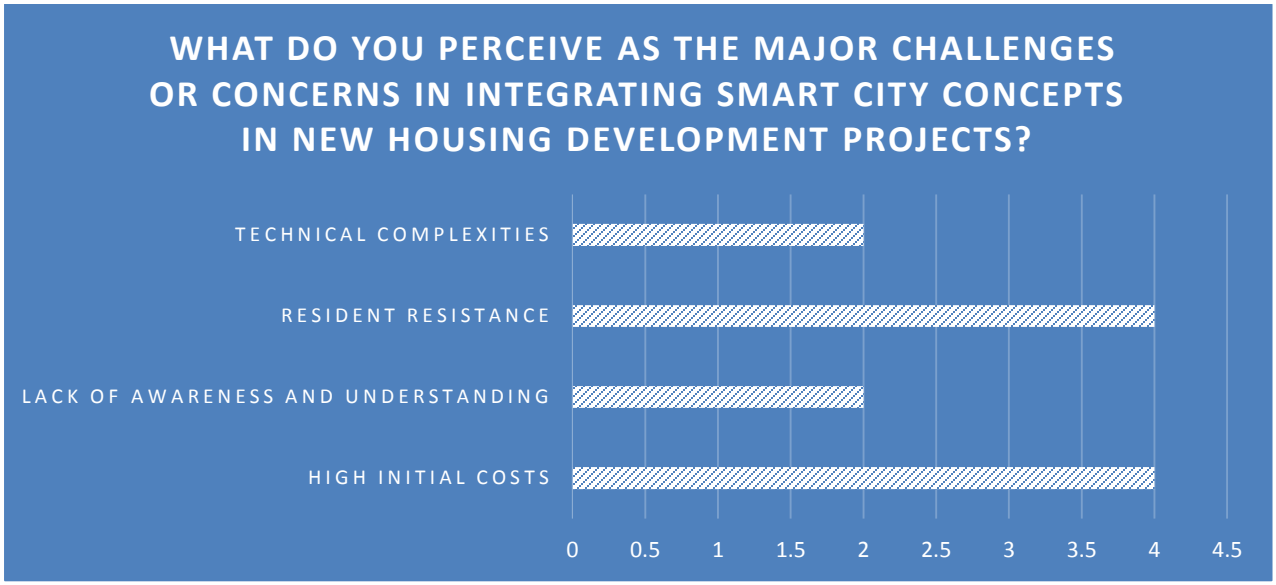
This graph shows that 66% of societies have features that are used by the authority to improve infrastructure and connectivity to become a smart city on the other hand 34% do not use or take any step or feature which improves infrastructure and connectivity to become a smart city.



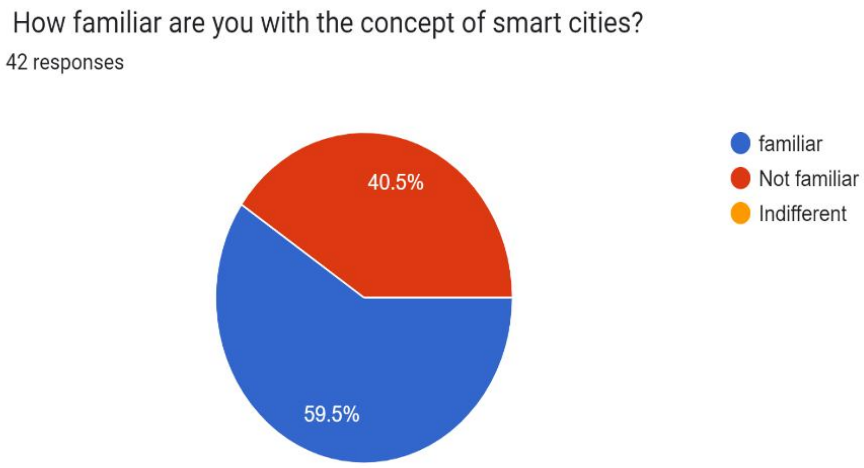
This graph represents the societies that are familiar with different financing models that can be used for smart city development in which 83% of societies have public-private partnerships and 17% use loans.



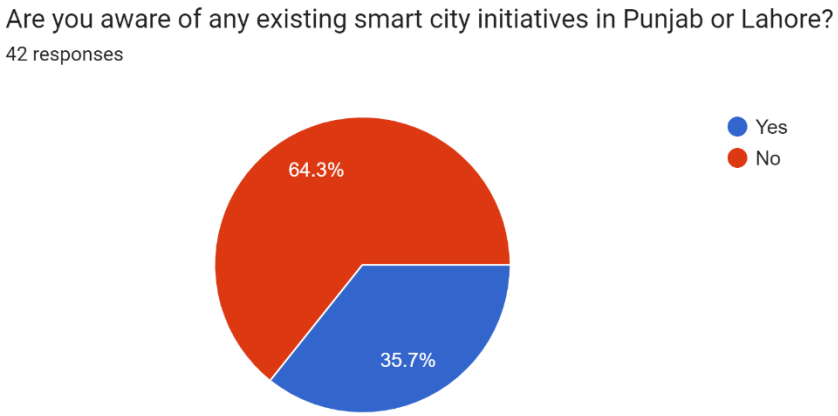
This graph shows that 75% Are not aware of any financial incentives or subsidies available for incorporating smart city concepts in housing development projects in Lahore on the other hand 25% are only aware of the financial incentives or subsidies available for incorporating smart city concepts in housing development projects in Lahore



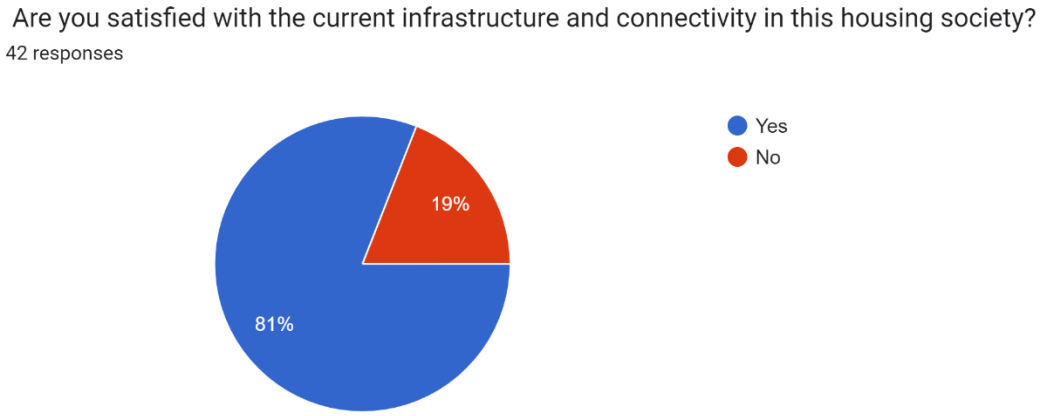
4.2.1 Result B: Resident perception



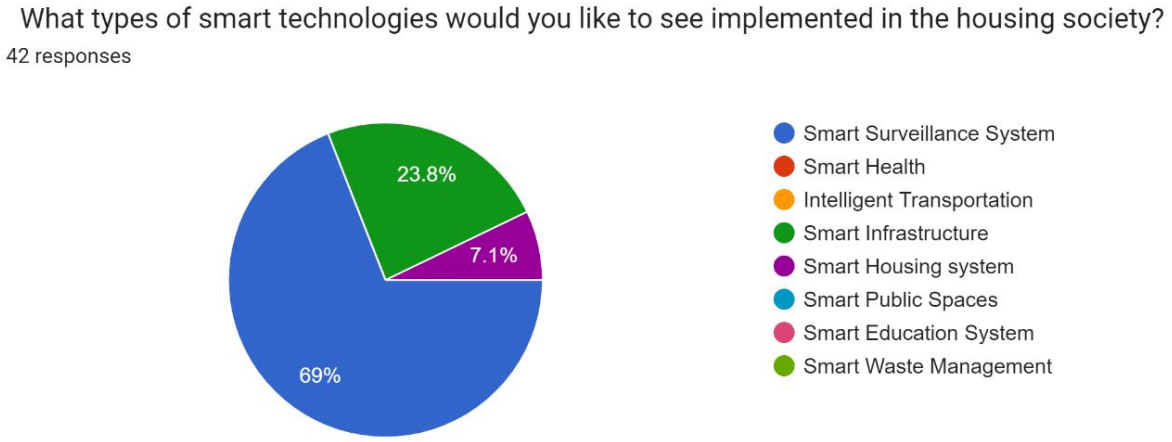
This is the questionnaire base analysis from the residents in which the graph shows the percentages of the familiar and not familiar with the concept of the smart city which 59.5% represent the familiar persons and 40.5% are not familiar with the concept of smart cities.



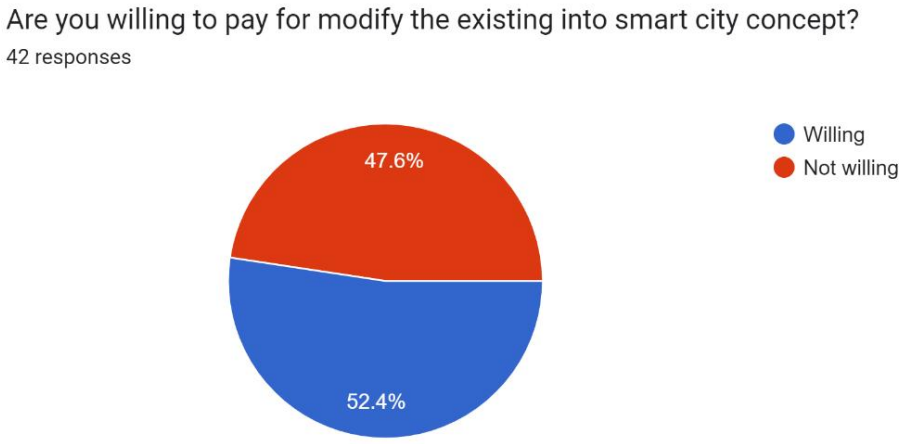
This is the questionnaire base analysis from the residents in which the graph shows the percentages of people who are aware of any existing smart city initiatives in Lahore Lahore which 35.7% represent the persons who are aware and 64.3% are not aware of the existing smart cities initiative.



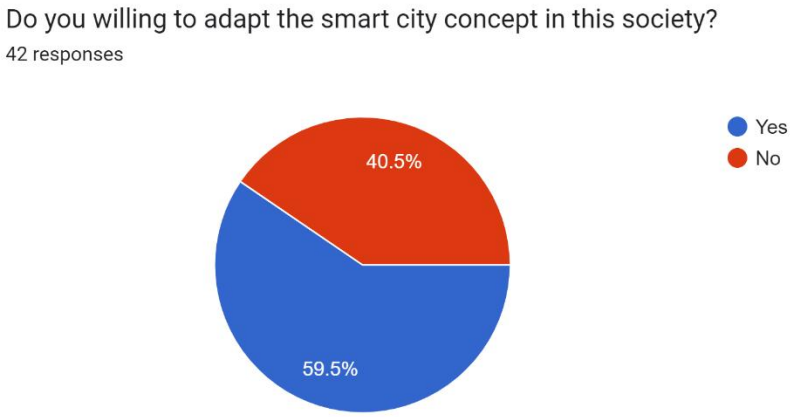
This is the questionnaire base analysis from the residents in which the graph shows the percentages of the people that are satisfied or unsatisfied with the current infrastructure and connectivity in the society which 81 % represent the peoples who are satisfied with the current infrastructure and 19% are not satisfied with the current infrastructure and connectivity in the society.



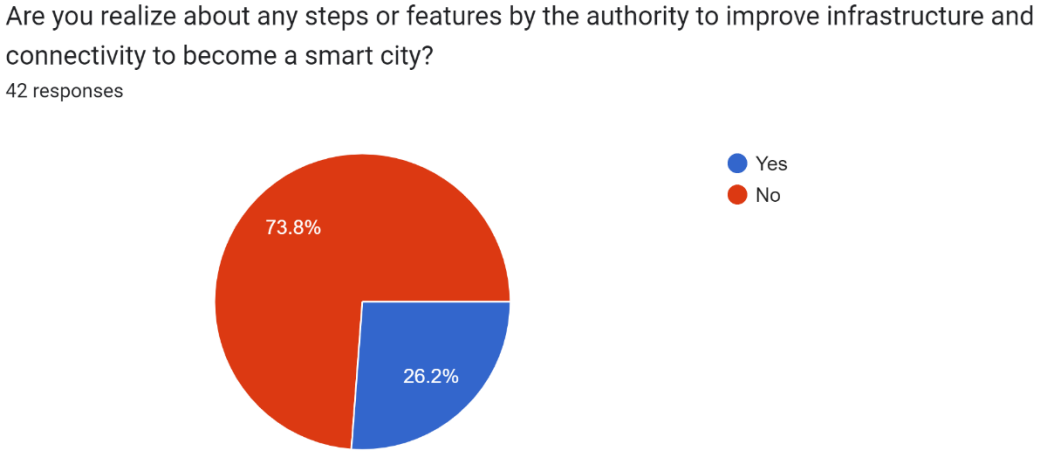
This is the questionnaire base analysis from the residents in which the graph shows the percentages of smart technologies that peoples like to see implemented in the housing society like Smart Surveillance Systems, Smart Health, Intelligent Transportation, Smart Infrastructure, Smart Housing Systems, Smart Public Spaces, Smart Education System, Smart Waste Management, in which 69 % represent the peoples want Smart Surveillance like to see implemented in the housing society and 23.8% represent the peoples want Smart Infrastructure like to see implemented in the housing society and 7.1% represent the peoples want Smart Housing System like to see implemented in the housing society.



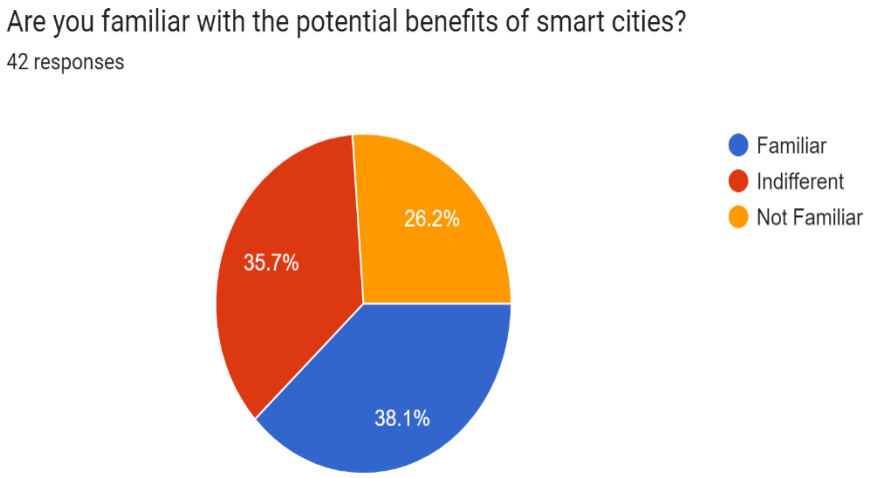
This is the questionnaire base analysis from the residents in which the graph shows the percentages of the people that are willing to pay to modify the existing into a smart city which 52.4% represent the peoples who are willing to pay to modify the existing into smart city and 47.6% represent the peoples are not willing to pay for modify the existing into the smart city



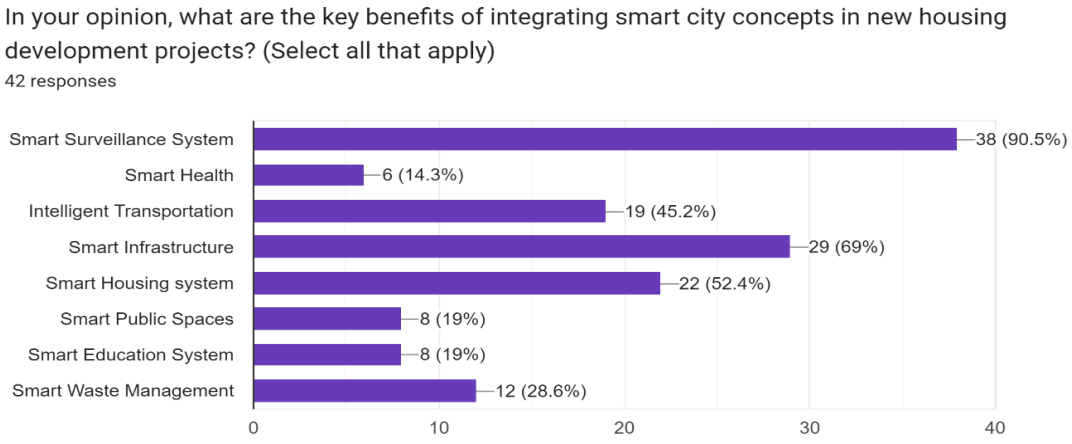
This is the questionnaire base analysis from the residents in which the graph shows the percentages of the people that are willing to adapt the smart city concept in the society which 59.5% represent the peoples who are willing to adapt the smart city concept in society and 40.5% represent the peoples are not willing to adapt the smart city concept in the society.



This is the questionnaire base analysis from the residents in which the graph shows the percentages of the people that realize any steps or features the authority take to improve infrastructure and connectivity to become a smart city which 73.8% represent the peoples who said no and 26.2% represent the peoples who said yes



This is the questionnaire base analysis from the residents in which the graph shows the percentages of the familiar with the potential benefits of smart city which 38.1% represent the familiar persons with the potential benefits of smart city and 26.2% are not familiar with the potential benefits of smart city and 35.7% are indifferent with the potential benefits of smart city



This graph shows the percentages of the key benefits of integrating smart city concepts in new housing development project here is the some elements that is shown in the graph in which each element is scored out of 100% like Smart Surveillance system 90.5% peoples want this smart city concept in new housing development projects and Smart Health system 14.3% peoples want this smart city concept in new housing development projects and Intelligent Transportation system 45.2% peoples want this smart city concept in new housing development projects and Smart Infrastructure 69% peoples want this smart city concept in new housing development projects and Smart Housing system 52.4% peoples want this smart city concept in new housing development projects and Smart Public spaces 19% peoples want this smart city concept in new housing development projects and Smart Education system 19% peoples want this smart city concept in new housing development projects and Smart Waste management 28.6% peoples want this smart city concept in new housing development projects.

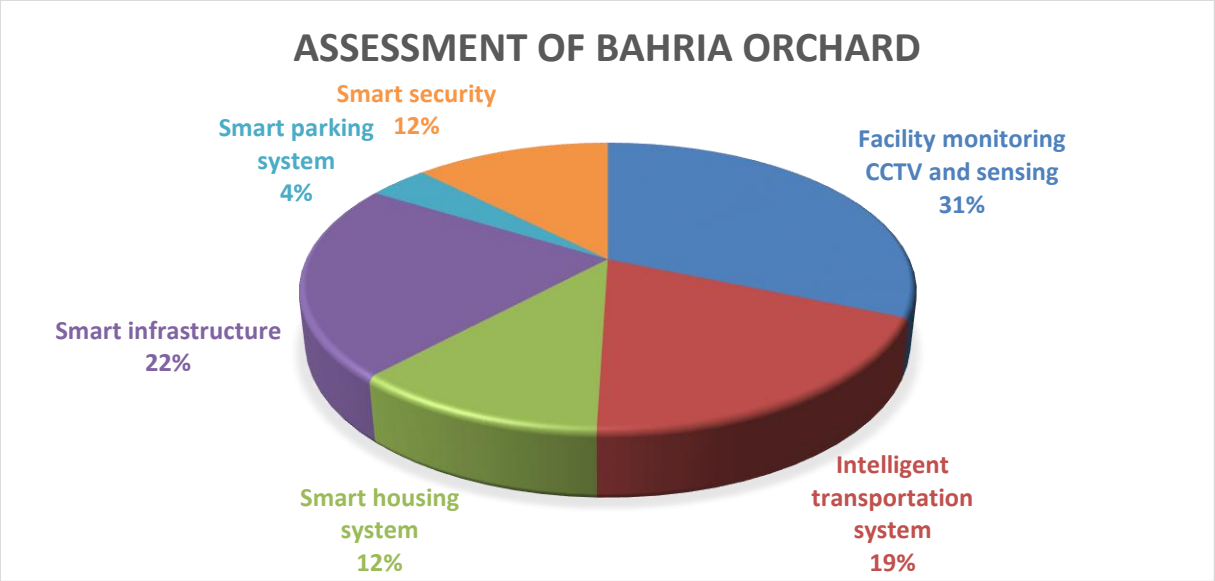
4.2.2 Result C: Field Observations

These are the results of the societies which represent the elements of the smart city which exist in the societies. This information provides by the society's offices.

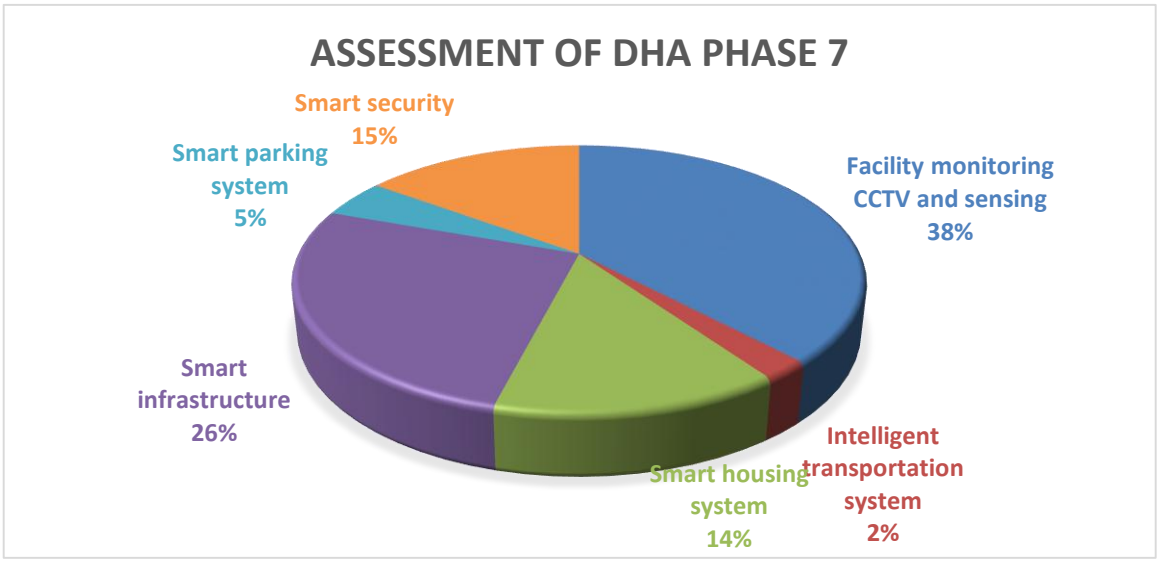
Table 3: Assessment Base Result

Assessment of Housing Schemes									
	Bahria orchard	Park View City	Al-Kabeer	Dream Garden	Dha Phase 9	Dha Phase 7	Damaan City	Mid City	Smart City
Facility monitoring CCTV and sensing	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Smart Survilliance	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Smart housing system	No	No	No	No	Yes	No	No	Yes	Yes
Smart infrastructure	No	No	No	No	Yes	No	No	No	Yes
Intelligent transportation system	Yes	No	No	No	No	No	No	No	Yes
Smart parking system	No	No	No	No	No	No	No	No	Yes
Smart Health	No	No	No	No	No	No	No	No	No
Smart education system	No	No	No	No	No	No	No	No	No
Smart public Spaces	No	No	No	No	No	No	No	No	No

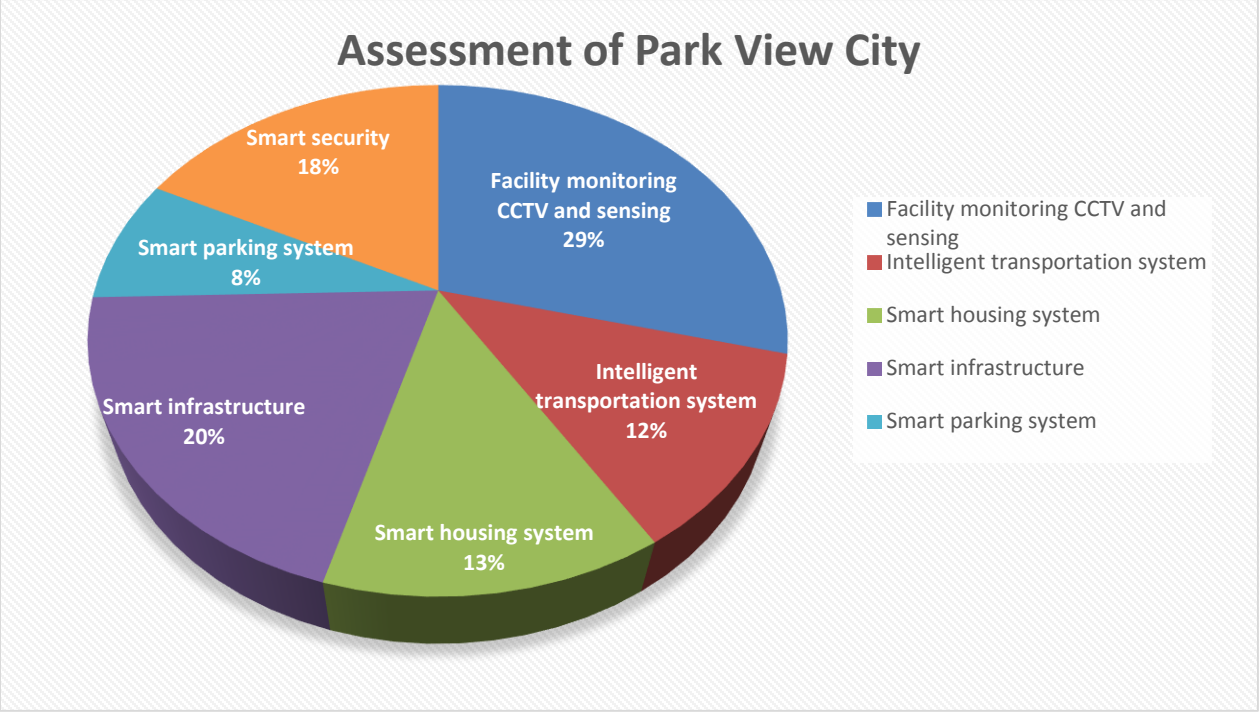
These results show the elements which are currently in use in the societies and also show the different technologies that societies are using to facilitate their residents.



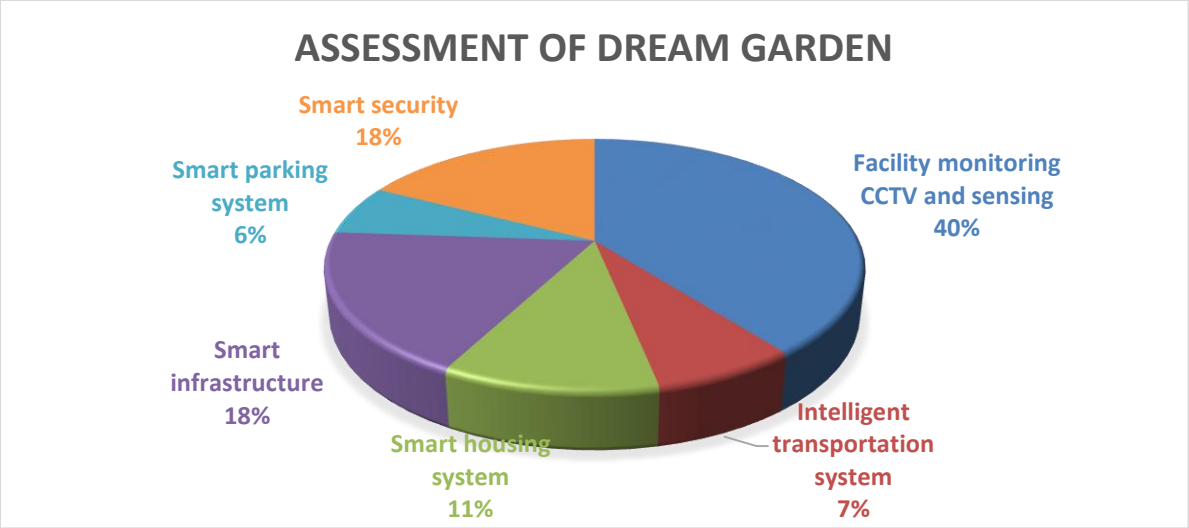
The graph represents the assessment-based elements of Bahria's smart infrastructure. Facility monitoring and sensing represent the largest share at 31%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for 19%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 22%, emphasizing the integration of advanced technologies. Smart housing and smart security each contribute 12%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 4%, indicating the implementation of intelligent parking solutions.



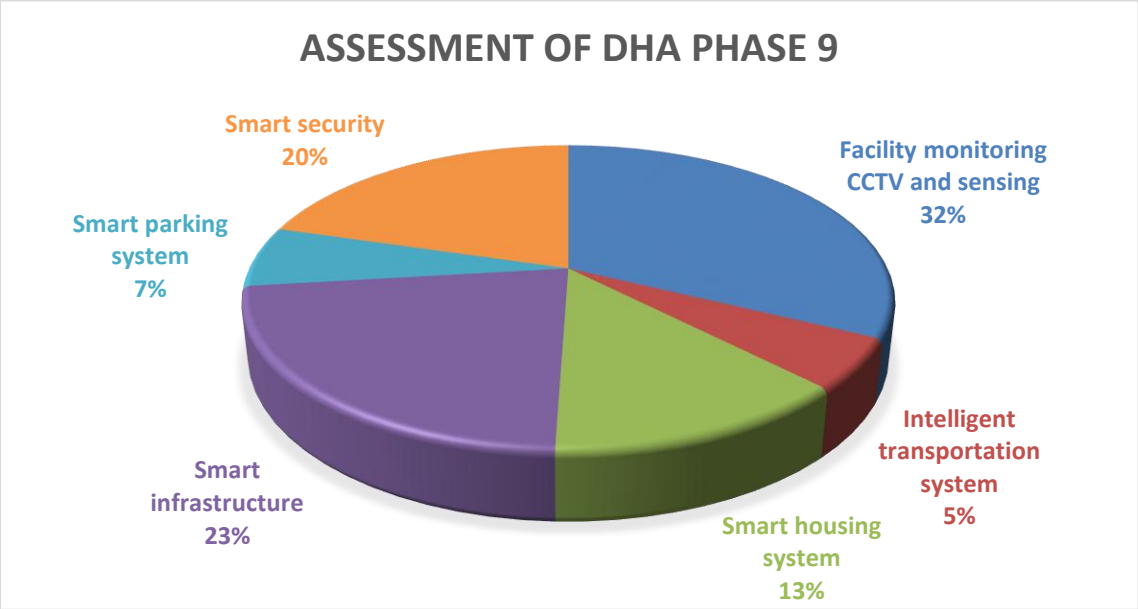
The graph represents the assessment-based elements of DHA Phase 7 smart infrastructure. Facility monitoring and sensing represent the largest share at 38%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for the smallest share of 2%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 26%, emphasizing the integration of advanced technologies. Smart housing contributes 14% and smart security contributes 15%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 5%, indicating the implementation of intelligent parking solutions.



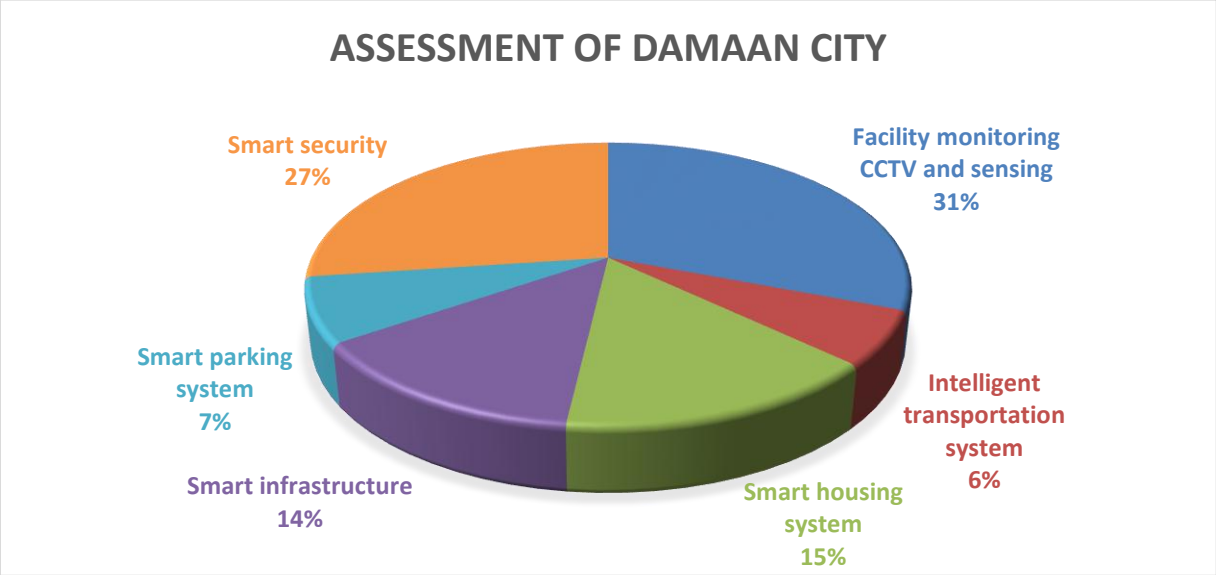
The graph represents the assessment-based elements of Park View City's smart infrastructure. Facility monitoring and sensing represent the largest share at 29%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for 12%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 20%, emphasizing the integration of advanced technologies. Smart housing contributes 13% and smart security contributes 18%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 8%, indicating the implementation of intelligent parking solutions.



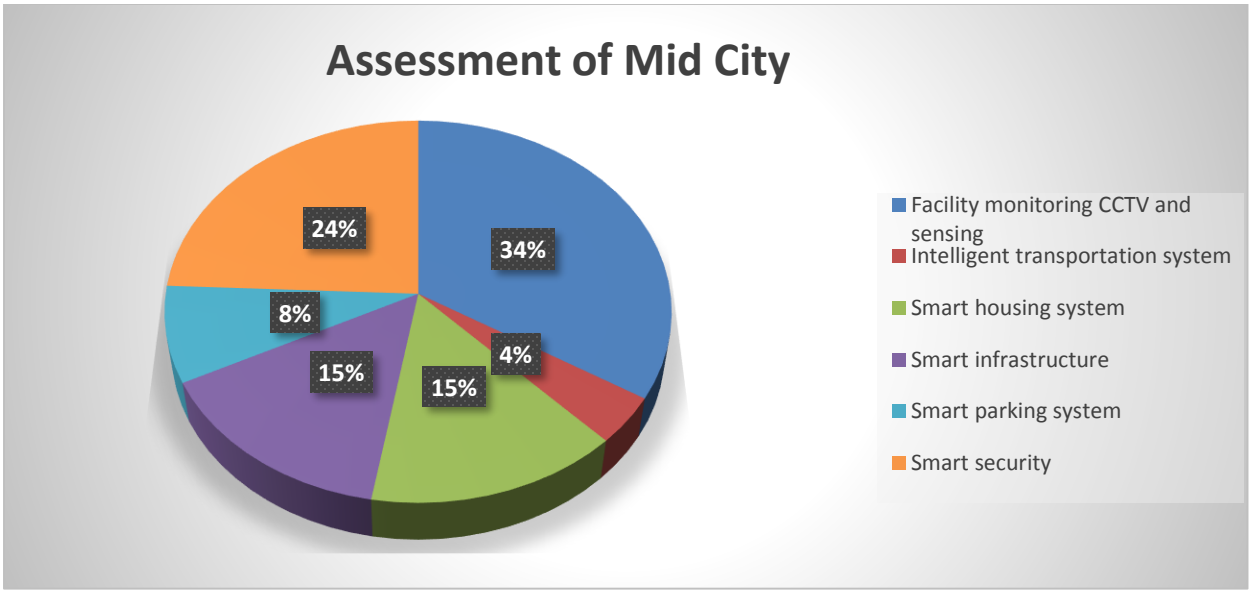
The graph represents the assessment-based elements of Dream Garden's smart infrastructure. Facility monitoring and sensing represent the largest share at 40%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for 7%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 18%, emphasizing the integration of advanced technologies. Smart housing contributes 11% and smart security contributes 18%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 6%, indicating the implementation of intelligent parking solutions.



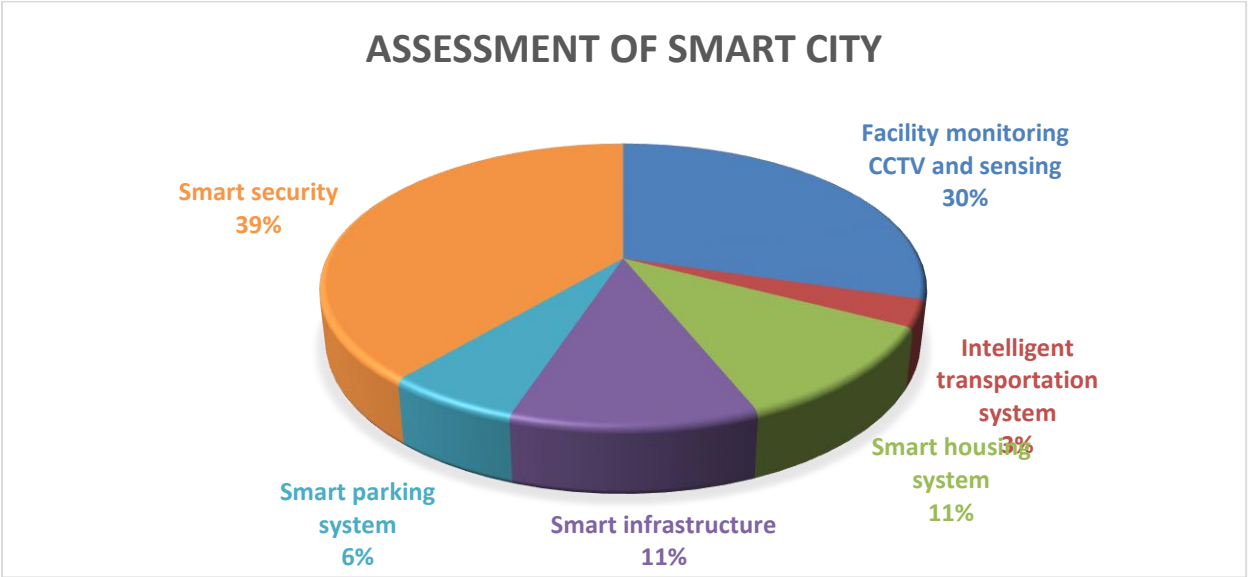
The graph represents the assessment-based elements of DHA Phase 9 smart infrastructure. Facility monitoring and sensing represent the largest share at 32%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for the smallest share of 5%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 23%, emphasizing the integration of advanced technologies. Smart housing contributes 13% and smart security contributes 20%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 7%, indicating the implementation of intelligent parking solutions.



The graph represents the assessment-based elements of Damaan City's smart infrastructure. Facility monitoring and sensing represent the largest share at 31%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for the smallest share of 6%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 24%, emphasizing the integration of advanced technologies. Smart housing contributes 15% and smart security contributes 27%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 7%, indicating the implementation of intelligent parking solutions.



The graph represents the assessment-based elements of Mid-City smart infrastructure. Facility monitoring and sensing represent the largest share at 34%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for the smallest share of 4%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 15%, emphasizing the integration of advanced technologies. Smart housing contributes 15% and smart security contributes 24%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 8%, indicating the implementation of intelligent parking solutions.



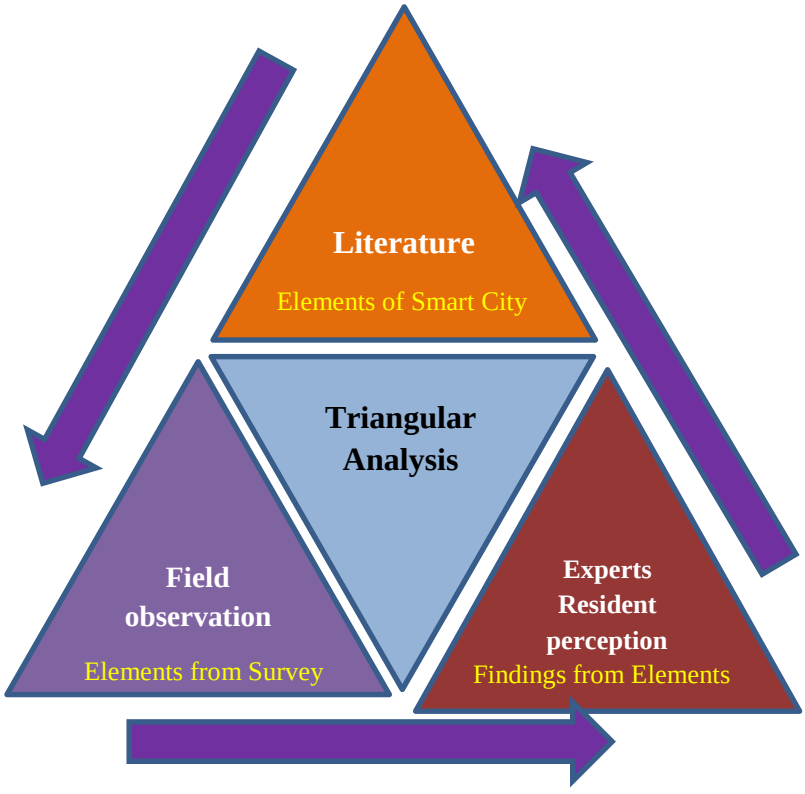
The graph represents the assessment-based elements of DHA Phase 9 smart infrastructure. Facility monitoring and sensing represent the share at 30%, highlighting the emphasis on efficient monitoring and resource management. Intelligent transportation systems account for the smallest share of 3%, indicating a focus on optimized mobility and traffic flow. Smart infrastructure holds 11%, emphasizing the integration of advanced technologies. Smart housing contributes 11% and smart security contributes the largest 39%, highlighting the importance of technologically advanced residential units and a secure environment. Smart parking holds a smaller share of 6%, indicating the implementation of intelligent parking solutions.

4.3 RESULTS

4.3.1 TRIANGULAR BASE ANALYSIS

In this analysis first, we review the literature and find the elements from the literature then we narrow down the major elements into sub-elements after that we conduct a survey from different society offices in which we see the approaches or elements that are currently in use in the societies and then we conduct a survey from residents of the societies in which we see the perception of residents how they take the concept of the smart city.

findings Through Elements



Literature		Field Observation	Based on interviews with the owners	Residents Perceptions
Smart Housing System	• Smart Community • Smoke sensor system • Smart home air detection system • Zero energy buildings	• Smart Meters • Zero energy buildings	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have lack of awareness about these elements only 33% residents have the knowledge of these elements that are used in the societies
Smart Education	• School zone safety system • Smart library system	School zone safety system, Smart Library	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have knowledge about these elements but these elements are not existed in the societies
Smart Infrastructure	• Smart water supply remote metering system • Smart water disposal • Smart Grid monitoring • smart environmental monitoring system • Smart street lights • Smart workstation system	Smart Street Lights Smart Grid monitoring	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have lack of awareness about these elements only 22% residents have the knowledge of these elements that are used in the societies

	• The smart recycling pickup system • Smart energy			
Smart Security	• Smart firefighting system • Facility monitoring CCTV and sensing • Smart emergency system • Citizen safety platform	Sensors and Cameras sensors to wireless CCTV footage	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have awareness about these elements only 88% residents have the knowledge of these elements that are used in the societies

Smart Public	• AI robot for public service • Smart park • Digital content for a local historical tour • Internet of things	Internet of Things	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have lack of knowledge about these elements and these elements are not existed in the societies
ITS	• Smart Charging system • E-mobility • Traffic control • Vehicle detection system • Electric transportation	Sensors (Red, Green, and Orange Light Systems) Vehicle detection system	From the literature we find different elements which are shown in literature tier. On the basis on these elements we make observational sheet & by observational sheet we find these elements by the owners. Owners tells about that they have these features in their housing schemes & owner have the awareness about these smart elements.	On the basis of rank analysis mostly residents have lack of awareness about these elements only 22% residents have the knowledge of these elements that are used in the societies

	• Smart parking system • Bus Information system • Car sharing system • City bike system			
Smart Health	• Remote Patient Monitoring: • Health Analytics and Insights: • Electronic Health Records (EHR):	Electronic Health Records (EHR)		On the basis of rank analysis mostly residents have no knowledge about these elements but these elements are existed in the societies

4.4 Comparison of Societies

4.4.1 Comparison Between DHA Phase 7 and Bahria Orchard

The smart elements that are used in DHA Phase 7.

Table 4: Elements in DHA Phase 7

Elements Currently in Use	**Technology in Use**
Smart Surveillance	sensors to wireless CCTV footage
Facility monitoring CCTV and sensing	Sensors and Cameras

4.4.2 The smart elements that are used in Bahria Orchard

Table 5: Elements in Bahria Orchard

Elements Currently in Use	**Technology in Use**
Facility monitoring CCTV and sensing	Sensors and Cameras
Smart Surveillance	sensors to wireless CCTV footage
Intelligent transportation system	Vehicle detection system

This is an assessment-based survey from the authority in which we find out the different elements of smart city that are used in DHA phase 7 and Bahria Orchard Lahore. This is a comparison between these two societies as you can see that the data, we collected from these two societies show different elements and the smart technologies that they are using in their societies to facilitate their residents. DHA Phase 7 for the surveillance they are using sensors for wireless CCTV footage, and for Facility monitoring CCTV and sensing they are using Sensors and Cameras. Bahria Orchard surveillance they are using sensors for wireless CCTV footage, for Facility monitoring CCTV and sensing they are using Sensors and Cameras, and for Intelligent transportation systems they are using the Vehicle detection system. Bahira Orchard has more smart city elements as compared to DHA Phase 7.

4.4.3 Comparison Between DHA Phase 9 and Park View

The smart elements that are used in DHA Phase *9*

Table 6: Elements in DHA Phase 9

Elements Currently in Use	**Technology in Use**
Smart infrastructure	Smart Street lights, Smart Grid Monitoring
Facility monitoring CCTV and sensing	Sensors and Cameras
Smart Housing	Solar panels, Smart Meters, Zero Energy Buildings
Smart Surveillance	sensors to wireless CCTV footage

The smart elements that are used in Park View

Table 7: Elements in Park View City

Elements Currently in Use	**Technology in Use**
Smart Surveillance	sensors to wireless CCTV footage
Facility monitoring CCTV and sensing	Sensors and Cameras

This is an assessment-based survey from the authority in which we find out the different elements of smart city that are used in DHA phase 9 and Park View Lahore. This is a comparison between these two societies as you can see that the data, we collected from these two societies show different elements and the smart technologies that they are using in their societies to facilitate their residents. DHA Phase 9 for Smart infrastructure they use Smart Street lights, Smart Grid Monitoring, and smart surveillance they are using sensors for wireless CCTV footage and for Facility monitoring CCTV and sensing they are using Sensors and Cameras, and for Smart Housing they are using Solar panels, Smart Meters, Zero Energy Buildings. Park View Lahore for Smart Surveillance they are using sensors to wireless CCTV footage and for Facility monitoring CCTV and sensing they are using Sensors and Cameras. DHA Phase 9 has more smart city elements as compared to Park View Lahore.

4.5 Comparison Between Al-Kabir Town Phase 2 and Dream Garden

4.5.1 The smart elements that are used in Al-Kabir Town Phase 2

Table 8:Elements in Al-Kabir Phase 2

Elements Currently in Use	**Technology in Use**
Nil	Nil
Nil	Nil

4.5.2 The smart elements that are used in Dream Garden

Table 9: Elements in Dream Garden

Elements Currently in Use	**Technology in Use**
Smart Surveillance	sensors to wireless CCTV footage
Facility monitoring CCTV and sensing	Sensors and Cameras

This is an assessment-based survey from the authority in which we find out the different elements of smart city that are used in Al-Kabir Town Phase 2 and Dream Garden Lahore. This is a comparison between these two societies as you can see that the data, we collected from these two societies show different elements and the smart technologies that they are using in their societies

to facilitate their residents. Al-Kabir Town Phase 2 has no smart feature. Dream Garden Lahore for smart surveillance they are using sensors for wireless CCTV footage and for Facility monitoring CCTV and sensing they are using Sensors and Cameras. Dream Garden Lahore has more smart city elements as compared to Al-Kabir Town Phase 2.

4.6 Comparison Between Mid-City and Smart City Lahore and Damaan City

4.6.1 The smart elements that are used in Mid-City

Table 10: Elements in Mid City

Elements Currently in Use	**Technology in Use**
Smart infrastructure	Smart Street lights
Facility monitoring CCTV and sensing	Sensors and Cameras
Smart Housing	Solar panels, Smart Meters, Zero Energy Buildings

4.6.2 The smart elements that are used in Smart City Lahore

Table 11: Elements in Smart City Lahore

Elements Currently in Use	**Technology in Use**
Smart Housing	Solar panels, Smart Meters, Zero Energy Buildings
Smart Surveillance	sensors to wireless CCTV footage
Facility monitoring CCTV and sensing	Sensors and Cameras
Smart infrastructure	Smart Street lights
Intelligent transportation system	Vehicle detection system
Smart Parking System	Sensors (Red, Green, and Orange Light Systems)

4.6.3 The smart elements that are used in Damaan City

Table 12: Elements in Damaan City

Elements Currently in Use	**Technology in Use**
Facility monitoring CCTV and sensing	Sensors and Cameras
Smart Surveillance	sensors to wireless CCTV footage

This is an assessment-based survey from the authority in which we find out the different elements of smart city that are used in Mid-City and Damaan City and Smart City Lahore. This is a comparison between these three societies as you can see that the data, we collected from these three societies show different elements and the smart technologies that they are using in their societies to facilitate their residents. Damaan City for smart surveillance they are using sensors for wireless CCTV footage and for Facility monitoring CCTV and sensing they are using Sensors and Cameras. Mid-City for Facility monitoring CCTV and sensing they are using Sensors and Cameras and for Smart Housing they are using Solar panels, Smart Meters, Zero Energy Buildings, and for Smart infrastructure they are using Smart Street lights. Smart City Lahore for Smart Housing they are using Solar panels, Smart Meters, Zero Energy Buildings, and Smart Surveillance they are using sensors for wireless CCTV footage and for Facility monitoring CCTV and sensing they are using Sensors and Cameras for Smart infrastructure they are using Smart Street lights and for Intelligent transportation system they are using Vehicle detection system and for Smart Parking System they are using Sensors (Red, Green, Orange Light System). Smart City Lahore has more smart city elements as compared to Mid-City and Damaan cities.

This is the assessment result of all the societies & the rank analysis based on this assessment from the societies.

4.7RANK ANALYSIS BASED ON SURVEYS

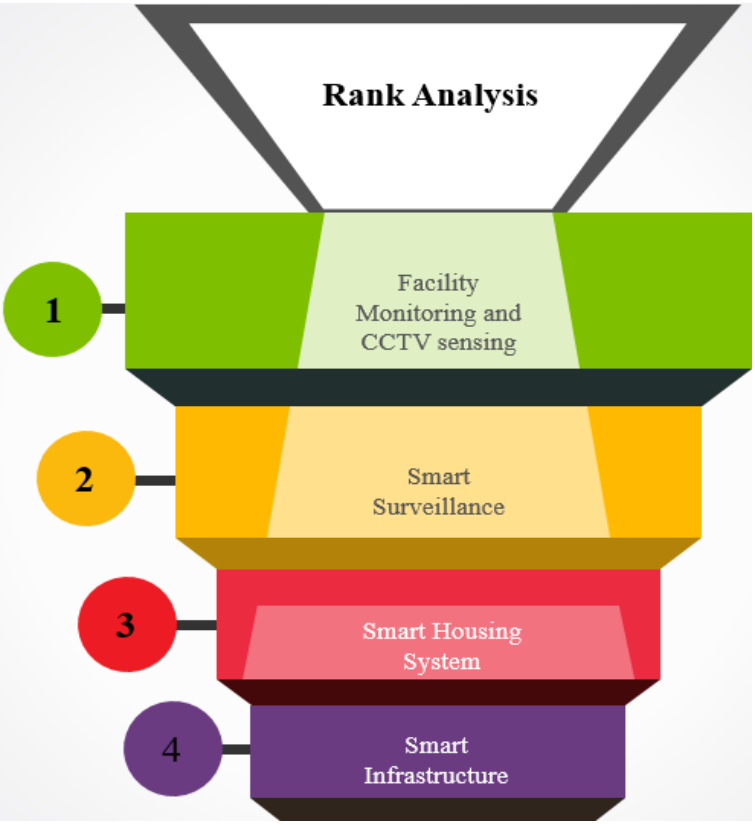
Table 13:RANK ANALYSIS based on SURVEYS

Rank Analysis on the basis of Surveys				
Total Societies=9				
Elements	**Percentage**	**Score Rank**	**Sub Elements**	
Facility monitoring CCTV and sensing	88%	1	Sensors and Cameras	Highest Rank
Smart Survilliance	78%	2	sensors to wireless CCTV footage	
Smart housing system	33%	3	Smart Meters,Zero Energy Buildings	
Smart infrastructure	22%	4	Smart Street Lights,Smart Grid Station	
Intelligent transportation system	22%	4	Vehicle detection system	
Smart parking system	11%	5	Sensors (Red, Green, Orange Light System)	
Smart Health	0%	0	Electronic Health Records (EHR)	
Smart Education	0%	0	School zone safety system,Smart Library	
Smart Public Spaces	0%	0	Internet of Things	

Figure 5:Assessment Base Ranking Of Elements

In this analysis first, we shortlist the societies the total number of societies is 9 after that we conduct a survey in which we see the elements that are used in societies. Then rank the elements according to the percentages that are mostly used in the societies.

‘’ There are two steps involved in rank analysis. First, rank scores are awarded to observations, usually from smallest to greatest (the largest values given the highest ranks). Then, using the rank scores, test statistics are computed. The most typical are. Kruskal-Wallis (1952) ’’



4.8 Findings

4.8.1 Result A: Semi structure interviews

Most of the society owners are familiar with the concept of smart city which is 73% scoring according to survey results. They are mostly familiar with smart surveillance as a smart city concept in housing schemes. But most of the owners disagreed to implement the smart city in the current infrastructure. Their perception is that most of the residents of the society did not want to adopt the smart city concept in the current housing society. Because their mostly community is satisfied with their current infrastructure. But on the other hand. The owners are also working to improve their current infrastructure.in the financial aspect, they are familiar with the public-private partnership. There is a lack of subsidies available incorporating the smart city concept in housing development projects in Lahore. Cording to the owners the major challenges for smart housing schemes is resident resistance & high land values.

4.8.2 Result B: Resident perception

The residents of the society are mostly familiar with the concept of a smart city. As per scoring which is 59% survey. Most of the residents are not aware of smart city initiatives in the context of Lahore or Punjab & they are satisfied with the current infrastructure of their housing schemes. in the context of the smart city, most residents want to implement smart surveillance as a smart city feature in the housing society. About 52% of residents are ready to pay to modify the current infrastructure in a smart city context. According to 73.8% of residents. the owners did not take any steps for improving the current infrastructure into a smart city concept. About 38% are familiar with the potential of smart cities.

4.8.3 Result C: Field Observations

According to the observations of smart city elements from owners & residents. Smart Surveillance, smart housing, smart infrastructure, intelligent transportation system smart parking system only these major elements are assessed in the societies. The residents & owners are aware & familiar with only these smart elements.

Chapter 5: Proposal & Recommendation

5.1 Introduction

After the study, which begins with literature review and data collecting, data analysis, and outcomes. An assessment of the viability of the smart city idea is now made based on these factors. We presented a smart city housing project with smart features that we found from results and analysis since Lahore has the potential for a smart city idea. In the context of Lahore, we evaluate the impression of the residents and private housing scheme Owners regarding the presence of just these aspects in private housing schemes: smart surveillance, smart street lighting, smart parking systems, smart grid stations, and smart buildings. Therefore, we create a design concept for a house project with all of these elements. Also in this chapter we give the recommendations about the potential of smart city on the basis on our research.

Smart City

Smart City is a model for sustainable development across the country. The concept of a smart city revolves around a comprehensive urban management model which encourages international standards of efficiency and control on the one hand and the best practices of inclusion and participation on the other.

5.2 Location

The Site is on Barki Road Lahore. Road Is Connected with Also Ring Road Lahore Which will enhance the accessibility of the society. The site is located near the paragon housing scheme

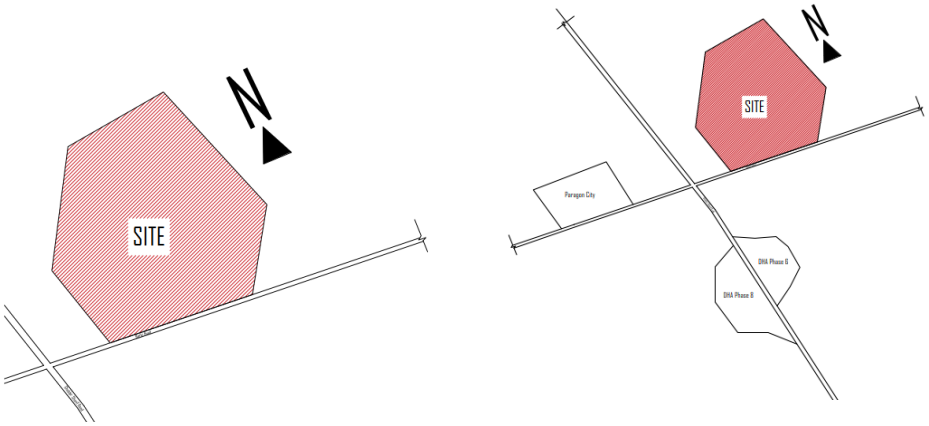


Figure 6: Site & Location Map

Layout plan

This is the layout plan of our proposal.the area of this proposal is 4000kanal.

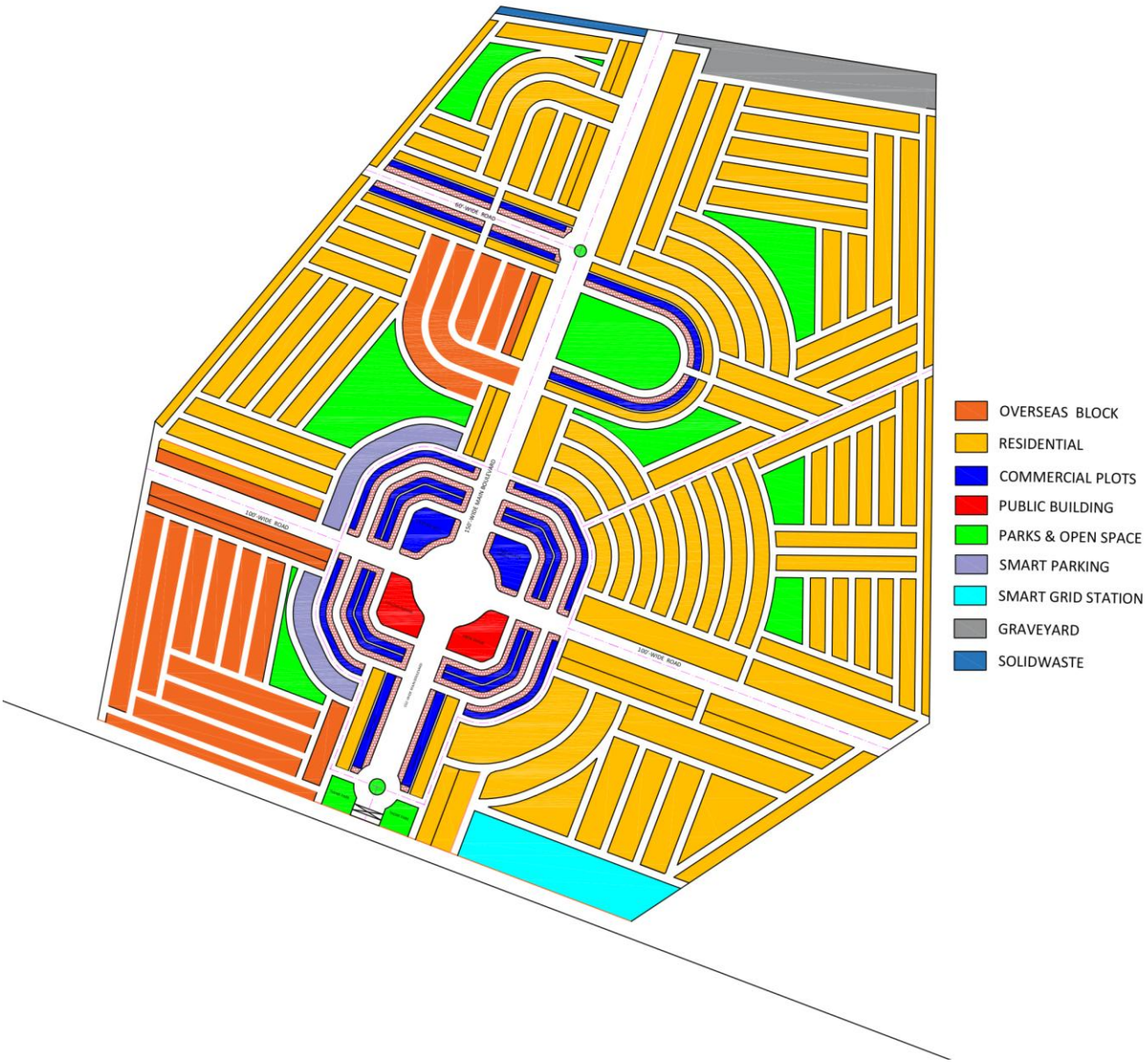


Figure 7:Layout Plan

5.3 Layout with Smart Features (Design Process)

The Features which is in the proposal on the basis of literature & Different analysis on surveys of different housing societies

- Smart Surveillance System
- Smart Grid Station
- Smart Houses
- Smart Parking
- Smart Buildings
- Smart Street Lights

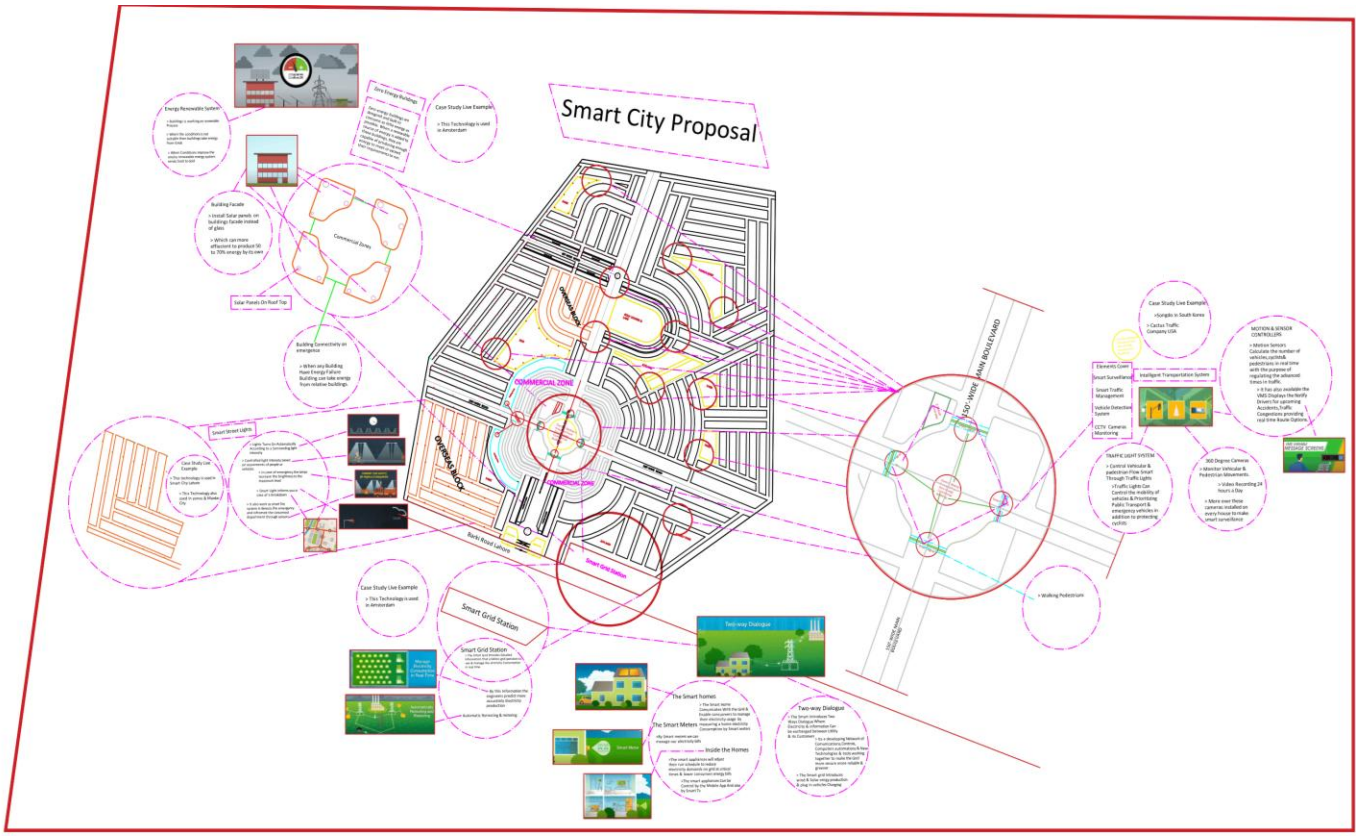


Figure 8:Layout Plan with Smart Features

5.3.1 Smart Surveillance system

A smart surveillance system refers to an advanced and intelligent network of surveillance technologies that are designed to enhance security and monitoring capabilities in various environments. These systems utilize cutting-edge technologies such as artificial intelligence (AI), computer vision, and machine learning to automate and optimize surveillance processes.

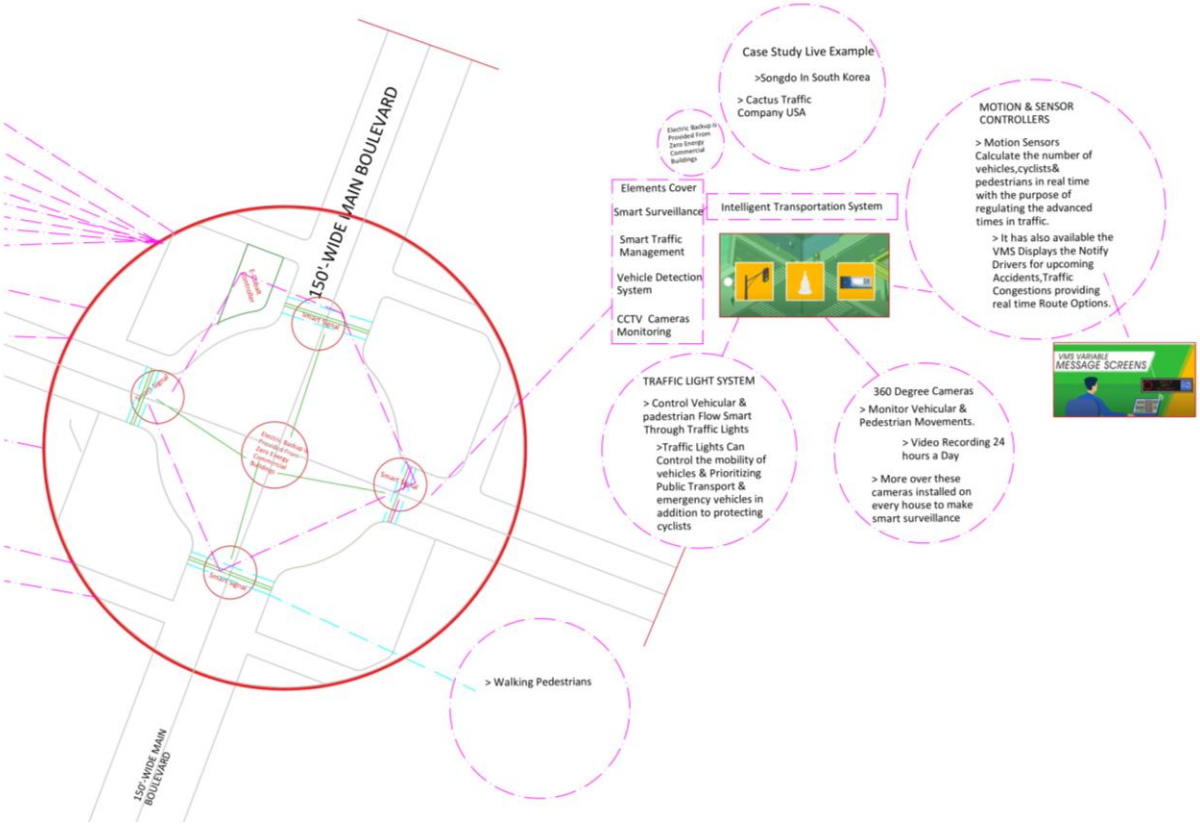


Figure 9:Smart Surveillance System

Main Commercial Zone is connected with smart surveillance & other elements like zero energy building, vehicle detection system proper 360 degree cameras, smart traffic lights system, and motion sensor & controller system.

Table 14: Smart Surveillance Working

- **Smart Surveillance**
- **(Intelligent transportation system)**

Traffic Light System	**360 Degree Cameras**	**Motion & Sensor Controllers**
Control Vehicular & pedestrian Flow Through Smart Traffic Lights	Monitor Vehicular & Pedestrian Movements.	Motion Sensors Calculate the number of vehicles, cyclists& pedestrians in real-time with

		the purpose of regulating the advanced times in traffic.
Traffic Lights Can Control the mobility of vehicles & Prioritizing Public Transport & emergency vehicles in addition to protecting cyclists	Video Recording 24 hours a Day	It has also available the VMS Displays the Notify Drivers of upcoming Accidents, Traffic Congestions providing real-time Route Options.

5.3.2 Smart Grid Station

A smart grid station, also known as a smart substation or intelligent substation, is a key component of a modern electrical power distribution system. It is a technologically advanced facility that plays a crucial role in managing and controlling the flow of electricity in a more efficient and reliable manner. Here are some features and components commonly found in a smart grid station.

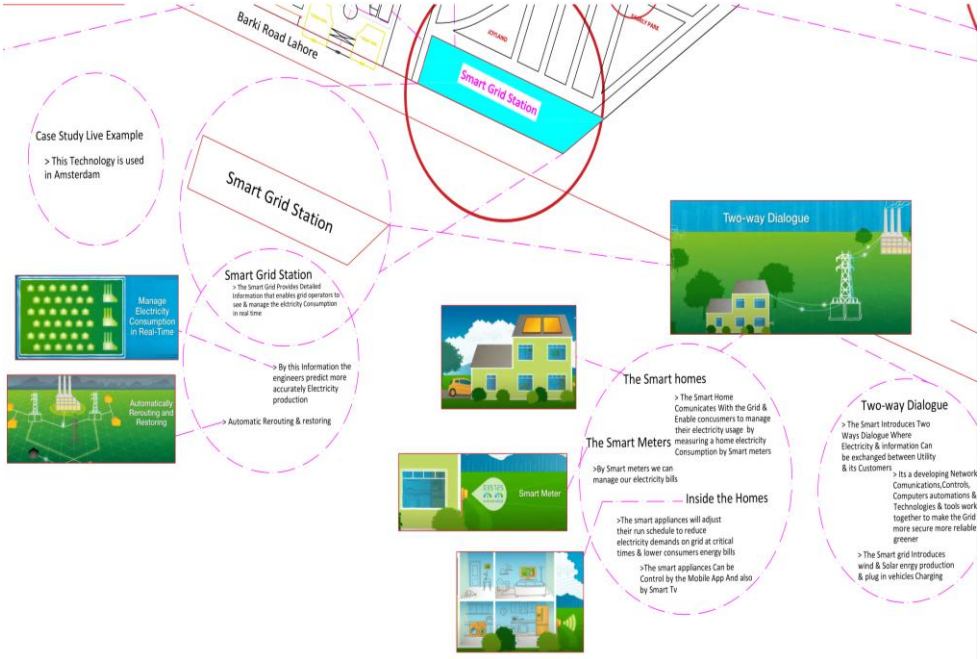
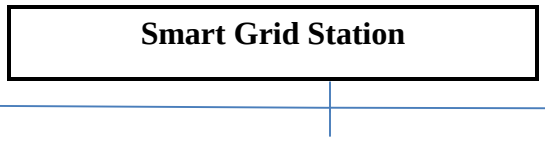


Figure 10: Smart Grid Station



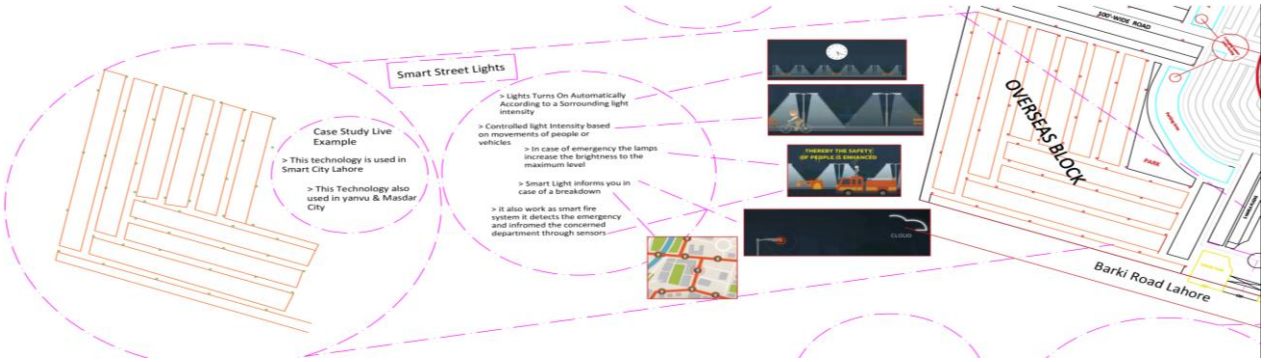
Smart Grid Station	T **Smart homes**	**Two-way Dialogue**
The Smart Grid Provides Detailed Information that enables grid operators to see & manage electricity Consumption in real-time	The Smart Home Communicates With the Grid & Enables consumers to manage their electricity usage by measuring home electricity Consumption by Smart meters	The Smart Introduces Two Ways Dialogue Where Electricity & Information Can be exchanged between Utility & its Customers
With this information, the engineers predict more accurately Electricity production	**Smart meter attached by the grid & homes.** By Smart meters, we can manage our electricity bills	It's a developing Network of Communications, Controls, Computer automation & New Technologies & tools working together to make the Grid more secure more reliable & greener.
Automatic Rerouting & restoring if any type of failure occurs in any grid	The smart appliances will adjust their run schedule to reduce electricity demands on the grid at critical times & lower consumer's energy bills. Also, Smart Appliances controlled by the mobile apps	The Smart grid Introduces wind & Solar energy production & plug-in vehicles Charging

5.3.3 Smart Infrastructure (Smart Street Lights)

Smart street lights, also known as intelligent street lights or connected street lights, are a modern lighting infrastructure that leverages advanced technologies to provide enhanced functionality and energy efficiency compared to traditional street lighting systems.

- Smart Street Lights are installed every 100 feet.
- Lights Turn On Automatically According to a Surrounding light intensity
- Controlled light Intensity based on movements of people or vehicles
- In case of emergency, the lamps increase the brightness to the maximum level.
- Smart Light informs you in case of a breakdown
- it also works as a smart fire system it detects the emergency and informed the concerned department through sensors

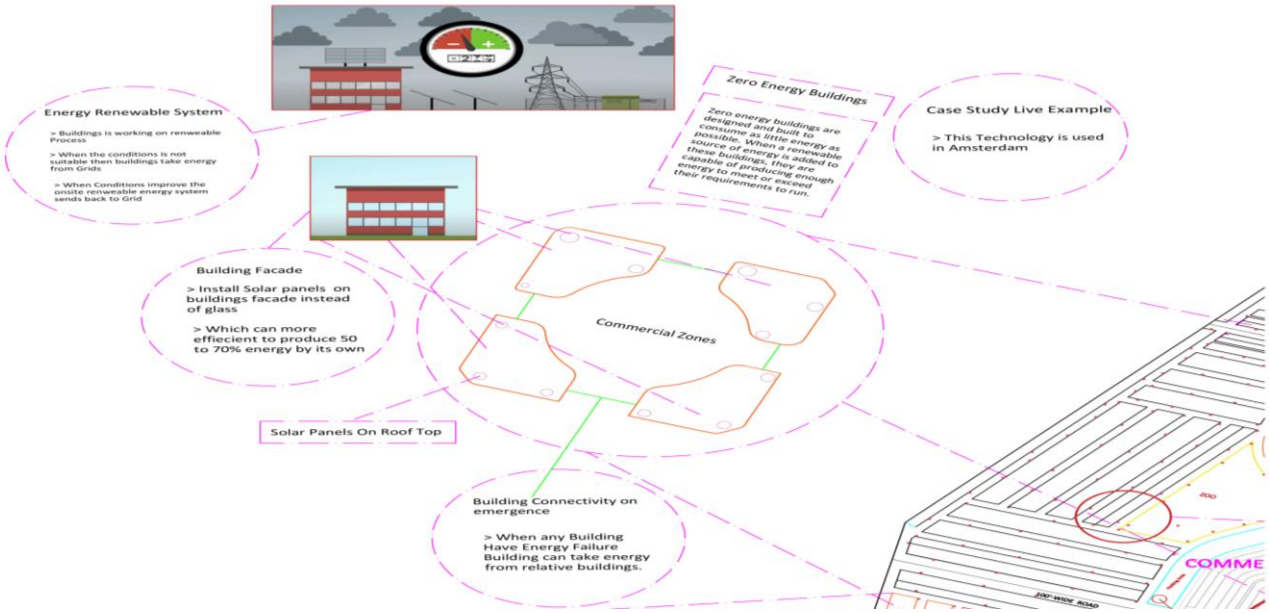
Figure 11:Smart Street Lights



5.3.4 Smart Buildings

Smart buildings, also known as intelligent buildings or connected buildings, are structures that leverage advanced technologies and automation to enhance the functionality, efficiency, and sustainability of building operations.

Figure 12: Smart Buildings



5.3.4.1 Smart Buildings

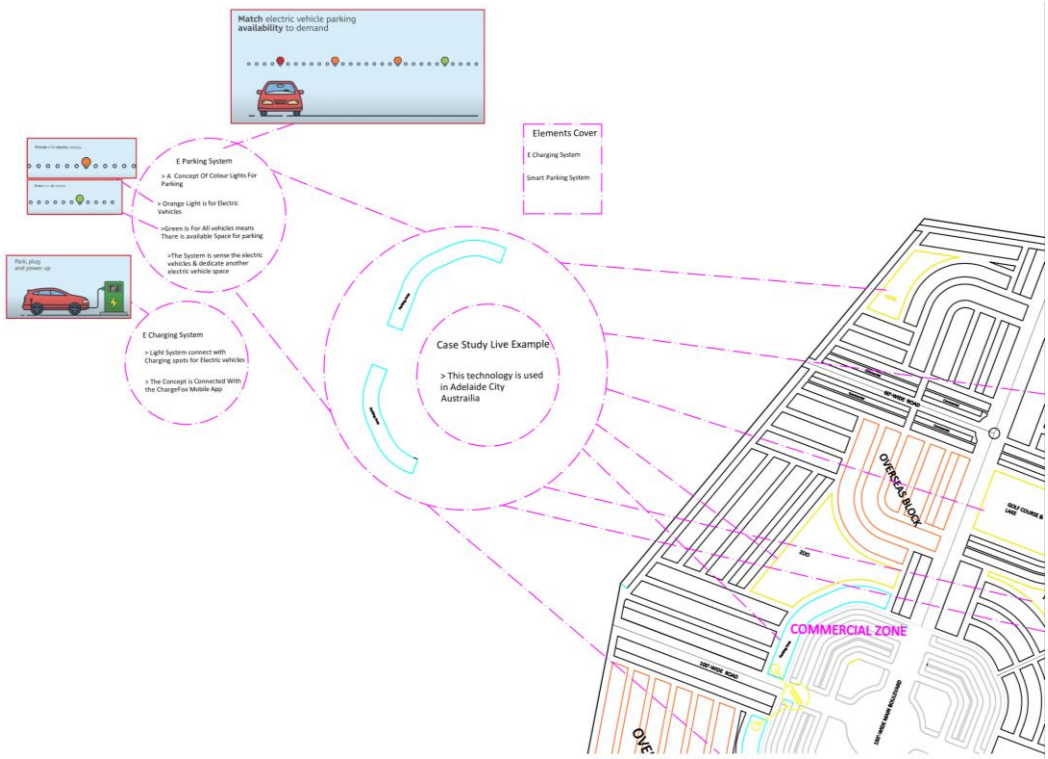
Energy Renewable System	**Building Facade**	**Zero Energy Buildings**
Buildings are working on renewable Processes	Install Solar panels on the building's facade instead of glass	Zero-energy buildings are designed and built to consume as little energy as possible. When a renewable source of energy is added to these buildings, they are capable of producing enough energy to meet or exceed their requirements to run.

When the conditions are not suitable then buildings take energy from Grids	Which can be more efficient to produce 50 to 70% energy on its own	**Building Connectivity on Emergence**
When Conditions improve the onsite renewable energy system sends back to Grid		When any Building has Energy Failure Building can take energy from relative buildings.

5.3.5 Smart Parking System

A smart parking system refers to a technologically advanced solution that leverages various sensors, devices, and data analytics to efficiently manage parking spaces and provide a better parking experience for users. Smart parking systems aim to reduce the time spent searching for parking spaces, optimize space utilization, and enhance overall parking management.

Figure 13: Smart Parking



5.3.5.1 Smart Parking System

E Parking System	**E Charging System**
A Concept Of Color Lights For Parking	Light System connect with Charging spots for Electric vehicles
The System senses the electric vehicles & dedicates another electric vehicle space	The Concept is Connected With the Charge Fox Mobile App
Orange Light is for Electric Vehicles	
Green Is For All vehicles means There is available Space for parking	

5.4 Conclusion

We understand the concept of a smart city through the literature & we do the ranking analysis in the local context. These elements are the outcomes on the basis of triangular analysis. We did the detection on the basis of these particular analyses as an expert. Also, this study aims to provide valuable insights into the potential of the smart city concept for new housing development in Lahore. The findings will help urban planners, and developers make informed decisions about integrating smart city technologies to create sustainable, efficient, and livable communities that cater to the evolving needs of the city's residents. Additionally, this research can contribute to the broader discussion of smart city development in rapidly urbanizing regions globally.

5.5 Recommendations

- Government should make those platforms in which stakeholders consider smart infrastructure in the private housing sector because the residents of the private housing schemes in Lahore are familiar with the concept of smart city.
- Involve residents in the decision-making process and gather feedback on the implementation of smart city technologies. Engaging the community will foster a sense of ownership and improve the overall success of the initiatives.
- Peoples should be smart enough for smart city concept. Because Peoples knowledge about smart city is very generic. They know about smart city but they don’t know about the working of smart city features.
- Owners should grow more like other countries. In other countries, the smart sector also includes smart health, smart education, and smart waste management. Owners should broaden their perspective on the smart city concept. They should have constructed more intelligently, as other countries have. Because 52% of residents are prepared to pay for the smart city idea.

Annexure

1.1 Assessments of Societies:

No	Elements	Assessment
1	Zero energy buildings	
2	Intelligent transportation system	
3	Bus Information system	
4	Smart parking system	
5	Smart energy	
6	E-mobility	
7	Traffic control	
8	Smart Charging system	
9	Smart Grid monitoring	
10	Transportation	
11	Smart education system	
12	Smart housing system	
13	Smart security	
14	smart environmental monitoring system	
15	Safe drop service	
16	Vehicle detection system	
17	Smart firefighting system	
18	The smart recycling pickup system	
19	City bike system	

20	School zone safety system	
21	Car sharing system	
22	AI robot for public service	
23	Smart infrastructure	
24	Smart public spaces	
25	Smoke sensor system	
26	Smart library system	
27	Smart water supply remote metering system	
28	Digital content for a local historical tour	
29	Citizen safety platform	
30	Smart emergency system	
31	Smart Community	
32	Electronic vehicle	
33	Facility monitoring CCTV and sensing	
34	Smart workstation system	
35	Smart home air detection system	
36	Smart park	
37	Smart street lights	

2 Semi Structure Interviews

Interviewee Biography

Name ----------

Age ----------

Designation ----------

1. **How familiar are you with the concept of smart cities? and their potential benefits?**
    - familiar
    - Indifferent
    - Not familiar
2. **Are you aware of any existing smart city initiatives in Lahore or Lahore?**
3. **Are the Community satisfied with the current infrastructure and connectivity in this housing society?**
    - Yes
    - No
4. **What types of smart technologies would you like to see implemented in the housing society? (e.g., smart grids, waste management systems, intelligent transportation, etc.)**
    - Smart Surveillance System
    - Smart Health
    - Intelligent Transportation
    - Smart Infrastructure
    - Smart Housing system
    - Smart Public Spaces
    - Smart Education System
    - Smart Waste Management

5. How do You rate These elements?

1 to 10

6. Is there anything else you would like to add or any specific concerns or suggestions you have regarding the challenges of implementing a smart city in the housing society?

7. Are you agree to spend to modify the existing smart city concept?

- **Agreed**
- **disagreed**

8. Are you willing to Implement the concept of the smart city in existing society?

- **Yes**
- **No**

9. How do you think this will be benefices for your society?

1 to 10

10. If implemented do you think the resident society willing to adopt the smart city concept society?

- Yes
- No
- If yes, please how

11. Are the Community satisfied with the current infrastructure and connectivity in this housing society?

- Yes
- No

12. Is there any steps or features which is used by the authority to improve infrastructure and connectivity to become a smart city?

- Yes
- No

13. In your opinion, what are the key benefits of integrating smart city concepts in new housing development projects? (Select all that apply)

- Smart Surveillance System
- Smart Health
- Intelligent Transportation
- Smart Infrastructure
- Smart Housing system
- Smart Public Spaces
- Smart Education System
- Smart Waste Management

14. Are you familiar with different financing models that can be used for smart city development?

- Public-Private Partnerships
- Loans

15. Are you aware of any financial incentives or subsidies available for incorporating smart city concepts in housing development projects in Lahore?

- Yes
- No

16. What do you perceive as the major challenges or concerns in integrating smart city concepts in new housing development projects? (Select all that apply)

- High initial costs
- Data security and privacy concerns
- Lack of awareness and understanding
- Technical complexities
- Regulatory and policy barriers
- Resident Resistance

3 Residents Perception:

Name ----------

Age ----------

Society Name ----------

5. **How familiar are you with the concept of smart cities?**
    - familiar
    - Indifferent
    - Not familiar
6. **Are you aware of any existing smart city initiatives in Lahore or Lahore?**
    - Yes
    - No
7. **Are you satisfied with the current infrastructure and connectivity in this housing society?**
    - Yes
    - No
8. **What types of smart technologies would you like to see implemented in the housing society?**
    - Smart Surveillance System
    - Smart Health
    - Intelligent Transportation
    - Smart Infrastructure
    - Smart Housing system
    - Smart Public Spaces
    - Smart Education System
    - Smart Waste Management

5. How do You rate These elements?

1 to 10

6. Is there any Smart City elements in the existing infrastructure of this Housing society?

- Yes
- No
- If yes, then please Specify….

7. Is there anything else you would like to add or any specific concerns or suggestions you have regarding the challenges of implementing a smart city in the housing society?

8. Are you willing to pay to modify the existing smart city concept?

- Willing
- Not willing

9. If implemented do you willing to adopt the smart city concept in this society?

- Yes
- No
- If yes, please how

10. Are you realize of any steps or features by the authority to improve infrastructure and connectivity to become a smart city?

- Yes
- No

11. In your opinion, what are the key benefits of integrating smart city concepts in new housing development projects? (Select all that apply)

- Smart Surveillance System
- Smart Health
- Intelligent Transportation
- Smart Infrastructure
- Smart Housing system
- Smart Public Spaces
- Smart Education System

- Smart Waste Management

12. How familiar are you with the potential benefits of smart cities?

- Familiar
- Indifferent
- Not Familiar

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