LAHORE'S GAJJU MATTA URBAN SPRAWL: ASSESSING THE COST OF PUBLIC UTILITIES' PROVISION."

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CERTIFICATE

This is to certify that this thesis entitled "**Lahore's Gajju Matta Urban Sprawl: Assessing the Cost of Public Utilities' Provision.**" submitted by **Muhammad Abdullah Bin Afzal** is accepted with minor changes ensured to be incorporated in thesis by the concerned supervisor/s and the PIDE School of Social Sciences, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Development Studies.

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Dedication

I dedicate this dissertation to my father, Afzal Ahmed and my sister, Memoona Afzal.

ABSTRACT

This research focuses on assessing the financial costs of providing public utilities in the context of urban sprawl and compact development, using the case study of Lahore. The study aims to calculate the expenses associated with basic public utilities in both the developments, in our case Gajju Matta and Ichra of Lahore, analyze the disparities between the current and targeted urban areas, and estimate the costs of providing public utilities under the suggested land-use paradigm. The findings indicate that urban sprawl in Lahore, particularly in Gajju Matta, increases the financial burden of public service provision, due to reduced population density, longer commutes, increased demand for public transit, and traffic congestion. While in compact development the government burden of providing public utilities is far lesser than the sprawled development. The study emphasizes the need for alternative approaches to urban growth, highlights the importance of informed decision-making in resource allocation, and provides valuable insights for policymakers to prioritize investments and promote sustainable infrastructure design.

Keywords:

Urban sprawl, Compact Development, financial costs, public utilities, Gajju Matta, Land-use paradigm

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Chapter 1

Introduction

1.1. Sprawl

Urban sprawl, a recognized challenge in urban planning, has been associated with increased demands for urban infrastructure and public utilities. The implications of this pattern of development are well-documented, resulting in higher costs, environmental degradation, and various social and economic consequences (Hamidi, S., & Ewing, R., 2015; Litman, 2019; Burchell et al., 2018). Sprawl has been a widely studied phenomenon in urban planning and development research. The literature provides several definitions of sprawl, all of which revolve around low density. Comment (2015) argues that sprawl is a form of urbanization that is characterized by the rapid, low-density growth of cities and towns, which tends to be unplanned ssand uncoordinated, leading to negative consequences for both society and the environment. Likewise, Didier et al. (2012) suggest that sprawl is a spatial phenomenon that arises from the interaction of demographic, economic, and social factors, leading to the expansion of urban areas into previously undeveloped land. Sprawl is a pattern of land use conversion that outpaces population increase over a certain period and transforms rural areas that were formerly farms, parks, and other natural areas into built-up areas (Ewing, 2008).

Sprawl, as a phenomenon, is multifaceted and has a complex relationship with various influencing factors that contribute to the growth of unplanned urban development. In terms of its capacity to generate more conversation on the subject, a straightforward definition of sprawl can serve as a starting point for understanding its negative consequences on society and the economy (Comment, 2015; Didier et al., 2012; Ewing, 2008).

Sprawl also has significant social consequences. As urban areas become more spread out and car-oriented, people tend to become more socially isolated and have fewer opportunities to interact with their neighbors, leading to reduced levels of social cohesion (Garrido et al., 2017). This social isolation also have a negative impact on health, as people are less likely to engage in physical activity, leading to increased rates of obesity and other health problems (Garrido et al., 2017).

The adverse consequences of sprawl are widely recognized, and there is a growing body of research on this topic. The above-mentioned studies provide evidence of the social, environmental, and economic costs of sprawl, highlighting the importance of sustainable urban planning and development policies. Moreover, It has been an established fact in urban studies that urban sprawl imposes financial burdens on communities and municipalities due to the expansion of infrastructure networks and public services (Ewing, 2008).

According to research, several different elements contribute to the process of unplanned urban growth, as shown in Fig. 1. These include rapid urbanization, declining agriculture, expanding industry, migration, economic development, income growth, development policy, market failure, and exponential population growth (Angel et al., 2010; Bhatta, 2010; Sultana et al., 2013).

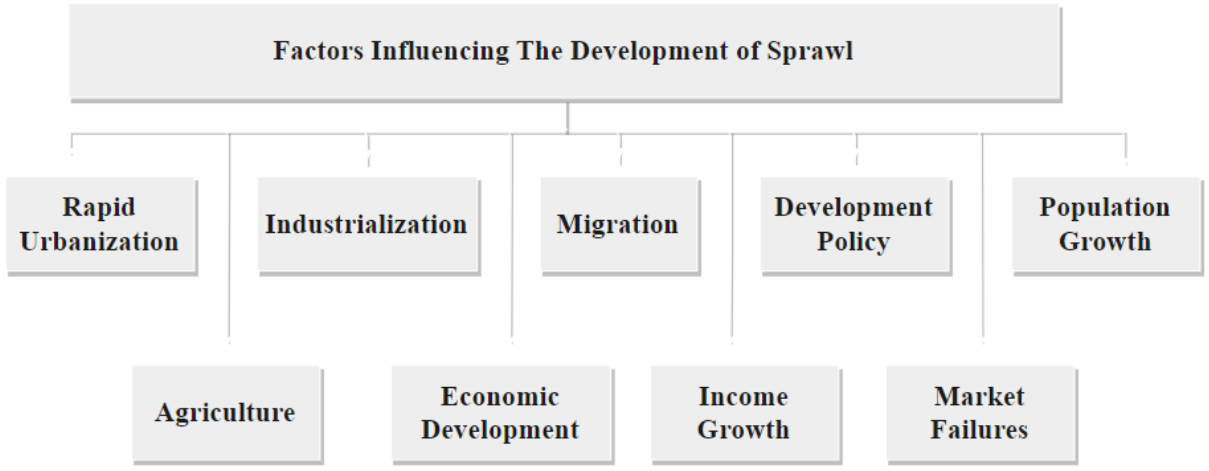

Figure 1.1: Factors influencing the Development of Sprawl

Sprawl has several negative impacts on the economic, social, and environmental well-being of a metropolis, as illustrated in Fig. 1.2. for instance, sprawl can lead to increased traffic congestion, air pollution, and energy consumption, as well as decreased access to public transportation, social isolation, and loss of open space and farmland (Garrido et al., 2017).

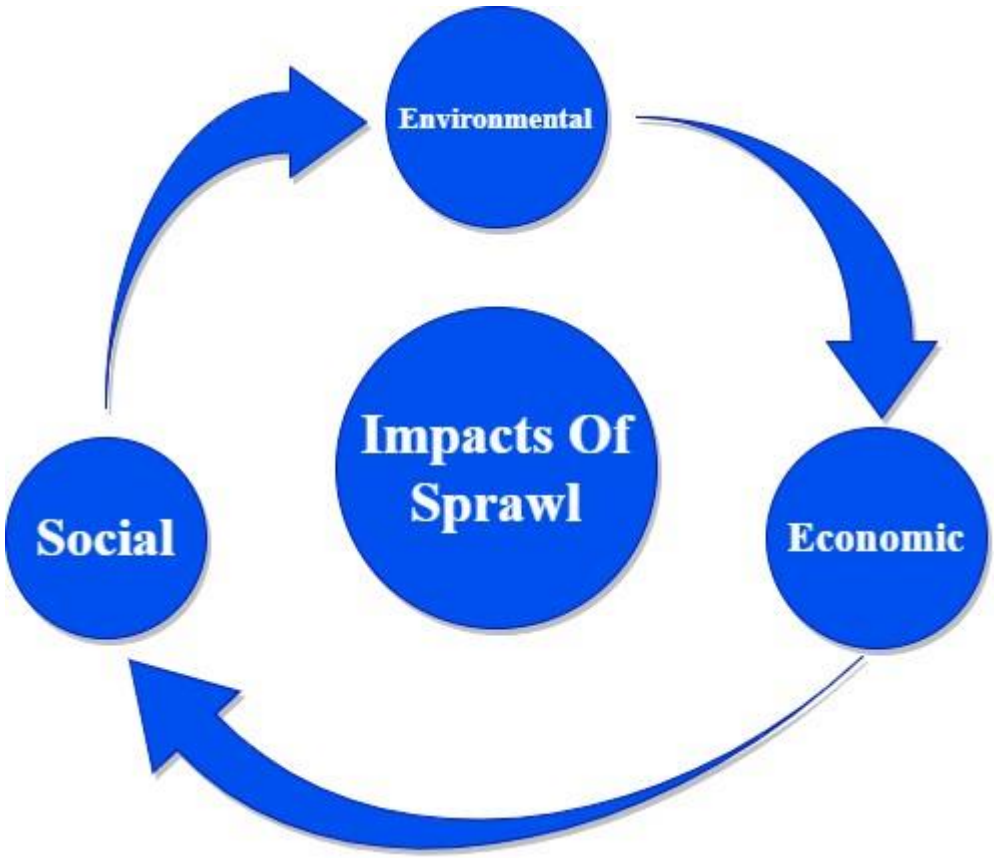

Figure 1.1: Impact of Sprawl

In contrast to sprawl, there is another approach named as smart growth, also known as balanced growth and sustainability, refers to the idea of striking a balance between urban expansion and the preservation of a city's economic, social, and environmental well-being (Litman, 2015). Smart growth advocates for in-fill development that uses existing urban infrastructure and provides space for people to carry out urban activities. This type of development results in healthy, wealthy, and wise communities that are socially vibrant and equitable.

1.2. Challenges of Unplanned Urban Development in Lahore, Pakistan

Urban development is a crucial aspect of any country's growth, and Pakistan is no exception. However, land development and consumption have become out of control and disordered in major cities, particularly in Lahore, during the past thirty years. Lahore, the capital city of the Punjab province, is one of the fastest-growing urban centers in Pakistan. According to the census of 2017, its population is estimated to be over 11 million (Hasan 2021). Moreover, the city's population is

estimated to be growing at 4 percent per annum. To better understand this statistic, the urban population growth for the whole province of Punjab, between 1998 and 2017, was 2.74 percent (Pakistan Bureau of Statistics 2021). This population growth rate of Lahore was not only the highest among all cities of the province, but it is projected to grow up to 17 million by 2030 (World Population Review 2022.

Unfortunately, the urbanization of Lahore has been accompanied by significant challenges, including rapid and unplanned land development. The city has been separated into housing developments for the low-, middle-, and high-income classes, resulting in segregated communities. The public spaces in the city, such as Packages Mall and Emporium Mall, are monopolistic, further exacerbating the inequality. This kind of urban development has led to a disordered and uncoordinated growth pattern, with little regard for the environment or social cohesion (Mahboob & Atif, 2015). Fig. 3 illustrates some of the direct costs of sprawl which include those to taxpayers, social issues, high labor expenses, new infrastructure, automobile use, and the environment (Ewing R.H., 2008).

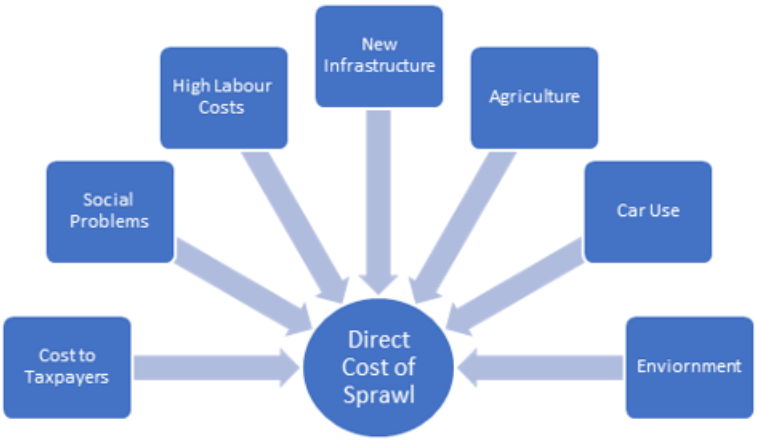

Figure 1.3: Direct Cost of Sprawl, Author

Lahore has been experiencing a rapid expansion of grey infrastructure in the past few decades and its urban growth has been divided into three phases. Pre 1995 is the first phase. This phase encompasses the period before 1995 when Lahore experienced initial urban growth. From 1995 to 2005, the city experienced the second phase of the urban transition, which is characterized by suburbanization, with the fastest growth occurring just outside the core of the city. However, from 2005 to 2015, the urban growth is in the third phase of the urban transition, known as the

counter urbanization phase, where the population in the core and suburbs starts to move out to more rural areas, as shown in Fig. 4 (Urban Unit).

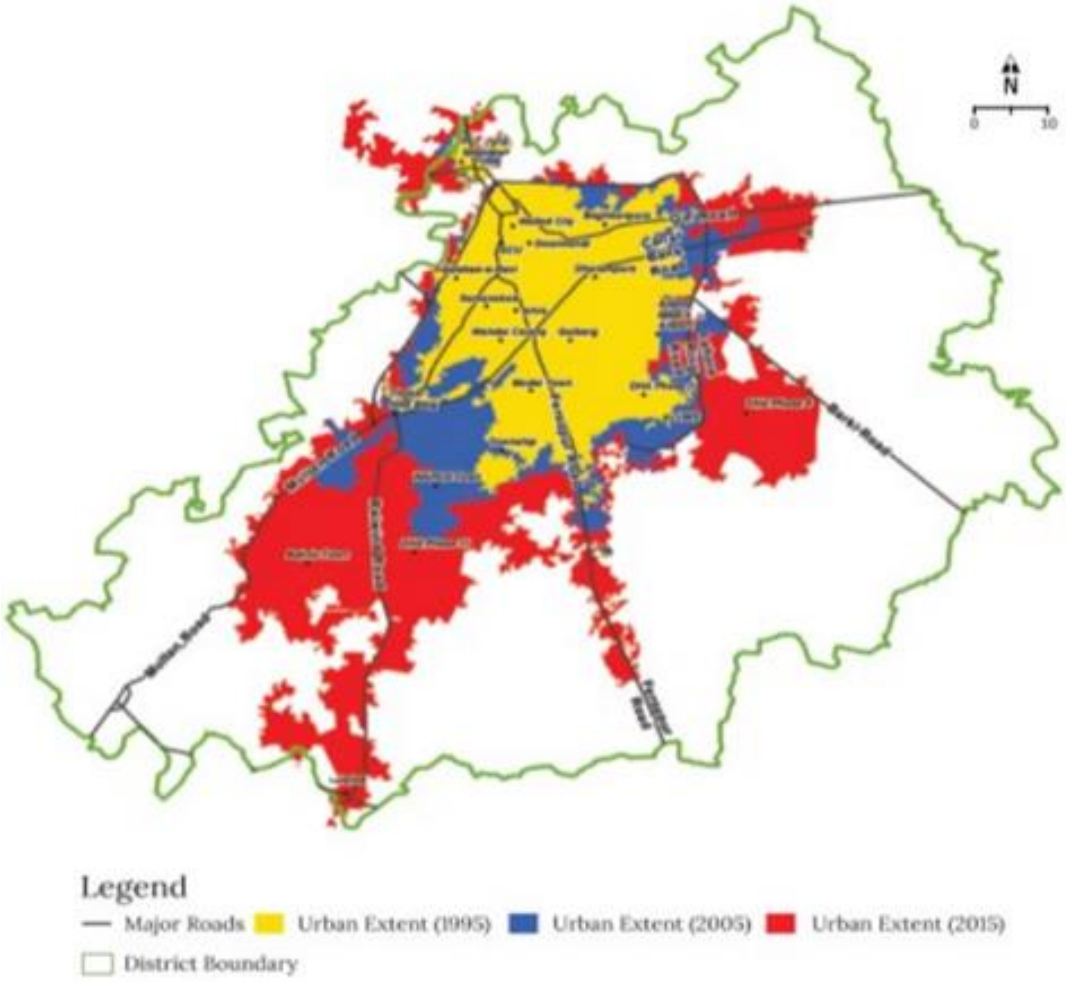

Figure 1.4 Lahore Urban Extent, Source: Urban Unit

Lahore's rapid urbanization is putting pressure on the city's infrastructure, particularly its water and sewage systems. The city's water supply is already insufficient, and its sewage system is outdated and unable to cope with the current population density. Moreover, the increasing traffic congestion is making it difficult for people to move around the city efficiently. These issues have led to a decline in the residents' quality of life and ability to grow (Ibrahim & Riaz, 2018).

The existing urban practices in Lahore have been widely criticized in the literature. Mahboob & Atif (2015) argue that the city's urban development has resulted in unequal access to resources and

services, including health care and education. They suggest that the city's policymakers need to focus on inclusive and equitable urban planning to address these issues. Similarly, Ibrahim & Riaz (2018) emphasize the importance of sustainable urban development in Lahore, highlighting the need for integrated and coordinated urban planning that considers social, economic, and environmental factors.

The city's rapid urbanization has led to several challenges, including unplanned and disordered land development, which has resulted in a shortage of adequate housing and infrastructure facilities for the city's growing population (Mumtaz et al., 2020). Furthermore, the rapid growth of informal settlements, which lack basic services and facilities, has led to significant environmental and health risks for residents (Siddique et al., 2021).

Policymakers in Lahore need to adopt inclusive, egalitarian, and sustainable urban planning methods that put the needs and interests of all inhabitants first in order to address these issues. To guarantee that new developments are connected with existing infrastructure and facilities, they might, for example, consider executing urban development projects that are compliant with the city's master plan and zoning requirements (Khan et al., 2020).

Moreover, if prioritization will be given to the provision of basic services and facilities such as water, sanitation, and healthcare to informal settlements and other marginalized communities in the city this would not only improve the living conditions of residents but also help reduce environmental risks and improve public health outcomes. Regarding leapfrog development, policymakers can consider the potential negative impacts on the environment and agricultural land use. They could promote a more compact and connected urban form by encouraging infill development and the rehabilitation of existing urban areas (Khan et al., 2020). Furthermore, the adoption of green infrastructure solutions, such as green roofs and urban forests, could help mitigate the environmental impacts of urbanization (Hassan, 2021).

Rapid urbanization in Lahore presents issues that need for an all-encompassing, comprehensive strategy that takes into account the social, economic, and environmental factors affecting the city's growth. There is a dire need to give the implementation of inclusive, equitable, and sustainable urban planning techniques top priority in order to accomplish this.

It is pertinent to note that, one of the most important aspects of dealing with urban sprawl is examining the monetary costs connected with its development and management. In order to comprehend the monetary effects that sprawl has, it is necessary to analyze the supply side of sprawl. More can be learned about the financial effects of urban sprawl and the economic effects of haphazard urban expansion by studying the financial aspects of urban development. This includes evaluating the costs incurred in acquiring land, constructing new infrastructure, and providing public services to accommodate the expanding population. Assessing ongoing costs for operation and management of the expansive urban regions, such as the price of utilities, transportation networks, and waste management systems, is another aspect of this process.

This research aims to study the cost of utilities as it is essential to comprehend the financial cost of urban sprawl for improved resource allocation and decision-making. It will enable the decision-makers to pinpoint the most successful and economical methods for urban development, ensuring that scarce resources are used wisely. Policymakers can then prioritize infrastructure investments that support sustainability and the city's long-term growth ambitions by evaluating the financial ramifications.

However, it is essential to recognize that not all land areas share the same characteristics and potential for development. In the context of Lahore, Pakistan, the Gajju-Mata land stands as a distinct and promising landscape, offering a unique opportunity to reimagine urban expansion. The purpose of this research is to emphasize that urban sprawl does not have to follow a one-size-fits-all approach, especially when dealing with a land area as strategically located and resource-rich as Gajju-Mata.

Gajju-Mata's potential lies not in perpetuating the conventional urban sprawl model but in paving the way for context-specific solutions that can effectively manage the city's future population growth. As Lahore continues to experience demographic expansion, it is crucial to explore segregated and tailored approaches to urban development. Rather than conducting business as usual, the Gajju-Mata land represents a vital asset that can be leveraged to accommodate the increasing population while integrating smart growth models.

One of the distinctive features of Gajju-Mata is its existing urban infrastructure, including the Lahore Ring Road, which encircles the city, providing an efficient transportation network. This road infrastructure's wide expanse serves as a strong foundation for the application of smart growth

models. By capitalizing on these existing resources, such as the Lahore Ring Road, we can construct an urban landscape that aligns with the principles of smart growth, facilitating connectivity, accessibility, and sustainable urban development.

In light of the unique qualities of the Gajju-Mata land and the challenges posed by urban sprawl, this research endeavors to present a fresh perspective, one that underscores the importance of contextualized solutions. It will investigate how the principles of smart growth can be integrated into the development of Gajju-Mata, not merely as an antidote to urban sprawl, but as a proactive strategy to efficiently manage Lahore's population increase. By focusing on this specific case, we aim to highlight the potential of Gajju-Mata as a catalyst for innovative, sustainable urban development that can serve as a model for other growing urban areas.

Furthermore, the examination of financial costs in the context of Gajju-Mata plays a pivotal role in identifying potential disparities and inequalities resulting from spontaneous urban development. This analysis not only helps policymakers gain insights into how these costs and benefits are distributed but also allows for a fair and inclusive development process that addresses the diverse socio-economic groups present in the region. By understanding the financial implications specific to Gajju-Mata, we can tailor policies that are equitable and responsive to the unique characteristics of this area, ultimately contributing to a more harmonious and balanced urban landscape.

An in-depth understanding of the financial consequences of urban sprawl, particularly in the context of Gajju-Mata, empowers decision-makers to make informed choices and establish effective growth-management strategies. It provides a foundational framework for the development of policies that mitigate the adverse effects of sprawl, emphasizing compact and mixed-use development strategies that can be aptly applied to the Gajju-Mata region. Through a financial lens, Lahore can progress toward a more sustainable, economically competitive, and socially inclusive urban environment, underscoring the significance of incorporating financial considerations into the urban planning processes for Gajju-Mata.

1.3. Statement of the Problem

This research aims to calculate the financial principal cost of the built public infrastructure (per square kilometers) in the undertaken sprawled and compact area in Lahore. The built infrastructure includes parks, roads, sewage systems, water pipes, gas, electricity, lighting, and mandi (Vegetable

and fruit market). Generally, this research will explore the supply side of the sprawl and compact development of Lahore, aiming to explore the monetary burden of developing and handling sprawl in Lahore. These estimations will fill in a gap for better decision-making and further research while using a practitioner approach. Based upon the finding, this research will help in analyzing the existing infrastructure capacity while valuing the present-day and future public burden.

The costs that the public utilities places on the authorities such as Planning and Development (P&D), Lahore Development Authority (LDA), Lahore Electric Supply Company (LESCO), Water and Sanitation Authority (WASA), and Infrastructure Development Authority, Punjab (IDAP) are essential to study and understand. Figure 7 provides a list of authorities that are at the supplier side of the equation and their functions.

Housing Urban Development & Public Health Engineering Department	• Rejuvenating the housing sector in general, and provision of shelter to shelter-less, low-income groups in particular
Punjab Housing and Town Planning Agency (PHTPA)	• To develop housing schemes for Low Income Group and to prepare Master Plans / Outline Development Plans.
Lahore Central Business District Development Authority	• Works for the development of environment-friendly, urban regeneration projects that are based on vertical design of buildings.
Infrastructure Development Authority, Punjab (IDAP)	• Autonomous body established for planning, designing, constructing, and maintaining infrastructure in the Punjab province of Pakistan.
Punjab Local Government & Community Development Department	• Look over the governance side of functioning in Lahore.
Metropolitan Corporation Lahore (MCL)	• Look over the metropolitan regulatory functions in Lahore.
Parks & Horticulture Authority Lahore (PHAL)	• Maintain all the parks and green cultivation in Lahore.
Lahore Development Authority (LDA)	• LDA is responsible for planning new development in Lahore while having the power to issue permits for new public and private construction. It also manages parks and green areas.
Planning and Development (P & D)	• Execution and processing of all development schemes, programs and proposals submitted by other Departments including autonomous bodies and making recommendations to Government.
Lahore Electric Supply Company (LESCO)	• Distributes electricity to Lahore, Kasur, Nankana, Sheikhupura, and Okara.
Water and Sanitation Authority (WASA)	• Plans, designs, and constructs the water supply, sewerage, and drainage facilities.

Table 1.1: Authorities and their Role

Due to involvement of various authorities in the development is very important and hard at the same time to measure the financial cost of it. So, this study aims to calculate the financial cost of providing public facilities in the sprawled and compact area of Lahore**.** For this purpose, the has undertaken the Gajju Matta as a sprawled development and Ichra as a compact development in Lahore.

1.4. Research Questions and Objectives

The objectives and research questions for this study are as below:

1.4.1. Research Problem

Based on the narrative of the statement of the problem case stated in the preceding text I am narrowing my research problems into "assessing the cost of public utilities' provision in sprawl verses compact development: a case study of Lahore" and have operationalized my topic into following research questions and objectives.

1.4.2. Objective of the Study

This study's primary goal is to calculate the financial cost of public utilities using the present land-use model. Based on the existing land-use model for where Lahore will be in the future, the study also intended to explain the difference between the targeted urban area and the current urban area. The cost of supplying public utilities under the suggested land-use paradigm will also be estimated in this research.

Although it may seem that this study is attempting to reiterate a widely acknowledged truth concerning the influence of urban sprawl on infrastructure expenses, it is imperative to critically examine this matter within the unique context of Gajju Matta and Ichra. Theoretical and academic discussions within this study will add to a comprehensive comprehension of the complexities and potentialities linked to urban development in this distinctive context.

The main objective of this study is to highlight the financial burden of providing and running public utilities in the sprawled verses compact area of Lahore.

Public Utility	Definition
Road Infrastructure	Road infrastructure refers to the network of roads, including local, metro, primary, and secondary roads, within the urban area. It plays a crucial role in facilitating transportation and connectivity.
Sewage System	The sewage system encompasses the infrastructure designed to collect, convey, treat, and dispose of wastewater and sewage from residential, commercial, and industrial sources.
Public Buildings	Public buildings include structures such as parks, public schools, public hospitals, and other facilities intended for public use and benefit.
Transmission Lines	Transmission lines are infrastructure components used to transmit electricity for delivery to consumers.
Street Lights	Street lights are lighting fixtures installed along roads and pathways to illuminate public areas during nighttime, enhancing visibility and safety for pedestrians and motorists.
Gas Pipelines	Gas pipelines are conduits designed to transport natural gas from production facilities or storage sites to distribution networks and ultimately to end-users for various applications.

Table 2.2: Definition of the public utilities Source: The gazette of Pakistan, 1991 & Building and zoning regulation until 2019 – LDA

1.4.3. Research Objectives

The main prominence of this research is to study the cost of utilities, as this study aims to advocate the stance that authorities should follow the alternative approaches towards the urban growth. While doing so the purpose is to answer the following question.

1. What is the financial public cost of providing public utilities in sprawled and compact development in Lahore?
2. What is the per-capita cost of supplying public utilities in sprawled and compact development in Lahore?

1.4.4. Scope of the Study

Using the current land-use model, this study seeks to evaluate the financial expenses of public utilities in Gajju Matta, Lahore and Ichra, Lahore. Based on the suggested land-use paradigm, the study will evaluate the per-capita costs related to providing public utilities, offering insightful information about the financial effects of urban expansion and aiding decision-makers in resource allocation and sustainable infrastructure design.

While this study focuses on understanding the financial implications of urban sprawl in the specific context of Gajju-Mata in Lahore, it acknowledges the importance of comparative analysis by comparing the relevant costs in the specific context of Ichra in Lahore.

Given the limited scope of this research, a comprehensive comparative analysis between sprawled and compact development in various contexts is beyond its current objectives. However, it paves the way for future studies to delve into these comparisons and validate the established facts by examining different urban development patterns. Such comparative studies would indeed provide valuable insights into the cost-effectiveness of various development models and contribute to more informed decision-making in urban planning.

1.4.5. Significance of the Study

This study holds significant importance as it provides a comprehensive understanding of the financial costs associated with public utilities in Lahore. Policymakers will be able to prioritize investments in public utilities and allocate resources effectively as a result of this research's contribution to informed decision-making. As Lahore continues to experience increasing urbanization, it will also help identify areas for improvement and establish plans to ensure sustainable and fair provision of basic services, promoting the city's overall development and well-being.

1.5. Rationale of Choosing the Locale

The choice to focus on Gajju Matta for analyzing the financial aspects of public utilities in Lahore was deliberate, as it serves as a vivid illustration of the challenges posed by urban sprawl. Gajju Matta's sprawling, unregulated growth epitomizes the complexities of unplanned urbanization, making it an ideal case study to explore the financial intricacies of providing public amenities. By meticulously examining these intricacies within Gajju Matta, the study aims to shed light on the far-reaching consequences of urban sprawl within a specific urban context.

Furthermore, contrasting Gajju Matta with Ichra, where vertical urban infrastructure predominates, provides valuable insights into the differing dynamics of horizontal and vertical urban development. This comparative analysis enriches our understanding of the fiscal implications

associated with various urbanization patterns, underscoring the importance of strategic urban planning practices in effectively managing urban expansion.

Through this comparative approach, the study seeks to inform targeted interventions aimed at mitigating the challenges posed by urban sprawl and fostering sustainable development in both Gajju Matta and similar urban areas facing similar issues. By synthesizing findings from both settings, the study contributes to a more comprehensive understanding of urban development dynamics and informs future urban planning initiatives.

1.6. Organization of the Thesis

The thesis is organized into nine chapters. Chapter 1 provides an introduction to the research topic, outlines the research objectives, and presents the rationale for selecting Gajju Matta in Lahore as the case study area. Chapter 2 presents a comprehensive literature review on urban sprawl, its impacts on public utilities, and smart city solutions. Chapter 3 describes the research methodology, including data collection methods and analytical techniques. Chapters 4 and 5 explore the impacts of urban sprawl and the management of urban growth in Lahore, respectively. Chapter 6 focuses specifically on urban growth in Gajju Matta. Chapters 7 and 8 delve into the costs of public utilities in Gajju Matta, including the running and operating costs. Chapter 9 compares the cost of provision of public infrastructure in the sprawled development and the compact development, Ichra. This chapters also sheds a light on the per capita cost comparison. Lastly, chapter 10 proposes a way forward based on the findings and recommendations derived from the study.

Chapter 2

Literature Review

2.1. Understanding Sprawl

Urban sprawl refers to the outward expansion of urban areas into previously undeveloped or rural land, often characterized by low-density residential and commercial development (Hamidi & Ewing, 2015). It has become a significant issue in many regions worldwide, leading to various social, environmental, and economic concerns. The effects of urban sprawl include increased automobile dependence and traffic congestion, loss of agricultural and natural lands, fragmented habitats, decreased air and water quality, and diminished social interactions (Litman, 2019; Burchell et al., 2018). Additionally, urban sprawl can lead to higher infrastructure costs, inefficient land use patterns, and increased energy consumption, contributing to climate change and exacerbating environmental challenges (Glaeser & Kahn, 2010). Understanding the causes and consequences of urban sprawl is essential for effective urban planning and sustainable development strategies (Kühn, 2021). To establish effective urban planning and sustainable development strategies, it is necessary to delve into the regional and local implications of urban sprawl and the associated costs of infrastructure provisioning.

It is important to gain an understanding of how urban sprawl works in order to better understand the issue. The urban expansion and transition model developed by Berry and Plaut in 1978 sheds light on the urban sprawling process. The model outlines four stages of urban development, each of which has specific characteristics. The first phase of suburbanization sees the greatest amount of development in the city center, while the second phase has the fastest expansion immediately outside the city center. People start moving out of the urban centre and its suburbs and into more rural areas during the third phase, which is known as counter-urbanization. Re-urbanization, which entails expansion in the city center, is the final stage.The third phase of the model is particularly relevant to the present population's preferences. During this phase, people prefer to live close to the city's suburbs. However, one of the most critical features of sprawl is the construction of two separate infrastructure systems, both of which are underused according to several studies. The development of new sprawling areas outside the city center leads to increased demands for additional infrastructure such as roads, water, and sewage systems. This results in additional

financial expenditures associated with unplanned physical growth, which can have negative effects on the environment and the economy.

Urban sprawl has important social repercussions as well as the previously mentioned environmental and economic ones, such as increased social isolation and longer commute times. Employment prospects grow more dispersed as cities spread outside, making it challenging for low-income people to acquire occupations that are located far from their homes. In their study, Burchell et.al (2018) discovered that urban sprawl is linked to increased commute times, poorer social cohesion, and community participation, which causes social and economic inequality.

In addition, the longer commutes that come with suburbanization have a financial impact on the taxpayers. The time spent traveling, longer commutes result in higher costs for gasoline, vehicle depreciation, and maintenance. These extra expenses put a strain on people and families and have larger effects on how much energy is consumed, how much pollution is produced, and how congested the roads are—all of which contribute to environmental deterioration (Schwanen, T., et al. (2018).

Thus, the negative effects of urban sprawl extend beyond the physical landscape and infrastructure challenges. They include economic inequalities, social isolation, and rising costs for both people and society at large. Unchecked urban growth can also lead to a loss of sense of communal identity and cohesiveness. The cost of labor may increase as new communities are built on the outside of a city's suburbs, increasing the expense of relocating there. Additional public and private infrastructure is needed to accommodate the requirements of these new communities, which may result in major financial and economic obligations for stakeholders (Iyer and Ghosh, 2013).

The creation of underutilized infrastructure is a significant concern linked to urban sprawl. In the context of urban expansion, both new and existing communities may witness the construction of infrastructure to support anticipated growth that fails to materialize. This results in a misallocation of resources and investments, ultimately leading to underutilized infrastructure (Downs, 1999). New infrastructure, such as roads, utilities, and public amenities, is frequently erected in anticipation of population development and increased demand when urban sprawl spreads into formerly undeveloped areas. However, if the predicted expansion does not materialize, these infrastructural resources become underutilized since they lack the essential demand to operate effectively.

While the model of urban growth presented by Berry and Plaut provides a useful framework for understanding the process of suburbanization, it is essential to consider the associated costs and negative consequences when planning for future urban development.

2.2. Cost of Sprawl

The cost of urban sprawl is a significant concern for urban planners and policymakers. Inherent costs associated with sprawl, such as infrastructure expenses, environmental degradation, and social isolation, are of concern to both urban planners and policymakers. One study found that the annual cost of infrastructure provision per household in a sprawling development was 2.6 times that of a traditional neighborhood (Ewing, 2010). Another study found that sprawl can contribute to air pollution, which can cause respiratory problems, heart disease, and other health issues (Frank and Engelke, 2005). To better address local and regional challenges, it's crucial to explore how these costs manifest in specific contexts and the nuanced factors that contribute to them.

Researchers have quantified the costs of urban sprawl and have shown that it is essential to employ effective land-use strategies to combat it. Vermeiren et al. (2021) found that the infrastructure costs in the Flanders region of Belgium, where dispersed buildings and ribbon development predominate, are significantly higher than in regions with dense structures. The authors also presented an alternate land-use plan that could result in cost savings of 246-383 million euros per year due to lowered capital expenditures and running costs.

Gurran, Ruming, and Randolph (2009) emphasize the importance of data on transportation, land use, housing typology, travel behavior, energy consumption, and real capital and running expenses of utilities over a long time period to assess the impact of different urban growth patterns on infrastructure costs. They further highlight those assessments of development costs on a 15–20-year horizon are necessary for land supply policies that govern urban containment/growth boundaries, land use zoning, and development controls for density and building design in urban centers.

However, many studies focus on projects with shorter time spans, such as 10–15 years, while longer time horizons of 15+ years are needed to capture the effects of urban form characteristics (Gurran, Ruming, & Randolph, 2009). Therefore, long-term investigations into the effects of

different growth patterns on infrastructure costs are needed, with variations in size, breadth, and duration of the investigations.

For example, Vermeiren et al. (2021) conducted a study on the Flanders region of Belgium, where dispersed buildings and ribbon development predominate, and found that infrastructure costs were significantly higher in such areas compared to the region with dense structures. They also proposed an alternate land use plan that could result in yearly cost savings of 246-383 million euros due to lowered capital expenditures and running costs. Such quantitative data and analysis can help policymakers recognize the importance of various land-use strategies and make informed decisions for sustainable urban development.

2.3. Environmental Cost of Urban Sprawl

Cities in the twenty-first century face a serious problem with air pollution, which has negative consequences on both the environment and public health. The Global Burden of Disease project estimates that air pollution caused 6.7 million deaths globally in 2019—the majority of which occurred in low- and middle-income nations ((Institute for Health Metrics and Evaluation, 2020). In especially in emerging nations where growing urbanization is contributing to increased pollution levels, this emphasizes the critical need for cities to take action to solve this global health catastrophe.

In addition to its negative effects on health, air pollution has high financial expenses. According to World Bank estimates, health care expenses and lost productivity associated with air pollution cost the global economy $5.7 trillion a year (World Bank, 2022). This emphasizes the requirement for communities to give clean air programs top priority as part of their economic development plans.

In order to combat air pollution, cities all over the world are pursuing a variety of measures, such as establishing low-emission zones, encouraging active transportation, and spending money on renewable energy sources. By using a mix of energy-saving techniques and the utilization of renewable energy sources, the city of Copenhagen, for instance, has set a target to become carbon-neutral by 2025 (City of Copenhagen, 2021). In a similar vein, the city of Los Angeles has put in place a number of initiatives to lower air pollution, including encouraging the use of electric

vehicles and spending money on infrastructure for public transportation (City of Los Angeles, 2021).

Finally, the land-scaling strategy used in sprawling cities can have a significant impact on agricultural land and the environment. Agricultural land is converted to residential and commercial uses, resulting in a loss of productive land and increased pressure on natural resources. The increased use of automobiles and the loss of green space can also contribute to environmental degradation (Muthukumaran and Chauhan, 2016).

Sustainability and urbanization are strongly related and entwined. To ensure that cities can meet the demands of their citizens while protecting natural resources and minimizing environmental damage, sustainable infrastructure and practices are becoming more and more necessary as metropolitan areas continue to expand. Urban policymakers and stakeholders needs to work together to ensure that cities are developed in a sustainable manner to achieve the economic, social, and environmental objectives that are essential for urban sustainability.

Moreover, sustainable infrastructure can help reduce the adverse impacts of climate change on cities, such as flooding, extreme temperatures, and air pollution. For instance, sustainable infrastructure such as green roofs, porous pavements, and wetlands can mitigate the effects of urban heat islands and reduce the risk of flooding (Frank et.al, 2005). Sustainable infrastructure can also improve the quality of life for urban inhabitants by enhancing public spaces, promoting walkability, cycling, and reducing congestion and air pollution (Ewing et al., 2019).

2.4. Impact of Urban Growth Patterns on Infrastructure

The physical expansion of a city can have a significant impact on its infrastructure, leading to increased expenses for both the government and taxpayers. Therefore, it is crucial to study how different urban growth patterns affect infrastructure expenses. Studies have shown that compact and mixed-use development, which concentrates growth around transit and urban centers, can lead to lower infrastructure costs than sprawl development, which spreads development over a larger area and increases the distance between activities (Ewing et al., 2015; Vermeiren et al., 2021).

Understanding the impact of urban growth patterns on infrastructure costs requires data on transportation, land use, housing typology, travel behavior, energy consumption, and real capital

and running expenses of utilities for an extended period. Such data enable policymakers to make informed decisions regarding land-use strategies and development controls that could result in cost savings and a more sustainable city (Gurran et.al., 2009)

As urban areas expand, there is a corresponding increase in the need for various types of infrastructure to support the growing population. This includes linear infrastructure such as parks, roads, sewage systems, water pipes, gas, electricity, lighting, and mandis (Angel et.al., 2023). These services must be extended to the newly developed areas, often resulting in increased costs and strain on existing infrastructure. Additionally, emergency services such as ambulances and fire protection must be strategically located to meet response time objectives, which may require additional medical facilities, fire stations, and vehicles.

Schools also play a crucial role in urban infrastructure, as they are designed based on factors such as the maximum walking and transportation distances that students can safely traverse and the typical teacher-to-student ratio (Ramaiah & Avtar, 2019). Similarly, police infrastructure must be planned based on staffing ratios and emergency response time objectives, which are often tied to both population and municipal growth (Regoeczi & Parks, 2010).

In addition to these essential services, parks and open spaces are also important elements of urban infrastructure. As more land is converted to urban uses, minimum population standards are established for these spaces, which are more tied to population increase and have an impact on urban form (Ramaiah & Avtar, 2019).

The development cost of a housing unit is influenced by several factors such as land costs, infrastructure expenses, and construction costs. Infrastructure costs, in particular, are a major concern for local governments and authorities. In many cases, these costs are borne by the public sector, and the expenses associated with infrastructure provision can be significant (Gurran et al, 2009).

Studies have shown that infrastructure costs per housing unit can vary significantly depending on the type of development and location. For example, a study conducted in the United States found that infrastructure costs for new single-family homes in suburban areas can be up to three times higher than those for new multifamily homes in urban areas (Kellett et al, 2019). Another study conducted in Australia found that the cost of providing infrastructure for new greenfield

developments (i.e., undeveloped land) was significantly higher than for infill developments (i.e., developed land) (Hamilton & Kellett, 2017).

Moreover, it has been noted that the cost of providing infrastructure in urban areas is generally higher than in rural areas due to higher population densities and the need for more complex infrastructure systems (Tang et al, 2008)). In addition, the cost of providing infrastructure in areas with challenging terrain or environmental conditions (e.g., flood-prone areas, earthquake-prone areas) is often higher due to the need for specialized design and construction techniques.

It is also important to note that infrastructure costs are not only influenced by the type and location of development but also by the policy and regulatory frameworks in place. For instance, some local governments provide incentives for developers to build in certain areas or to use certain building materials, which can affect the cost of infrastructure provision (Gurran et al, 2010). Similarly, regulations related to environmental protection, historic preservation, and accessibility can also increase the cost of providing infrastructure.

2.5. Financial Impact of Sprawl and Smart Growth Initiative

Cities are using smart growth policies to combat urban sprawl, putting an emphasis on density, diversity, and design to encourage compact, walkable communities and effective transit systems (Ewing et al., 2019). Cities that implement smart growth strategies can maintain a balance between urban expansion and preservation of their economic, social, and environmental well-being (Ewing et al., 2019). The success of these strategies is dependent on the unique context of each city and requires continuous adaptation and evaluation to ensure long-term sustainability.

Cities around the world have been experimenting with various smart growth strategies to tackle urban sprawl and promote sustainable development. For example, Curitiba, Brazil, has implemented a successful Bus Rapid Transit system that has improved transportation efficiency and reduced air pollution (Cervero, R., et al. 2020). Similarly, Barcelona, Spain, has implemented a Superblock system that promotes pedestrian and cyclist-friendly streets by transforming small clusters of city blocks into urban parks (Litman, 2019).

To estimate the financial impact of sprawl, Osman and his team developed a conceptual framework that considers the costs associated with different aspects of sprawl development. These costs

include infrastructure costs, transportation costs, and social costs such as increased crime rates and reduced public health. The framework also considers the potential benefits of compact, sustainable urban development, such as reduced transportation costs and increased environmental quality (Osman et al., 2009).

Studies have found that sprawl development can have significant negative impacts on society, including increased traffic congestion, reduced air and water quality, and decreased public health and safety (Ewing & Hamidi, 2015; Renne, 2019). Furthermore, sprawl development can have long-term economic costs, such as increased infrastructure maintenance and replacement costs and reduced property values (Ewing & Hamidi, 2019).

In contrast, compact, sustainable urban development has been shown to have numerous benefits, including reduced transportation costs, increased public health and safety, and improved environmental quality (Ewing & Hamidi, 2015; Renne, 2019). Additionally, compact urban development has been shown to increase property values and promote economic growth (Ewing & Hamidi, 2015).

The challenges facing Pakistan's urbanization are further compounded by the country's agricultural policies and reliance on foreign aid for infrastructure development. Despite the fact that more than 70% of Pakistan's population lives in urban areas, the mythical notion that Pakistan is an agricultural nation directs resources and subsidies into rural areas (Haque, 2014). This has resulted in a lack of investment in urban infrastructure and services, hindering the ability of cities to meet the necessities of urban life.

To address these challenges, a smart growth initiative has been proposed as a possible solution. Smart growth is a comprehensive approach to urban planning that emphasizes compact, mixed-use development, public transportation, and the preservation of natural and cultural resources (Ewing, 2019) By promoting compact, mixed-use development, smart growth can reduce sprawl and associated infrastructure costs, while also promoting economic development and social equity.

2.6. Best Practices for Controlling Urban Sprawl and Reducing Infrastructure Costs

In addressing the challenges of urban sprawl, the study conducted by Dr. Naeem and his fellows offers pertinent insights into the specific context of the Greater Kuala Lumpur region. By

examining factors driving urban sprawl and assessing the effectiveness of policies promoting compact development, the research provides valuable parallels to the issues faced in our own urban landscape. Through a meticulous review of policy documents and interviews with stakeholders, (Naeem et al., 2016) uncovers critical drivers of sprawl, including the availability of affordable land on city outskirts and the absence of growth limit boundaries. Moreover, the study highlights commendable initiatives by planning agencies to foster more sustainable urban environments. Incorporating findings from this study into my thesis enriches the discourse on urban development strategies, offering practical strategies for addressing sprawl and promoting compact, livable cities.

This following discussion provides an in-depth overview of best practices aimed at controlling urban sprawl, achieving compact development, and ultimately reducing the costs associated with providing and maintaining public utility infrastructure. These practices offer a sustainable and efficient approach to urban development.

1. **Urban Growth Boundaries:** Urban growth boundaries are geographic limits imposed by local governments to confine urban development within defined areas. This practice, effectively implemented in Portland, Oregon, helps control growth, preserve rural lands, and encourage sustainable urban development. It is substantiated by sources such as Nelson et al. (2018) and Oregon Metro (2021).

2. **Mixed-Use Zoning:** Mixed-use zoning allows various types of land uses, such as residential, commercial, and recreational, within the same area. This practice promotes walkability, reduces automobile dependency, enhances social interaction, and minimizes travel distances. Litman (2019) provide valuable insights into the benefits of mixed-use zoning.

3. **Transit-Oriented Development (TOD):** TOD involves designing communities around transit hubs, encouraging residents to use public transportation. This practice reduces car ownership, long commutes, increases accessibility, and minimizes urban sprawl. Sources supporting TOD include Calthorpe & Fulton (2001).

4. **Land-Use Density:** Increasing population and development density within urban areas is a sustainable practice. It fosters efficient land use, encourages mixed land uses, and reduces travel distances. Ewing (2010) and Renne (2015) have conducted research in this area.

5. **Brownfield Redevelopment:** Brownfield redevelopment focuses on reusing and redeveloping previously contaminated or abandoned sites. This practice reclaims underutilized land, conserves open spaces, reduces urban sprawl, and infrastructure expansion. Ghose (2003) and Roberts et al. (2010) support the effectiveness of brownfield redevelopment.

6. **Green and Open Spaces:** Designing parks, green belts, and open spaces within urban areas enhances the quality of life, promotes recreation, and preserves natural habitats. This practice also attracts residents and businesses to urban centers. Crompton (2001) and Wolf (2008) discuss the value of green and open spaces.

7. **Compact Infrastructure:** Concentrating infrastructure investments within existing urban areas is an efficient approach. It reduces the need for new infrastructure development and maintenance, promotes the efficient use of utilities and public services. Ewing (2008) provides insights into the benefits of compact infrastructure.

8. **Pedestrian and Cycling Infrastructure:** Creating pedestrian-friendly streets and cycling networks encourages active transportation, reducing car reliance and infrastructure demand. This practice improves public health, air quality, and community well-being. Dill & Carr (2003) and Pucher & Dijkstra (2003) are key sources that support this practice.

These practices include implementing urban growth boundaries to restrict expansion, encouraging mixed-use zoning, fostering transit-oriented development, increasing land-use density, redeveloping brownfields, creating green spaces, concentrating infrastructure, and enhancing pedestrian and cycling infrastructure. Each practice is supported by well-documented research and case studies, offering a holistic approach to urban development that ensures cost-efficiency, sustainability, and improved urban living conditions.

2.7. Research Gap regarding estimation of Financial Cost of Sprawl in Lahore

The literature on urban sprawl in Lahore has explored various facets, including land use changes, environmental consequences, and urban growth patterns (Fahad et al., 2021; Jaffar & Malik, 2019; Sadiq et al., 2019). However, there's a noticeable research gap concerning the quantification of

financial costs linked to urban sprawl in the city, especially within a regional and local framework. While some studies have acknowledged the higher infrastructure costs in sprawling districts (Makarewicz et al., 2005), there is limited research dedicated to precisely estimating the financial costs of providing public facilities in Lahore.

Understanding the opportunity cost of urban sprawl in terms of public facility provision is crucial for policymakers and urban planners to allocate resources effectively (Makarewicz et al., 2005). Local and regional investigations into the specific financial implications of urban sprawl in Lahore are necessary for prioritizing investments and developing strategies for managing growth and promoting sustainable development tailored to the city's unique circumstances.

The absence of research on the financial costs of urban sprawl within a local and regional context is a research gap that demands attention. Future studies should employ methodologies that capture the regional and local nuances of these financial costs, helping policymakers make informed decisions and fostering more sustainable and cost-effective urban planning policies tailored to Lahore's specific challenges.

(Makarewicz et al., 2005). This information can then inform decision-making processes and help guide the development of more sustainable and cost-effective urban planning policies.

To bridge this research gap, future studies could employ methodologies that capture the financial costs of urban sprawl in Lahore. This may involve assessing the direct and indirect costs of infrastructure provision, maintenance, and service delivery in sprawling areas (Makarewicz et al., 2005). Additionally, considering the differential costs between compact and sprawling development patterns would provide valuable insights into the financial benefits of more efficient urban growth.

Chapter 3

Research Methodology

3.1. Conceptual Framework

The financial impact of urban sprawl has been extensively studied and has been shown to have numerous negative effects on society and the economy. The development of a conceptual framework for estimating the costs and benefits of sprawl development is a crucial step towards promoting sustainable, compact urban development and reducing the negative impacts of urban sprawl. The conceptual framework for estimating the financial impact of urban sprawl in Lahore, presented here, is adapted and tailored to the specific context of this study. It is developed based on a modified version of the framework proposed by Osman et al. (2009) to suit the research objectives and focus on Lahore's urban sprawl. This framework serves as a structured guide for comprehending the financial costs associated with urban sprawl, assessing the impact on public utilities, and guiding decision-making (see Figure 3.2.1 and 3.2.2).

The greater financial costs that must be borne, mostly via expenses associated to the unplanned physical growth, are fundamental to the negative effects of sprawl. Based on four (4) strategic steps—sprawl identification, measurement, decision, and financial analysis—a framework for comprehending sprawl and its financial cost in the context of a developing country—in this case, Malaysia—is proposed.

This framework compares the financial costs of development un sprawl and a planned strategy Fig. 7. The approach would give a systematic perspective on estimating the costs of development under both a planned strategy and uncontrolled sprawl. In Stephenson et al. (2001), the total cost of local government is used to calculate the cost of sprawl. By dividing the number of people served by the per capita cost of serving the population, one may compute the overall cost of government. Demographics, service standards, and the geographical features of growth can have an impact on the per capita cost of delivering services. Numerous services, including education, police protection, water, sewage, parks, roads, and recreation, are frequently offered by municipal governments. The link between local government expenses and the regional distribution of development is essentially depicted in the picture below (Figure 8).

3.2. Graphical Illustration of Conceptual Framework

Stage 1: Identification of Sprawl

In the first stage, the framework identifies and defines urban sprawl in the context of Lahore, Gaju Mata. This involves an extensive literature review of urban sprawl definitions, characteristics, and implications, both internationally and regionally. The review is adapted to incorporate local factors and dimensions unique to Lahore, population growth and structural changes, ensuring the definition aligns with the study's specific objectives.

Stage 2: Measurement Indicators for Sprawl

The second stage focuses on selecting relevant indicators to measure urban sprawl within Lahore's boundaries. These indicators include density, population growth, and built-up area. By adopting these indicators, the framework can quantify and assess the extent and impact of sprawl in Lahore while considering the local context.

Stage 3: Decision-Making

The third stage centers on decision-making regarding urban development in Lahore. It involves an analysis of the financial implications of sprawl development, considering Lahore's unique circumstances. The analysis primarily focuses on the impact of sprawl on public utilities, with a particular emphasis on urban infrastructure.

Stage 4: Financial Analysis

The fourth stage of the framework delves into the financial analysis that quantifies the financial impact of sprawl development over the years.

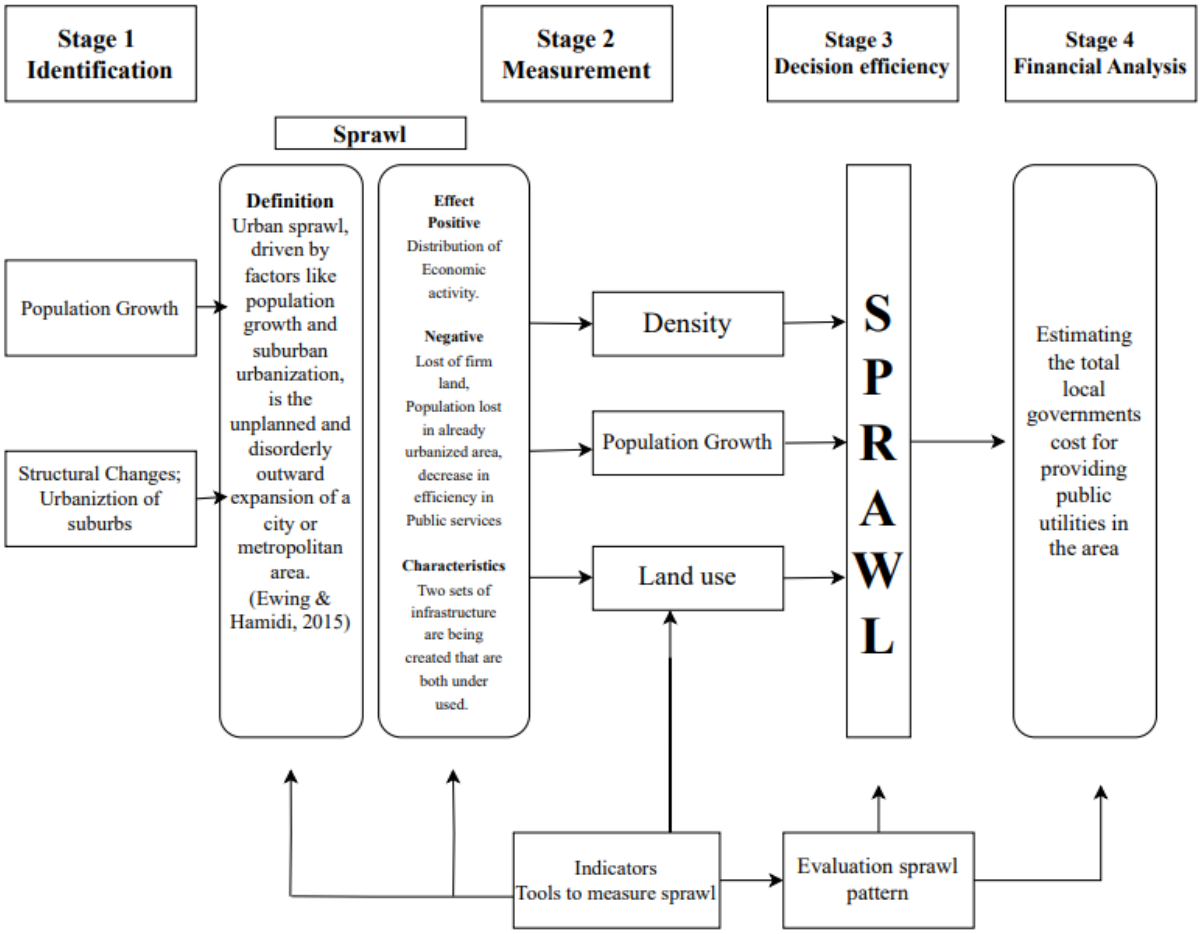

Figure 3.2.1: Graphical Illustration of Conceptual Framework, (Osman et al., 2009)

The second part of conceptual framework focuses on providing the financial analysis of providing public utilities in Gaju Mata. The methodology employed centers on estimating the per capita cost of delivering public utilities by dividing the area's total population by the cumulative local government expenditure spending on public utilities. This method enables a thorough and comprehensive exploration of the complex financial dynamics associated with the administration of vital public services in the study area.

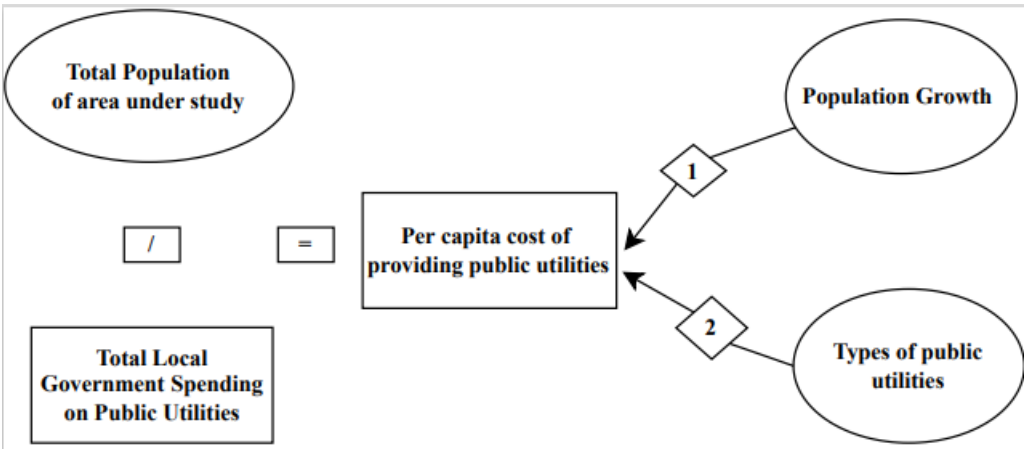

Figure 3.2.2: Graphical Illustration of Conceptual Framework (Part 2), (Osman et al., 2009)

3.3. Selection of Research Method: Qualitative and Quantitative Study

To achieve the study's objectives, a mixed method approach is being used, which involves the collection of both qualitative and quantitative data. The data is being collected through valid questionnaires, surveys, and face-to-face interviews from the relevant units of data collection. This approach enabled me to gain a comprehensive understanding of the phenomenon under study.

The research design will be descriptive and correlational. By descriptive research design this study aims to obtain relevant information to describe the phenomenon of urban sprawl. More specifically, it will help in answering the research question mentioned above. By correlational research design, the correlation between the cost of providing public utilities and the sprawl development.

Descriptive research aims to gather information and describe the phenomenon under investigation, in this case, urban sprawl. In order to accurately reflect the characteristics, behaviors, or situations of a specific subject, it includes methodically gathering data. The study's goal is to gather relevant information that will help us comprehend urban sprawl completely by employing a descriptive research design. The information will help in addressing the study's research topic.

By adopting a correlational research design, the study seeks to examine the relationship between two variables: the cost of providing public utilities and sprawl development. The strength of the relationship between changes in one variable and changes in another variable is examined by

correlational research. In this study, the research's aim's is to ascertain whether the cost of delivering public services (such water, power, or transportation infrastructure) and the growth of urban sprawl is related.

The study attempts to completely explain the urban sprawl phenomena and investigate any potential relationships between the cost of delivering public services and sprawl expansion. To do this, it combines descriptive and correlational research techniques. The descriptive component will provide with an in-depth understanding of urban sprawl, while the correlational component will explain how public utility expenses relate to sprawl's impact.

Categories	**Number of Interviews (Planned)**	**Number of interviews (Actual)**
Urban Unit GIS Experts	15	**12**
LDA Officials	08	**06**
WASA Official	07	**06**
Civil Engineers	10	**08**
PND Officials	07	**06**
LESCO Officials	02	**02**
Infrastructure Development Authority Officials	06	**05**
Total	55	**45**

Table 3.3.1: In-depth Interviews' Details

Selection criteria of In-Depth Interviewees

In-depth interviews were conducted as a part of the data collection process. The selection of interviewees was based on rigorous criteria, ensuring that the participants possessed relevant knowledge and experience to provide valuable insights into the financial impact of urban sprawl on public utility infrastructure in Lahore.

In total, 45 [1]in-depth interviews were conducted, each falling within distinct categories (see Table 3.3.1). The selection process for the number of interviews was initially planned for 55 interviews but adjusted based on practical feasibility.

The selection process for these interviews was thoughtfully designed to provide a comprehensive understanding of the financial costs per household in Gajju-Matta and the overall cost of Ichra. The process began with a thorough analysis of urban management stakeholders in Lahore. Various authorities and technical engineers responsible for financial assessments of utility provisions were chosen based on their expertise, direct involvement, and knowledge of financial intricacies.

By selecting interviewees from diverse authorities, the process aimed to capture a broad spectrum of perspectives within Lahore's urban management landscape. In essence, the selection process was carefully calibrated to ensure a holistic understanding of financial implications at the household level in the region.

Category	Respondents' Profiles
Urban Unit GIS Experts	Professionals with expertise in Geographic Information Systems (GIS) and urban planning. Familiarity with spatial data analysis and mapping techniques. Experience in analyzing urban development patterns and infrastructure planning
LDA Officials	Officials from the Lahore Development Authority (LDA) with more than 10 years' experience, responsible for urban planning and development in Lahore. Experience in overseeing infrastructure projects and assessing their impact on urban growth
WASA Official	Officials from the Water and Sanitation Agency (WASA), involved in water supply and sanitation services in Lahore. Understanding of water infrastructure systems and management

[1]The field data for this study was collected through in-depth interviews with urban experts. During these interviews, experts estimated the per unit cost of the utilities under study based on the material costs of the year 2023. They referred to official documents and used utility specifications, such as road classes and public building specifications, to calculate these costs.

Civil Engineers	Professionals with a background in civil engineering having knowledge of infrastructure design, construction, and maintenance.
PND Officials	Officials from the Punjab Planning and Development Department (PND)of grade 19 responsible for development planning in the province. Understanding of urban development policies, regulations, and strategies. Experience in coordinating and monitoring infrastructure development projects.
Infrastructure Development Authority Officials	Officials from the Infrastructure Development Authority responsible for infrastructure planning and development in Lahore. Knowledge of infrastructure planning, including transportation, utilities, and public amenities. Experience in managing infrastructure projects and assessing their impact on urban development.

Table 3.3.2: Respondents' Criteria

The research methodology employed a two-fold approach, combining secondary data analysis and expert interviews to comprehensively understand the financial costs of urban sprawl on public utility provision in Lahore.

The primary data collection phase involved soliciting quantitative estimations from experienced engineers with in-depth knowledge of urban development and public utility provision. The extensive dataset provides valuable insights into the changing economic landscape of urban sprawl over the years, which helps quantify the financial implications. [2]This quantitative data adds a novel dimension to the research, offering fresh perspectives on the evolving costs of infrastructure and public utility provision.

In parallel, qualitative insights were sought from the same respondents through a structured questionnaire. The questionnaire, although broad in scope, was meticulously designed to gather expert opinions on the complexities and challenges associated with public utility provision in sprawling urban areas. These qualitative responses provide a nuanced understanding of the real-

[2] With the help of this data, we estimated the per unit cost of providing public utilities by averaging these values while accounting for population growth and inflation.

world issues faced in the field, offering qualitative data that supplements the quantitative estimations.

This combined methodology ensures that the research benefits from the depth of expert knowledge while also introducing quantitative figures that complement the existing literature. As a result, the study can provide a holistic view of the financial costs of urban sprawl on public utility infrastructure in Lahore, ultimately contributing to more informed policy recommendations.

In conclusion, the conceptual framework has been adapted to focus on Lahore's specific context and objectives while providing a structured approach to analyze the financial impact of urban sprawl. The selection of interviewees, though initially planned for a larger number, was revised based on practical considerations, aligning with the research's needs and criteria for diversity among the participants. This framework forms the backbone of the study, guiding the analysis of urban sprawl's financial costs and implications on public utilities in Lahore.

Chapter 4

Urban Sprawl: Impacts, Costs, and Smart City Solutions

Urbanization, a global trend that is characterized by the quick growth of urban areas. Global policymakers are dealing with the challenging issue of properly regulating increasing urban sprawl and minimizing its effects on critical infrastructure and services. Pakistan, like many other nations, also dealing with the difficulties of managing urban growth. According, to the United Nations, Pakistan's urban population is expected to reach 118 million by 2050, placing significant stress on the country's infrastructure and services (UN Population Division, 2017).

In Pakistan, the urban policy has been dominated by housing and automobiles since 1960s. This approach has led to urban sprawl. As a result, there is a significant unmet demand for urban services, and private-sector investments are readily available to finance such activities (Haque, 2014). The Garden City Approach or Land Scaling Approach has also contributed to urban sprawl, increasing societal inequality and limiting opportunities for the youthful labor force.

Additionally, Pakistan's economy relies heavily on foreign aid, which is often used for road construction, but the country is also known for its agricultural sector, which receives a significant number of resources and subsidies. Despite this, the majority of the population lives in urban areas, which are struggling to meet the needs of their residents. In order to meet the demand of housing, these people often look for cheap housing which led them towards the housing facilities available outside the city’s limit.

In addition, the linear approach to development has made Pakistani cities highly energy-intensive, with a significant unmet demand for basic urban services. However, a smarter, more sustainable approach to urban development, such as the smart growth initiative; comprehensive planning techniques and policies that support walkable, accessible, well-designed, compact, and sustainable urban development patterns that effectively use resources and land while preserving natural areas, could help address these issues and ensure that cities in Pakistan are able to provide for the needs of their residents in a more equitable and efficient way.

Studies have shown that communities that experience unplanned urban expansion incur costs that are nearly 10% to 14% higher in terms of commuting times, constructing urban infrastructure, and delivering public services (Comment, L.S.E., 2015). Thus, urban sprawl has a significant impact on the demand for utilities. As cities expand into surrounding areas, the need for infrastructure and utility services grow exponentially. The construction of new residential and commercial developments necessitates the installation of utility lines, water and sewer systems, electrical grids, and more. This expansion increases the length and complexity of utility networks, requiring additional resources and investments to ensure reliable service delivery.

Urban sprawl often leads to low-density development patterns, resulting in larger distances between buildings and neighborhoods. This spread poses challenges for utilities, as they must cover greater areas, leading to increased transmission and distribution losses and higher costs (Frank et al., 2005). The demand for utilities in sprawling areas can be inconsistent, with underutilization in some areas and overwhelming demands in others, affecting overall efficiency (Ewing 2008). Moreover, urban sprawl strains water resources by reducing natural infiltration, increasing stormwater runoff, and placing additional stress on water treatment facilities.Water demand is also higher in sprawling areas, further impacting water supply and infrastructure requirements.

4.1. Negative Impacts of Sprawl

Urban sprawl entails several negative consequences, including increased environmental degradation, higher infrastructure costs, social isolation, and dependence on automobiles. Understanding these impacts is essential for effective urban planning and policymaking to mitigate the adverse effects of sprawl.

To address the negative impacts of urban sprawl, cities around the world are implementing various strategies to promote more sustainable development patterns. One approach is to encourage the development of compact, walkable neighborhoods that provide access to essential services and amenities. This approach aims to reduce the reliance on automobiles and promote active transportation, such as walking and cycling, which can have positive impacts on public health and the environment.

Another strategy is to improve the public transportation system, making it more accessible and affordable for residents. By providing efficient public transportation options, cities can reduce the number of cars on the road, decreasing traffic congestion and air pollution. Also, many cities are implementing policies to protect natural areas, such as parks and green spaces, from development.

Overall, addressing the challenges of urban sprawl requires a comprehensive approach that considers the economic, social, and environmental impacts of urban development. By promoting sustainable development patterns and reducing reliance on automobiles, cities can improve the quality of life for their residents while also protecting the environment for future generations.

4.2. Challenges in analyzing the costs of infrastructure.

Urban infrastructure is essential to support the functioning and growth of cities, and it encompasses a wide range of services and facilities. The typical urban infrastructure includes transportation systems, such as roads, highways, and public transportation, which enable people to move around the city. Parks and public squares provide spaces for recreation and community gathering, while utility services, such as water, wastewater, stormwater, and solid waste management, ensure the provision of basic needs. Power services are essential for both residential and commercial buildings, and community services like emergency services, public health, and social services help ensure the safety and wellbeing of city residents.

However, there are several challenges associated with analyzing the costs of infrastructure provision in diverse development situations. One major challenge is the changing urban context of cities, which can influence the types of housing units that are in demand. For instance, infill areas may have a higher concentration of apartment dwelling types, while suburban edge projects may see a preference for detached homes. In these cases, the costs of infrastructure and building will be very different and impossible to compare. Urban sprawl poses significant challenges to achieving sustainable development goals, particularly in the context of SDG 11, which emphasizes the importance of building sustainable cities and communities. The unchecked expansion of cities into surrounding areas leads to a host of sustainability issues, including increased demand for resources and strained infrastructure.

In addition, there may be significant variation in the sociodemographic variables of different areas, which can further complicate efforts to analyze infrastructure costs. Moreover, there may be

differences in record-keeping and accounting processes across different municipalities, making it difficult to standardize the analysis of infrastructure costs (Hamilton & Kellett, 2017).

To overcome these challenges, some international municipalities maintain cost databases in terms of per capita and some in terms of per housing unit. By changing the unit of analysis, it is possible to better compare infrastructure costs across different areas and housing types. However, there is still a need for further research in this area to develop more standardized methods for analyzing infrastructure costs and to better understand the factors that influence these costs.

Overall, the costs of infrastructure provision are an important consideration for policymakers and urban planners, as they can have a significant impact on the development of cities and the affordability of housing for residents. By better understanding the factors that influence these costs, it is possible to develop more effective policies and strategies for managing urban growth and ensuring the sustainability of cities over the long term.

4.3. Understanding and Estimating Financial Cost of Sprawl

Urban sprawl and its financial costs have been the subject of numerous studies and research in the field of urban planning and development. A framework for understanding and estimating the financial costs of sprawl was proposed by Osman et al. (2009) in the context of a developing country, Malaysia. The framework consists of four strategic steps:

1. Sprawl identification,
2. Sprawl measurement
3. Decision
4. Financial analysis.

By comparing the financial costs of development under both a planned strategy and uncontrolled sprawl, the approach provides a systematic perspective on estimating the costs of development.

Osman et al. (2009) used the total cost of local government to calculate the cost of sprawl. They divided the number of people served by the per capita cost of serving the population to compute the overall cost of government. The per capita cost of delivering services can be affected by demographics, service standards, and the geographical features of growth. Municipal governments often provide numerous services, including education, police protection, water, sewage, parks,

roads, and recreation. The link between local government expenses and the regional distribution of development is depicted in Figure 8.

The financial costs of sprawl have been found to be substantial in many studies. For example, Litman (2011) estimated that urban sprawl costs the United States around $1 trillion annually in various expenses, such as infrastructure, transportation, and environmental impacts. In addition, public parks are much more expensive to deliver in the case of sprawl compared to alternative growth patterns, according to numerous studies (Ewing et al., 2010;).

It is important to note that the financial costs of sprawl are not the only negative effects associated with this development pattern. Other costs include social costs, such as decreased social capital and community cohesion, and environmental costs, such as loss of natural habitats and increased pollution (Bhatta,2010). Therefore, it is essential to consider the full range of costs and impacts when evaluating the benefits and drawbacks of different development strategies.

Overall, the financial costs of sprawl are a significant consideration in urban planning and development. Understanding and estimating these costs can provide valuable insights into the trade-offs between different development strategies and can inform decision-making towards more sustainable and efficient urban growth. To address the challenges posed by urban sprawl, data-driven decision-making becomes crucial. However, collecting accurate and comprehensive data on the impacts and extent of urban sprawl can be challenging, especially in developing countries where data collection systems may be weak. Without reliable data, it is difficult for policymakers to identify and prioritize issues, hindering effective urban planning and management.

4.4. Smart cities as a solution for urban management

The concept of smart cities has emerged as a potential solution to some of the challenges facing urban management, as it can utilize technology and data to improve efficiency and sustainability. However, it is essential to implement smart cities in an inclusive and equitable manner to avoid exacerbating existing social and economic inequalities (Ziosi et al., 2022). Moreover, the development of sustainable infrastructure in cities can not only contribute to achieving sustainable development goals but also generate significant economic benefits, as highlighted by the Global Commission on the Economy and Climate (2018).

A possible solution to the problem of urban sprawl is the implementation of smart growth policies, which aim to create more compact and walkable communities while preserving open space and natural resources. Smart growth policies have been implemented successfully in numerous cities worldwide, resulting in economic, environmental, and health benefits. In Lahore, the implementation of smart growth policies could help to combat the negative consequences of urban sprawl while promoting a more sustainable and healthier city.

To achieve SDG 11 and build sustainable cities and communities, policymakers and urban planners are trying toadopt a holistic approach that considers economic, social, and environmental factors. Sustainable infrastructure, sustainable transportation, affordable housing, natural resource protection, and the integration of marginalized communities are all crucial components of this approach. In addition, the use of data and technology can help policymakers and urban planners make informed decisions about urban planning and management, and ensure that smart city initiatives benefit all residents, not just a select few.

However, it is important to note that the implementation of sustainable practices and smart city initiatives may face challenges, particularly in developing countries where data collection and infrastructure may be weak. Therefore, capacity building and knowledge transfer are crucial to support policymakers and urban planners in adopting sustainable practices and implementing smart city initiatives effectively (UNECE, 2020).

Lahore's rapid urbanization presents both opportunities and challenges. While it contributes to economic growth and development, it also leads to environmental degradation, social inequality, and other negative externalities. Therefore, it is crucial to adopt smart growth strategies and policies that promote sustainable urban development in Lahore.

Chapter: 5

Managing urban growth in Lahore

Managing urban growth in Pakistan is a complex task that requires careful consideration of the country's unique economic, social, and political context. Despite the challenges, there is an opportunity to adopt smart growth principles and promote sustainable and equitable urban development.

5.1. Background of Lahore

Punjab's capital city, Lahore, is the second-largest metropolitan area in Pakistan. Numerous historic buildings, gardens, and monuments are in the city. Originally a walled city under Mughal control (1524–1752) and British colonial administration, the city has developed into a major center for trade and business in the area. Lahore has a vast history dating back more than 2000 years and is referred to as the "cultural heart of Pakistan." The Mughal Empire had previously dominated the city, which afterwards fell under the control of the British Regime in the Indian Subcontinent. Near the shared eastern border with India, Lahore City joined the Islamic Republic of Pakistan after the country's declaration of independence. The city features a variety of architectural structures, including mosques, churches, temples, tombs, parks, and gardens, all of which draw tourists. The walled city, along with the nearby urban and sub-urban districts, predominantly to the south and southeast, now make up the city, which has expanded greatly. It is presently a thriving metropolis with a wide range of business and trade prospects; the city is developing into a center for the technology industry in the country. The city's gross domestic product (GDP) by purchasing power parity (PPP) was estimated at $84 billion in 2019 (PwC, 2019). These developments, however, are instigating pressure on urban administrations for providing infrastructure facilities. Lahore has nearly doubled in size over the past 14 years, although it is still the 42nd most populated city in the world. Lahore District has been designated a metropolitan area and divided into nine zones under the Local Government Act of Punjab, 2013, including Ravi Zone, Shalimar Zone, Aziz Bhatti Zone, Data Gunj Bakhsh Zone, Samanabad Zone, Gulberg Zone, Wahga Zone, Allama Iqbal Zone, and Nishtar Zone. A substantial road network connects the city, providing easy access.

According to the provincial highway authority, there are around 1265 km of highways in the city (Punjab Bureau of Statistics, 2015).

The city's Excise and Taxation Department registers almost 4 million automobiles. The Metro bus system, vans, taxis, and rickshaws are the primary modes of public transportation. There isn't a metropolitan rail network yet to make local commuting easier.

5.2. Urbanization in Lahore

An official of urban unit has quoted that:

"*The built-up area has doubled between 1999 and 2022, and it is anticipated to continue to increase at a similar or even faster rate. This would put more pressure on the municipal administration to manage infrastructure and squatter settlements."*

Problems including the absence of integrated urban development policies, unrestrained urban growth, overlaps in the purview of land regulating entities, and inefficient building regulation make the situation worse. However a representative of LDA has claimed that:

"Despite recent progress (such as the improvement of commuting options through the Metro and Orange Line transportation systems and the restoration of the walled city), Lahore still requires dynamic and structured institutions with technical, legal, and regulatory support for managing the city's constantly growing population".

Lahore, like many other rapidly growing cities, has a complex and evolving land-use model that reflects a mix of historical patterns, market forces, and government policies. A representative of urban planning department is of the view that:

"*At present, the city's land-use model is characterized by a mix of different land uses, such as residential, commercial, industrial, and institutional uses, which are often scattered throughout the area of Gajju Matta . However, this model has led to the proliferation of low-density, automobile-oriented developments that are disconnected from each other and lack access to key services and amenities. This has resulted in significant negative impacts on the environment, public health, and social equity, including increased traffic congestion, air pollution, and urban sprawl."*

There is currently no comprehensive land-use plan in Lahore that is based on the principles of New Urbanism which is an approach to urban design and planning that seeks to create livable and sustainable communities by focusing on human-scale development, compact and connected neighborhoods, walkability, and mixed-use development. Some of the key principles of New Urbanism include creating walkable neighborhoods that are designed for people, not just cars, promoting a mix of housing types and affordability, providing access to public transit and services, and protecting green spaces and natural resources (Makarewicz et al., 2005).

An official of LDA has stated that

"*There are some promising initiatives under the concept of new urbanism in Lahore that are aimed at promoting more livable and sustainable communities. For example, the Lahore Development Authority (LDA) has recently launched a new master plan for the city that includes provisions for mixed-use development, pedestrian-friendly streets, and green spaces. The plan also aims to promote public transportation and reduce dependence on private cars."*

In addition, there are some private developers who are incorporating principles of New Urbanism into their projects. For example, the Lake City development on the outskirts of Lahore is a mixed-use community that features walkable streets, green spaces, and a mix of housing types. However, these examples are still relatively limited in number, and more needs to be done to promote sustainable and livable neighborhoods throughout the city. An official of Infrastructure development authority stated that:

" It is also critical to recognize that Lahore's urbanization process has been haphazard and unplanned, aggravating the problem of land utilization. The problems facing the city have gotten worse as a result of the unchecked and rapid growth of urban areas without sufficient consideration for sustainable land use practices. Inefficient land use, encroachment on agricultural land, and environmental damage are all results of this haphazard urbanization."

Efforts to promote sustainable and livable neighborhoods in Lahore require a coordinated approach involving government agencies, private developers, and community organizations Multiple studies have provided empirical evidence and analysis on the issue of land utilization in Lahore and its impact on urban growth and development. The research done on the urban growth and development of Lahore shed light on the negative consequences of such unplanned urbanization.

They draw attention to the necessity of thorough urban planning approaches that place an emphasis on sustainable land use and encourage balanced growth. It takes a more planned and coordinated strategy to address the issue of land utilization, including careful land management, zoning laws, and the incorporation of environmental issues into urban planning processes.

5.3. Review of Existing Bylaws and Regulations

5.3.1. Key Regulations

A variety of rules have been put into place by the Lahore Development Authority to address the problem of urban sprawl and encourage sustainable development in the city. The purpose of zoning regulations is to regulate how land is used by properly designating residential, commercial, industrial, and recreational sectors. To protect natural regions and act as a barrier against further urban growth, green belts and open spaces have been constructed. To preserve the aesthetic appeal of the city and limit excessive sprawl, building regulations and height restrictions regulate the size and style of structures. Congestion reduction and improved connectivity are the main goals of infrastructure and transportation development. Initiatives for redevelopment and revitalization are designed to maximize the use of land in existing urban areas Table below highlights the key regulations implemented by the authorities in Lahore to tackle urban sprawl

Review of Key Regulations		
Regulation	**Description**	**Critical Review**
Master Plan	The Lahore Development Authority (LDA) has formulated a comprehensive Master Plan that serves as a guiding document for the city's development. The plan outlines the long-term vision and strategies for managing urban growth, land use, infrastructure development, and environmental conservation. It provides a framework for sustainable and controlled expansion, promoting balanced development and preventing unplanned sprawl. The Master Plan guides the decision-making process and ensures that new developments align with the city's overall vision.	The Master Plan aligns with smart growth principles, providing a strategic framework for sustainable expansion. However, its effectiveness depends on enforcement mechanisms and adaptability to urban challenges (Fulton, 2001).
Zoning Regulations	The LDA has established zoning regulations to regulate land use and control urban growth in Lahore. These regulations designate specific areas for various purposes, including residential, commercial, industrial, and recreational. Zoning helps manage land utilization, ensuring compatible land uses and preventing haphazard development. It promotes orderly growth, optimizes infrastructure planning, and protects agricultural land and open spaces from encroachment, thus curbing urban sprawl.	Zoning regulations are essential for managing land use and curbing urban sprawl. However, their success in promoting smart growth depends on aligning with sustainable development principles (Fulton, 2001), encouraging mixed land uses, and walkable communities instead of perpetuating sprawl.

Density Controls	Authorities in Lahore have implemented density controls to manage population density and prevent overcrowding in specific areas. These controls prescribe maximum population densities, floor area ratios, and building height restrictions. By controlling densities, the authorities aim to maintain a balance between population growth and infrastructure capacity, ensuring livable neighborhoods, efficient provision of services, and minimizing strain on resources.	The implementation of density controls is vital for balancing population growth and infrastructure capacity (Ewing, 1997). However, their success in promoting smart growth depends on ensuring alignment with a broader strategy that encourages compact, pedestrian-friendly neighborhoods and well-planned transit (Cervero, 1998).
Green Belts and Open Spaces	The authorities in Lahore have designated green belts and open spaces within the city to preserve natural areas and promote environmental sustainability. These areas act as buffers, limiting urban expansion and protecting ecological habitats. The authorities focus on conserving and enhancing these green belts, creating parks, recreational spaces, and tree-lined corridors. These initiatives improve the city's aesthetics, provide recreational opportunities, and mitigate the adverse impacts of urban sprawl.	The designation of green belts and open spaces in cities is a commendable approach to curbing urban sprawl and preserving ecological habitats (Calthorpe, 1993). These areas not only enhance the city's aesthetics but also provide residents with accessible recreational opportunities, supporting the principles of smart growth.

Transit-Oriented Development (TOD)	To promote sustainable transportation and reduce reliance on private vehicles, Lahore authorities have adopted Transit-Oriented Development (TOD) principles. TOD encourages compact, mixed-use developments around public transportation corridors. By integrating land use and transportation planning, TOD aims to create walkable neighborhoods, reduce traffic congestion, and improve accessibility. The authorities prioritize the development of mass transit systems and encourage high-density, pedestrian-friendly developments near transit stations.	The emphasis on Transit-Oriented Development (TOD) principles in Lahore aims to promote sustainable transportation and reduce private vehicle reliance (Cervero, 1998). By creating walkable neighborhoods around transit corridors, cities aligns with smart growth principles, reducing traffic congestion and promoting accessibility.
Redevelopment and Revitalization Initiatives	Authorities in Lahore encourage redevelopment and revitalization initiatives in existing urban areas. These initiatives aim to optimize land use, rejuvenate deteriorated areas, and enhance the efficiency of infrastructure. The authorities promote mixed-use developments, adaptive reuse of buildings, and the revitalization of historic and cultural sites. These efforts help curb sprawl by utilizing existing urban areas effectively and promoting compact, sustainable growth.	The encouragement of redevelopment and revitalization initiatives in existing urban areas aligns with smart growth strategies (Schwab, 2000). By optimizing land use, promoting mixed-use developments, and revitalizing deteriorated areas, Lahore's authorities contribute to compact, sustainable growth.

Table 5.3.1: Review of Key Regulations

Given below is the table summarizing the key bylaws for public utilities in Lahore.

Bylaws	Description
Water Supply and Sewerage Bylaws	Regulate the provision, distribution, and maintenance of clean water supply and the management of sewage and wastewater in Lahore, ensuring efficient and sustainable delivery of water and sanitation services.
Electricity Distribution and Safety Bylaws	Govern the distribution and safe use of electricity in Lahore, defining standards for installations, connection procedures, metering, billing, and safety guidelines to ensure reliable and safe electrical supply and promote energy conservation.

Solid Waste Management Bylaws	Address the proper management, collection, and disposal of solid waste in Lahore, promoting cleanliness, waste reduction, recycling, and the establishment of waste management systems to ensure effective and sustainable solid waste management practices.
Road Infrastructure Bylaws	Regulate the planning, construction, maintenance, and use of roads in Lahore, defining standards for road design, signage, markings, traffic flow, and parking regulations to ensure safe, efficient, and organized transportation networks within the city.
Gas Connection Bylaws	Govern the installation, distribution, and safe use of gas connections in Lahore, ensuring compliance with technical specifications, safety standards, metering, billing, and addressing any related issues to ensure the efficient and safe supply of gas to consumers.
Parks and Open Spaces Bylaws	Define regulations for the establishment, maintenance, and use of parks and open spaces in Lahore, addressing aspects such as landscaping, recreational facilities, hours of operation, and guidelines for public use to promote the creation of green spaces and provide residents with accessible and well-maintained areas for leisure and community activities.
Public Markets Bylaws	Regulate the establishment, operation, and management of public markets in Lahore, covering aspects such as stall allocation, cleanliness, waste management, pricing regulations, and compliance with health and safety standards to ensure organized and safe marketplaces that meet the needs of both traders and consumers.

Table 5.3.2: Review of Key By-Laws

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Chapter: 6

Urban Growth in Gajju Matta

This chapter delves into the analysis of the built-up area of Gajju Matta in Lahore, focusing on the years 1996, 2008, and 2017. Gajju Matta, located in Lahore, Punjab, Pakistan, encompasses a total area of around 9 sq. km.

Figure 6: Sprawl Development Source: Google Earth

The built-up area is a key indicator of urban growth and offers important information on how the area has changed spatially through time. We can determine the growth trajectory of Gajju Matta and comprehend the scope and rate of urbanization by looking at the data for these particular years. The insights gained from this analysis enable us to comprehend the dynamics of urban development in Gajju Matta, paving the way for informed decision-making in urban planning, infrastructure development, and sustainable management of the built environment. This chapter attempts to provide a thorough understanding of the changing urban landscape in Gajju Matta through the analysis of the built-up area, contributing to the knowledge base on urbanization patterns in Lahore.

Gajju Matta has experienced substantial growth in its built-up area over the past two decades. In 1996, the built-up area measured 1.1 square kilometers. By 2008, it had expanded to 2.9 square kilometers, and by 2017, it further increased to 4.8 square kilometers. This growth in built-up area is likely due to a number of factors, including population growth, economic development, and urbanization. The statistics and maps used in this chapter are provided by Urban Unit Lahore.

Year	Build-up Area (Sq. KM)
1996	1.1
2008	2.9
2017	4.8
Total Area	9

Table 6: Gajju Matta's built-up area over time.

6.1. Urban Expansion of Gajju Matta in 1996

Gajju Matta's built-up area encompassed 1.1 square kilometers in 1996. By examining the available data and maps, we can gain insights into the spatial distribution of the built-up area during this period. A mixture of residential, commercial, and industrial zones made up the urban landscape, which was a representation of the various uses and activities that the urban fabric was used for.

Gajju Matta's population was projected to be around 27,000 in 1996. We can see that the population density was rather low, indicating a compact urban settlement structure, when we take into account the built-up area of 1.1 square kilometers. This shows that Gajju Matta had a compact urban core with few open spaces and available plots of land.

The Gajju Matta urban expansion map from 1996 is shown in the graph below. The map gives an illustration of the spatial extent and configuration of the built-up area during this period. By examining the map, we can gain insights into the geographical distribution and patterns of urbanization in Gajju Matta, enhancing our understanding of the urban growth dynamics.

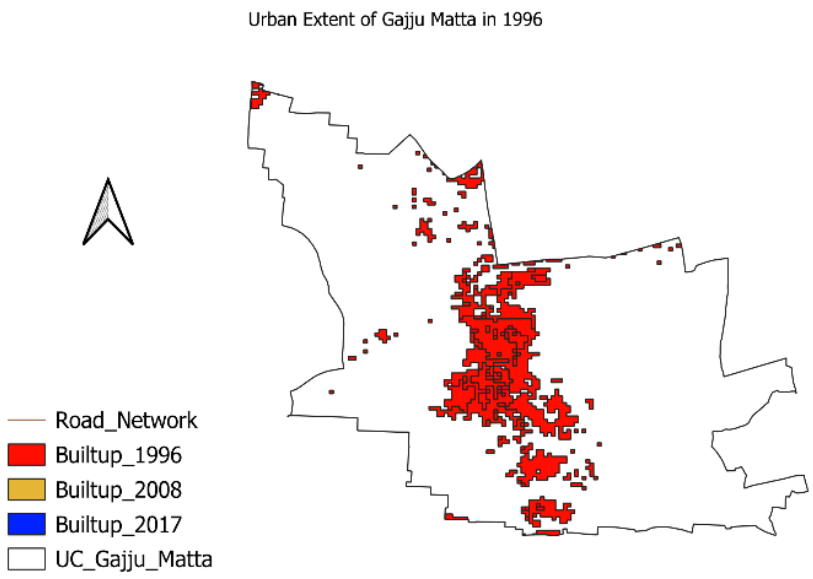


Figure 6.1: Gajju Matta's Urban Extent in 1996, Source Urban Unit

The map highlights the geographic distribution and extent of the built-up region as it depicts the urbanization of Gajju Matta in 1996. 1.1 square kilometers of the map's surface are designated as the built-up area by red colored areas. These regions show where Gajju Matta experienced concentrated urban growth and infrastructure during this particular year. The map shows that the majority of the urban growth took place in Gajju Matta's central area. In the center of the urban fabric, the built-up region is likely to be denser, gradually giving way to less densely developed areas as it moves outward.

The built-up region in 1996 is a reflection of Gajju Matta's early stages of urban growth. With just a little amount of encroachment into the nearby rural areas, it is likely that the urban expansion mostly took place within the already-existing urban fabric. This concentration of built-up area within a compact zone may indicate a centralized urban growth pattern, possibly influenced by factors such as land availability, infrastructure accessibility, and economic activities in the vicinity.

6.2. Urban Expansion of Gajju Matta in 2008

This section focuses on the urban expansion of Gajju Matta in 2008, examining the built-up area and population size during this period. By analyzing the changes in the built-up area and population dynamics, we can gain insights into the pace and scale of urbanization in Gajju Matta over the intervening years.

Gajju Matta's built-up area increased significantly from the 1996 figures, reaching 2.9 square kilometers in 2008. The rise of the built-up area is a sign of the urbanization of the locale and the gradual change in the landscape. In 1996, the population of Gajju Matta was approximately 27,000. With a population growth rate of 3.8%, the population of Gajju Matta would have been 38,340 in 2008.

Population growth from 1996 to 2008 shows a trend towards growth, which is consistent with the growth of the built-up area. The larger population size suggests an influx of residents into Gajju Matta, likely driven by factors such as economic opportunities, and employment prospects. This population growth has put a strain on the city's infrastructure, including its built-up area.

The increase in the built-up area in 2008 suggests the prospective development of new residential communities, the establishment of additional commercial centers, and the growth of industrial activities. With urbanization spreading outside of the central core noted in 1996, the built-up area's spatial distribution may have a more dispersed pattern.

The growth in the built-up area and population between 1996 and 2008 illustrates how quickly Gajju Matta's urban sprawl area has been progressed. The map below provides a visual representation of the spatial extent and configuration of the built-up area during this period. By examining the map, we can gain insights into the geographical distribution and patterns of urbanization in Gajju Matta, enhancing our understanding of the city's growth dynamics.

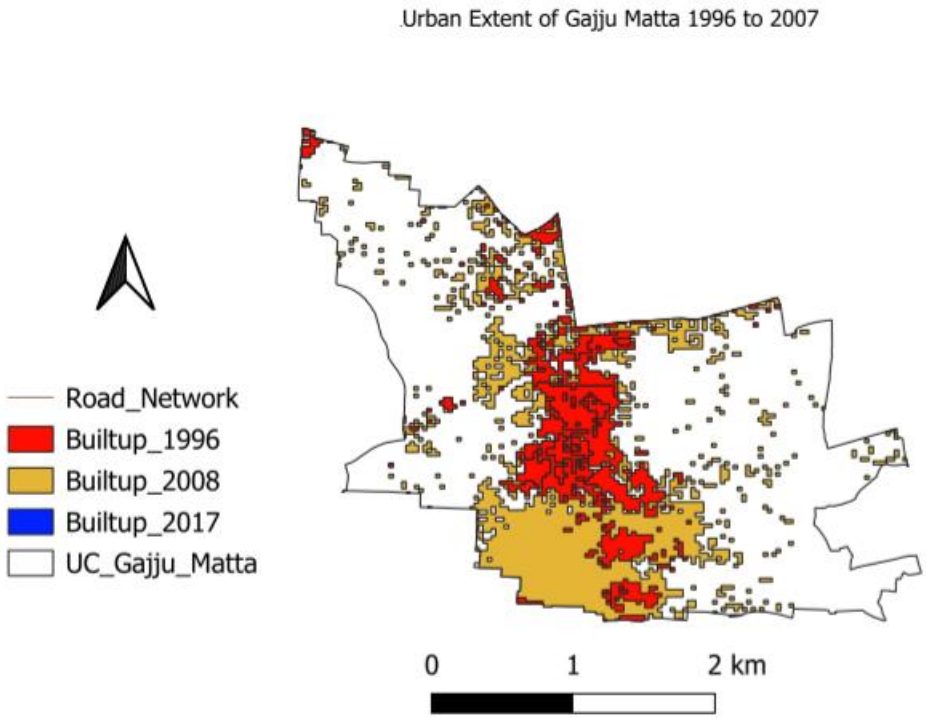


Figure 6.2: Gajju Matta's Urban Extent in 2008, Source: Urban Unit

The map illustrates the urban expansion of Gajju Matta in 2008, showcasing the spatial distribution and size of the built-up area. The yellow-colored regions on the map represent the built-up areas, covering approximately 2.9 square kilometers. This depiction highlights the concentrated urban development and infrastructure within Gajju Matta during this specific year.

On the map, we can see that the urban expansion in 2008 went beyond Gajju Matta's center, indicating that the built-up area has grown. As the city continued to grow, it's likely that new residential neighborhoods, shopping malls, and industrial areas emerged. The built-up area's spatial arrangement exhibits both heavily inhabited and less populated areas, reflecting the changing nature of the urban fabric.

6.3. Urban Expansion of Gajju Matta in 2017

This section will be focusing on the growth of Gajju Matta's urban area in 2017, looking at its built-up area, population, and growth rate at the time. We can comprehend the area's geographical development and demographic dynamics by examining changes in urbanization indices.

Gajju Matta's built-up area increased to 4.8 square kilometers in 2017, a substantial growth from the previous discussed years. The area's continuous urban growth and the extension of the urban fabric are indicated by the growing built-up area. Gajju Matta is a rapidly urbanizing. This urbanization has led to a shift from rural to urban living. This shift has put pressure on the city's built-up area, as more people are moving into urban areas.

The population of Gajju Matta has been growing steadily in recent years. This growth has put pressure on the city's infrastructure, including its built-up area. The population of Gajju Matta was 27,000 in 1996. By 2008, it had increased to 38,340. And by 2017, it had reached 63736 indicating a substantial growth rate of 3.5%.

The expansion of the built-up area and population size in 2017 indicates the sustained urbanization of Gajju Matta. The increased built-up area suggests the development of additional infrastructure, including housing, commercial facilities, and public amenities, to accommodate the growing population. The expansion of the urban fabric beyond previous boundaries demonstrates the city's evolving spatial configuration.

The map below provides a valuable visual representation of the areas's growth dynamics. By analyzing the map, we can gain a better understanding of how the area has changed over time. The expansion of the built-up area has had a significant impact on the city's landscape and its residents This understanding can be used to inform future planning decisions and to help the city to continue to grow in a sustainable way.

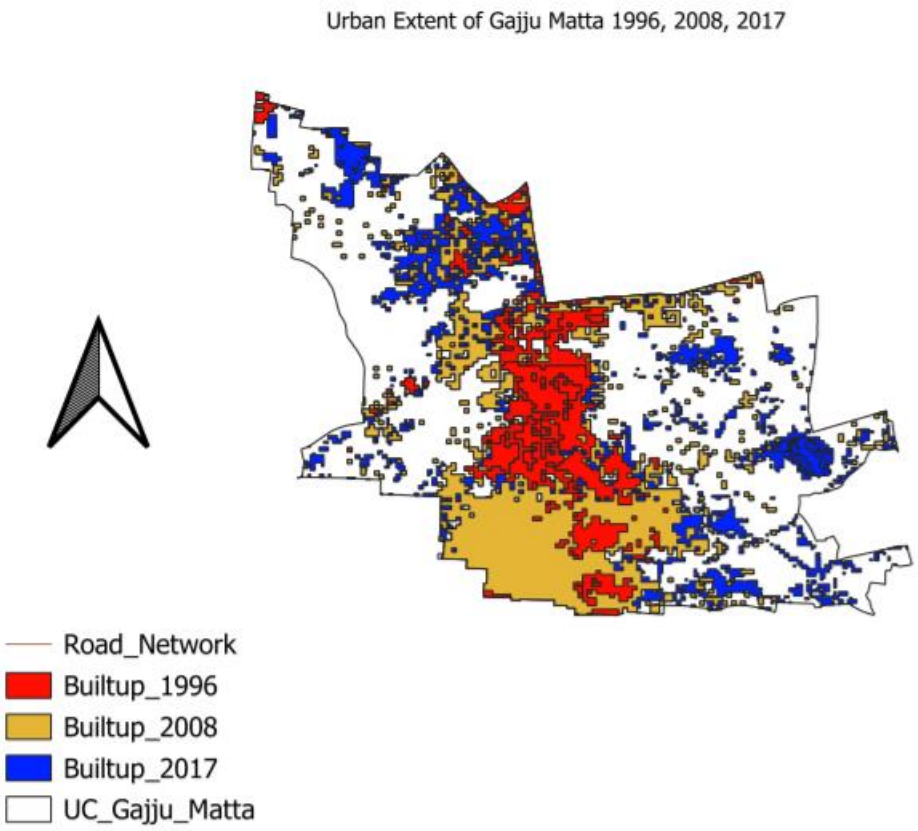


Figure 6.3: Gajju Matta's Urban Extent in 2017, Source: Urban Unit

The spatial distribution and size of the built-up area are shown on the map, which depicts the urbanization of Gajju Matta in 2017. The built-up areas, which occupy an area of around 4.8 square kilometers, are indicated on the map by the blue zones. This representation emphasizes the substantial infrastructure and urban development that took place in Gajju Matta during this particular year.

By examining the map, we notice that in 2017, the urban expansion went beyond the boundaries that had been previously set. Gajju Matta certainly experienced ongoing urban sprawl, leading to the emergence of new residential neighborhoods, shopping malls, and industrial zones. The built-up area's spatial structure shows more populous and less inhabited areas, reflecting the changing nature of the urban fabric.

6.4. A Comparative Analysis of Urban Expansion in 1996, 2008, and 2017

This section will analyze Gajju Matta's urban sprawl and growth by comparing the urban extent areas in 1996, 2008, and 2017. The spatial distribution and growth patterns of the city over this time are depicted visually on the map given below.

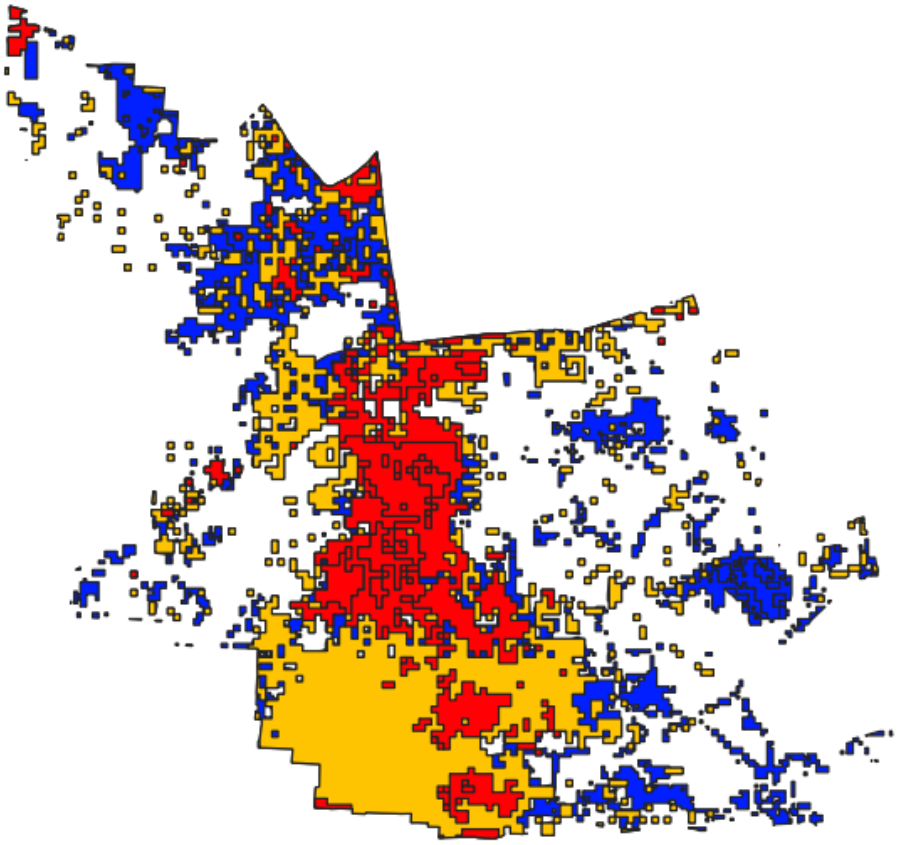


Figure 6.4: Comparative Analysis of Urban Expansion in 1996, 2008, and 2017

By examining the map, we can gain insights into the evolution of Gajju Matta's urban landscape, including the compactness of the urban area in 1996, the expanding urban sprawl in 2008, and the increased density beyond the 2008 limits in 2017.

The map showcases the urban extent of Gajju Matta in 1996, 2008, and 2017. In 1996, the urban area is depicted by a red shade, representing a compact and limited spatial extent. The concentrated urban development is indicative of a city with well-defined boundaries and limited expansion at that time. The smaller built-up area corresponds to the population of around 27,000, reflecting the early stages of urbanization in Gajju Matta.

Moving forward to 2008, the map illustrates an expansion in the urban extent, represented by a yellow shade. This expansion signifies urban sprawl, with the built-up area covering a larger portion of the map compared to 1996. The increased built-up area corresponds to a population of around 38,340, indicating the city's growth and the arrival of more residents seeking opportunities in Gajju Matta. The urban sprawl in 2008 demonstrates the expansion of residential, commercial, and industrial zones beyond the previously established boundaries.

In 2017, the map reveals further urban expansion and increased density beyond the limits set in 2008. The urban extent is depicted by a blue shade, indicating a more densely covered area. The intensified urbanization and population growth, with a population of approximately 55,000 and a growth rate of 3.5%, contributed to the increased density. The expansion beyond the 2008 limits signifies the city's ongoing urbanization and the need for expanded infrastructure, services, and amenities to cater to the growing population.

The comparative analysis of the urban extent maps highlights the evolving nature of Gajju Matta's urban landscape. The transition from a compact urban area in 1996 to expanded urban sprawl in 2008 and the subsequent increased density in 2017 signifies the area’s growth, development, and challenges associated with managing urban expansion. The expansion of residential, commercial, and industrial areas reflects the dynamic nature of Gajju Matta's urban fabric, demanding comprehensive urban planning, infrastructure development, and efficient provision of public utilities.

6.5 Comparative analysis of Population Density in in 1996, 2008, and 2017

In the case of Gajju Matta, a comparative analysis of population density over the years 1996, 2008, and 2017 provides invaluable insights of urban sprawl on population concentration.

Year	Population Density (people/sq km)
1996	24,545
2008	13,200
2017	11,458

Table 6.5.1: Gajju Matta’s Density over time

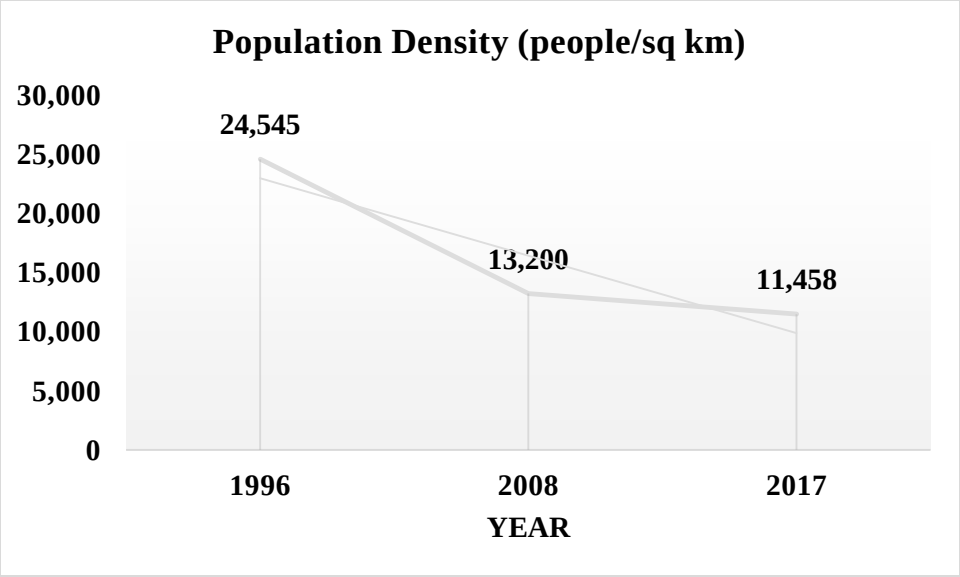


Figure 6.5.1: Gajju Matta's people per square km

Population density is computed using the fundamental formula for population density, which involves dividing the population of the area by its corresponding land area. In 1996, Gajju Matta exhibited a relatively compact urban landscape with a population density of approximately 24,545 people per square kilometer.

According to an official of urban unit

"The urban area in 1996 was delineated by well-defined boundaries, reflecting the early stages of urbanization in the region and a limited spatial extent. This compactness was indicative of a city that had yet to experience significant expansion."

However, in 2008, the population density declined to approximately 13,200 people per square kilometer as the urban extent expanded. Urban sprawl led to the enlargement of the built-up area, with the population growing to around 38,340. This expansion signaled the arrival of more residents and the development of residential, commercial, and industrial areas beyond the previously established boundaries. The decline in population density was a direct impact of this urban sprawl, which brought with it the challenges of managing increased urban development and the associated strain on infrastructure and resources.

In 2017, Gajju Matta continued to witness urban expansion, resulting in a population density of approximately 11,458.33 people per square kilometer. The increased density beyond the 2008 limits was attributed to the city's ongoing urbanization, with a population of approximately 55,000

and a growth rate of 3.5%. This heightened density underlines the growing demand for infrastructure, services, and amenities to accommodate the expanding population.

The comparative analysis of population density illustrates the evolution of Gajju Matta's urban landscape from a compact area with well-defined boundaries in 1996 to a sprawling urban area in 2008 and the subsequent challenge of managing increased density in 2017. The transition highlights the dynamic nature of urban development in the region.

Chapter 7

Cost of Public Utilities in Gajju Matta

This chapter offers a comprehensive analysis of the financial impact of urban sprawl on public utilities in Gajju Matta. The findings demonstrate the strong correlation between urban sprawl and rising costs associated with road infrastructure, sewage systems, public building construction, transmission lines, street lights, and gas pipelines. These insights contribute to a more informed understanding of the challenges posed by urban sprawl on public utility provision in Gajju Matta. The research methodology employed in this chapter ensures a robust and holistic analysis of the financial implications.

7.1. The Impact of Urban Sprawl on the Cost of Public Utilities

First, the study's findings imply that Lahore's sprawl is likely to result in greater public service expenses. This is due to the fact that sprawl reduces population density, which can make it more challenging to deliver efficient public services at reasonable costs. Sprawl, for instance, result in commutes that are longer, which can increase the demand for public transit. Sprawl can exacerbate traffic congestion, making it more challenging for providing routes and local connectivity to people. Some key findings from the interviews conducted are:

- **Reduced Population Density:** Sprawl frequently causes communities to disperse, which lowers population density in certain places. Same is the case in Gajju Matta. The built area of the region has increased more than double in last ten years as per the findings of Lahore urban unit. The provision of effective public services like transportation, water supply, sewage systems, and waste management have become more difficult as a result. It becomes less cost-effective to provide these services over a larger geographic area when there is a smaller concentration of population.
- **Longer Commutes and Increased Demand for Public Transit:** Sprawl frequently results in an inconsistency between residential areas and employment centers, which increases citizens' commute times. As individuals look for alternatives to driving, which can contribute to traffic congestion and environmental challenges, longer journeys raise

demand for public transit options as well as roads. Over the period of last ten years the cost of construction of per km road has significantly increased as per the data collected. In order to accommodate these lengthier trips, more expenditures have been done on public transport systems which has incurred an additional operating cost.

- **Traffic congestion:** Without careful planning, urban area growth in Gajju Matta results in worsening traffic congestion. Low-density developments frequently result from sprawl, which can result in higher travel times between locations. This have worsened the traffic congestion and have raised the demand for public transportation services like maintenance of roads and traffic control. It becomes more difficult to manage traffic congestion as routes and local connectivity has been altered or increased to accommodate the dispersed population.

Second, the results of the study reveal that the cost of public services are affected by sprawl in different ways depending on the type of service provided. For services like roads and sewerage, for instance, that depend on substantial physical infrastructure, the effects of sprawl are greater. This is due to the fact that sprawl necessitates the potentially costly building of more roads and sewerage.As described in Chapter 3, this research follows a mixed-method approach involving qualitative and quantitative data collection. We employed in-depth interviews with urban experts and analyzed data on cost estimations. The data collection process was rigorous, taking into account the expertise and direct involvement of stakeholders in urban development and public utilities within Gajju Matta.

The following discussion presents an in-depth analysis of the financial impact of urban sprawl on public utilities in Gajju Matta, Lahore. The study examines various factors, including the cost of road construction, sewage systems, public buildings, transmission lines, street lights, and gas pipelines, and how these costs have evolved over a 20-year period. These analyses are conducted in line with the research methodology outlined in methodology.

7.2. Per Kilometer Cost of Road

Due to its expansion, Gajju Matta has seen the effects of sprawl on public services. The demand for more roads and sewer infrastructure has grown as the city has grown outward. According to the data collected, this growth has been costly because it has necessitated constructing more roads and sewer systems to handle the area's expanding population and geographic size.

An official of planning and development authority quoted that

"The local authority has been heavily burdened financially by constructing new roads to combat sprawl in Gajju Matta. Along with the costs for constructing the roads, it also encompassed the additional maintenance costs brought on by a larger network of roadways. Additionally, sprawl has frequently resulted in the requirement for longer highways to connect various areas of the growing Gajju Matta, raising the expense of infrastructure."

In accordance with the research methodology, this section delves into the per kilometer cost of road construction in Gajju Matta. The dataset obtained from urban experts provides insights into the changes in road construction costs from 2003 to 2023. The analysis factors in inflation, technological advancements, urban development complexities, and population growth.

Year	**Per Km cost of Road construction**		
	Primary Road	**Secondary**	**Local Road**
	Shingle road (16.50 wide)	Shingle truck able (22 feet)	
2003	4199063	4048980	77654321
2004	4686911	4289870	83268685
2005	4989986	4500185	87659076
2006	4980914	4435643	86604603
2007	4864534	4300898	84324241
2008	5857472	5374868	107841301
2009	5665465	5092244	94261591
2010	4,654,988	4743298	90214566
2010	5398231	4992244	93456565
2011	5136064	4949898	92261371

2013	4880411	4323234	84545454
2014	4457688	4264445	82178788
2015	3822989	4007676	75987654
2016	3898989	4089768	78234534
2017	4,043,989	4108764	78456477
2018	4637640	4141915	78675767
2019	4756544	4928763	91898989
2020	4,454,988	4787675	90898763
2021	5086986	4735657	89900814
2022	5,718,985	5,256,544	95,657,940
2023	6350983	6818023	137223887

Table 7.3: Per KM Cost of Road in Gajju Matta over time *Sources: Field data*

For various types of roads in plain areas like Gajju Matta Lahore in 2023, the dataset provided indicates the average cost of road building per kilometer in Pakistani Rupees (PKR).

7.2.1. Analysis of Road Connectivity in Gajju Matta

The table presents an essential financial breakdown of the projected costs for the road infrastructure of Gajju Mata in the year 2023. The calculation method is based on multiplying the classified road length for each road category, which has been provided by the Urban Unit, with the projected cost associated with different types of roads, as determined by urban experts. The cost allocation is structured by road class, which includes Local Roads, Metro Roads, Primary Roads, and Secondary Roads, with their respective road lengths and total costs.

Road Class	Road Length (KM)	Cost of Roads of Gajju Mata 2023
Local Road	87.5	12,007,090,113
Primary Road	5.8	39544533.4
Secondary Road	4.1	26039030.3

Table 7.2.1: Road class and Length in Gajju Matta (Inflation adjusted values)

- **Local Road:** Gajju Mata has an extensive network of local roads spanning a total length of 87.5 kilometers. The cost incurred for local road maintenance and development in 2023 amounts to approximately 12,007,090,113 PKR. This substantial investment underscores

the significance of maintaining and expanding the local road network to cater to the needs of the local population. These roads are probably crucial for making sure that public utilities are accessible to residential areas and enabling the effective provision of services.

- **Primary Road:** Primary roads in Gajju Mata extend over a total length of 5.8 kilometers. The expenses allocated for these primary roadways reach 39,544,533.4 PKR. These roads likely play a pivotal role in connecting various parts of the city, considering the notable investment.
- **Secondary Road:** Secondary roads, covering 4.1 kilometers in total, are associated with costs amounting to 26,039,030.3PKR in 2023. These roads likely serve as supplementary routes, providing essential connectivity within the city.

We may better comprehend the spatial relationship between road networks and urban development in Gajju Matta by merging the road data with the maps of urban growth. The distribution and arrangement of the built-up areas are influenced by the road network, as seen in the map below.

Figure 7.2.1: Urban Extent of Roads in Gajju Matta

The road data helps us identify major road networks and their connectivity within the expanded urban areas. Residential neighborhoods are anticipated to be accessed by local roads, allowing residents to access amenities and commute inside the neighborhood. Primary roads probably pass-

through important business regions, linking several districts and handling more traffic. Secondary roads show that there are alternative routes available and that there is better connection within the expanded urban areas. These roads make Gajju Matta's urban fabric easy to understand in context of urban expansion.

7.3. Per Kilometer Cost of Sewage System

The analysis of data also emphasizes that there have been major impacts of sprawl on sewage services. According to a WASA representative

"To guarantee good sanitation and waste management, the area of Gajju Matta has needed more sewer lines and treatment facilities as it has grown. The local authority has faced significant financial pressures as a result of the development.".

Consistent with the research methodology, we evaluate the per kilometer cost of constructing sewage systems in Gajju Matta. The data shows significant cost increases from 2003 to 2023. We investigate the factors contributing to these cost escalations, such as inflation, the cost of construction materials, technological advancements, urban development complexities, and increased demand due to population growth.In 2003, the cost per kilometer of sewage line construction was approximately 310000000 Pakistani Rupees (PKR). However, in 2023, the cost has risen to approximately 655,000,000 PKR.

Service	Cost per km in 2003	Cost per km in 2023
Sewerage System	310,000,000	655,000,000

Table 7.3.1: Per KM cost of Construction of Sewerage Line

This substantial increase in cost suggests various factors contributing to the rise which are as follows:

Inflation and Cost of Material: As explained by an official of WASA

"*The overall costs related to constructing sewage lines have been impacted throughout time by inflation and the rising cost of construction materials. Costs have likely increased as a result of growing prices for raw materials like pipes, fittings, and construction supplies".*

Technological Advancements: A representative of LDA mentioned that costs have increased as a result of technological and methodological developments in the construction industry.

"Adopting innovative, more effective, and ecologically friendly materials and techniques has increased the cost. Modern sewage systems frequently include cutting-edge components, such as enhanced treatment capacities and sophisticated monitoring systems, which raise the overall cost."

Urban Development and Complexity: As discusses by an official of Infrastructure Development Authority that,

"*As cities grow and urban areas become more densely populated, the construction of sewage lines becomes more complex and challenging. The need to navigate through congested areas, deal with existing infrastructure, and address underground utility conflicts can lead to increased costs. The complexity of construction projects in urban areas often requires specialized engineering expertise and careful planning, which can contribute to the overall expense."*

Increased Demand and Population Growth: With the population expanding and urban areas experiencing growth, there is a greater demand for sewage infrastructure. The need to accommodate a larger number of households and businesses, along with the associated increase in wastewater volume, requires more extensive and comprehensive sewage line networks. This increased demand leads to higher costs for planning, design, and construction (Grafton et al., 2015).

7.4. Cost of Per Square Foot Buildings

This section analyzes the cost of constructing public buildings within Gajju Matta. The data provided by urban experts outlines cost variations between buildings with normal specifications and high-quality specifications.

Table below shows the data collected from the urban experts. This data has given us a significant cost which is required to construct two types of public building.

Per Square Feet of Construction cost of buildings		
Year	**Per square cost with normal specifications**	**Per square cost with high quality specifications**
2003	2062	6075
2004	2656	10100
2005	3241	12542
2006	2876	11201
2007	2721	10543
2008	3989	15438
2009	3641	14530
2010	3321	12323
2010	3632	13878
2011	3621	13424
2013	2891	10401
2014	2614	7654
2015	1989	5898
2016	2528	6345
2017	2431	6453
2018	2596	9767
2019	3541	7898
2020	3441	12765
2021	3341	12097
2022	3768	12898
2023	4956	17224

Table 7.4.1: Per Square Feet of Construction cost of buildings

These cost variations in the table gives an analysis of the increase in the cost over the period of 20 years the more urban sprawl the more will be the cost of public utilities. Urban sprawl and the cost of public utilities are strongly correlated with changes over time in the per square cost of building construction with typical and high-quality criteria (PIDE P & R). The need for housing and infrastructure grows as metropolitan areas grow, driving up construction prices.

7.5. Cost of Transmission Lines and Street Lights Per Kilometer

In accordance with the research methodology, this section evaluates the costs of transmission lines and street lights per kilometer. It identifies significant cost increases over time and attributes these increases to factors like inflation, technological advancements, and increased demand for services.

Service	Cost per km in 2003	Cost per km in 2023
Transmission Lines	9,453,654 PKR	17,019,780 PKR
Street Lights	6,213,345 PKR	12,165,833 PKR

Table 7.5.1: Cost of Transmission Lines and Street Lights Per Kilometer

The rise in the cost of transmission lines from approximately 9,453,654 PKR in 2003 to 17,019,780 PKR in 2023 suggests several underlying factors. In our context, the cost of street lights per kilometer has also experienced a substantial increase, from approximately 6,213,345 PKR in 2003 to 12,165,833 PKR in 2023. This rise can be attributed to similar factors as mentioned above, including inflation, technological advancements, and increased demand.

7.6. Cost of Gas Pipelines Per Kilometer

In 2003, the cost of gas line construction was approximately Rs 110,285,180 per kilometer, while in 2023, it has risen to approximately Rs 266,478,200 per kilometer. Depending on the terrain, pre-existing infrastructure, and urban or rural settings, installing gas lines vary in different areas. The necessity for specialized methods and equipment in difficult terrain, densely inhabited locations, or when passing through existing structures might raise construction costs. There is an increasing need for gas delivery networks as the population expands and new places are created. Costs may increase if the infrastructure for gas lines needs to be expanded to meet these demands, pipelines need to be extended to new locations, and more connections need to be made.

Service	Cost per km in 2003	Cost per km in 2023
Gas Pipeline	110,285,180	266,478,200

Table 7.6.1: Cost of Gas Pipelines Per Kilometer

Chapter: 8

Cost of Supplying Public Utilities

This chapter presents a thorough analysis of the financial aspects related to the supply of public utilities in the area of Gaju Mata. This study is guided by a methodology that emphasizes the key concept of dividing the overall population residing in an area by the combined expenditure of the local government allocated to public utilities. This methodology enables us to dissect the complex financial aspects associated with providing vital public services within our research field.

	Total Cost of Public Utilities over the years	Anticipated Population	Per Capita Pop Govt Cost of Public Utilities
2003	767964803	32282	23789.25726
2004	884143306	33682	26249.72704
2005	957335828	35199	27197.81323
2006	919560486	36716	25045.22513
2007	891488926	37016	24083.88065
2008	1268013058	38340	33072.84971
2009	1144751818	43352	26405.97476
2010	1003302861	44808	22391.15473
2010	1123365002	46264	24281.6229
2011	1030676347	47720	21598.41465
2013	900150695	49176	18304.67494
2014	839441761	50632	16579.27321
2015	734526427	52088	14101.64389
2016	794228949	53544	14833.20165
2017	807483762	55000	14681.52295
2018	823580031	56456	14587.99828
2019	1017851235	57912	17575.82599
2020	1083695208	59368	18253.8608
2021	991265102	60824	16297.2692
2022	1151066585	62280	18482.12243
2023	**1,535,930,242**	**63736**	**24098.31558**

Table 8.1.1: Per Capita Cost Public Utilities *Source: Urban Unit and Field data*

The analysis of the cost of providing public utilities in Gaju Mata, employing the methodology previously outlined, reveals valuable insights into the financial dynamics of public service delivery in the region. The data presented in Table 7.4.1, spanning from 2003 to 2023, showcases the total

cost of public utilities over the years, the anticipated population, and the per unit government cost of public utilities.

One striking observation is the consistent upward trajectory in the total cost of public utilities over the years, reflecting the growing demands of the population. In 2003, the total cost amounted to approximately 767.96 million, and by 2023, it had surged to a substantial 1.54 billion. This two-fold increase underscores the escalating financial burden placed on the local government to meet the rising demand for public utilities, a trend that deviates from the principles of New Urbanism, which emphasize compact, efficient, and sustainable urban development.

Concurrently, the anticipated population within Gaju Mata displays a noteworthy growth pattern. Starting at 32,282 in 2003, the population steadily increases to 63,736 by 2023. This steady rise is a pivotal factor in driving the higher costs associated with providing public utilities, as highlighted by the methodology, and poses a challenge to the principles of New Urbanism, which advocate for more compact and efficient urban growth. It's important to note that the population data was sourced from the Urban Unit.

The per unit government cost of public utilities, as anticipated, exhibits an increasing trend. In 2003, the cost per unit stood at approximately 23,789.26, and by 2023, it had grown to 24,098.32. This upward trajectory reaffirms the core principle of our methodology – that as the population expands, the per capita cost of delivering public utilities rises due to the amplified demand, a trend at odds with the efficiency goals of New Urbanism.

Furthermore, it's worth highlighting that the costs of providing public utilities were extracted from the insights of urban experts who were interviewed as part of the study. Their expertise and real-world experience enrich the data analysis and provide valuable context for the findings.

The relationship between population growth and the cost of providing public utilities is evident in this analysis. The rising population exerts pressure on the local government's budget, necessitating higher expenditures to meet the increased demand for services such as electricity, water, and sanitation. As the population continues to grow, so too will the financial commitments required to ensure the availability and sustainability of these vital services.

This analysis underscores the significance of understanding the financial intricacies of public utility provision in rapidly growing urban areas, and it emphasizes the need for proactive planning and budget allocation to meet the evolving needs of the population while striving to align with the principles of New Urbanism for more sustainable and efficient urban development.

8.1. Factors Comprising the Running Cost of Public Utilities

The running costs of public utilities in Gajju Matta can be broken down into the following categories as per the data collected from interviews

Water: A representor of WASA has quoted that:

> **"***Since there is a need of pumping water from a distance, Gajju Matta has a high cost of water supply. In addition, the water delivery system is outdated and ineffective, which causes significant leaks. For example, the demand for water is increasing as the population of Gajju Matta grows. However, the water supply system is not able to keep up with the demand, which is leading to water shortages. This is leading to higher water prices for public authorities like WASA."*

Sewerage: Another official of WASA has claimed that:

> ***"****Because of the need of massive network of sewers construction and maintenance, sewage disposal in Gajju Matta is expensive. Additionally, the sewage system is also outdated and ineffective, which causes issues like overflowing sewers and sewage backups."*

Solid waste management: Another responded has claimed that:

> ***"****The cost of solid waste management in Gajju Matta is high due to the need to collect and dispose of large amounts of waste. The solid waste management system is also old and inefficient, which leads to problems such as overflowing landfills and air pollution."*

Roads: A planning and development official has quoted that

> ***"****Due to the extensive network of roads that need to be repaired and upgraded, road maintenance in Gajju Matta is also expensive. Additionally, the road system is outdated*

and in need of maintenance, which causes issues like potholes, traffic jams, and accidents."

Respondents from Infrastructure development authority quoted that:

Electricity:

"*The cost of electricity supply in Gajju Matta is high due to the need to build and maintain a large network of power lines. The electricity supply system is also old and inefficient, which leads to problems such as blackouts and brownouts."*

Streetlights:

"*Because it is not a fundamental need like water or sewage, street lighting in Gajju Matta is comparatively inexpensive. Streetlights, however, continue to be a crucial convenience because they help to keep the streets safe at night."*

Sui Gas:

"The cost of sui gas is relatively low because it is a relatively new service in UC-145 Gajju Mata. The sui gas supply system is still in its early stages of development, and the government is working to improve the system."

Chapter 9

Cost Analysis: Sprawled Development vs. Compact Development

Urban development plays a crucial role in shaping the economic fabric of a region, particularly in the provision of essential public infrastructure (Kurvinen, A., & Saari, A., 2020). This chapter conducts a comparative cost analysis between two contrasting urban development paradigms: sprawling development, typified by Gajju Matta, and compact development, as exemplified by Lahore's Ichra – Samnabad area.

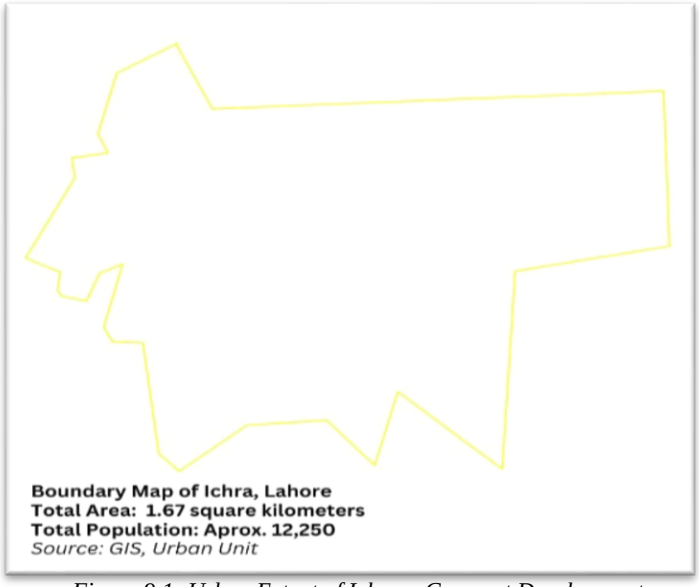


Figure 9.1: Urban Extent of Ichra – Compact Development

Ichra, located in Lahore, emerges as a prime illustration of compact urban development, accommodating a thriving population of approximately 26,000 residents across an area of approximately 1.67 square kilometers. This dynamic locality epitomizes the essence of compact development with its integrated urban design. Ichra seamlessly integrates residential and commercial zones, fostering a vibrant community that optimizes land utilization. Notably, the introduction of a 2.22 km metro line, coupled with underground bustling markets, showcases the efficiency and innovation intrinsic to compact urban planning. Ichra's model of compact development, characterized by its high population density, mixed-use spaces, and forward-thinking transit solutions, stands as a testament to the evolving urban landscape of Lahore. Ichra's population density is approximately 15,569 people per square kilometer, highlighting the efficiency of its compact design in maximizing urban space and fostering a sustainable living environment amidst a rapidly growing urban population.

Ichhra, a residential and commercial area in Lahore, is noted for its Ichhra Bazaar, among the most economical markets of Lahore. This market is known for its traditional and cultural dresses and other handicrafts supplied from all over Punjab, as well as its furniture selection. There is a large

Christian community living in Ichhra. The area is also known for its healthcare centers and hospitals. Ichhra forms Union Council (UC 100), and is administered as part of Samanabad Tehsil.

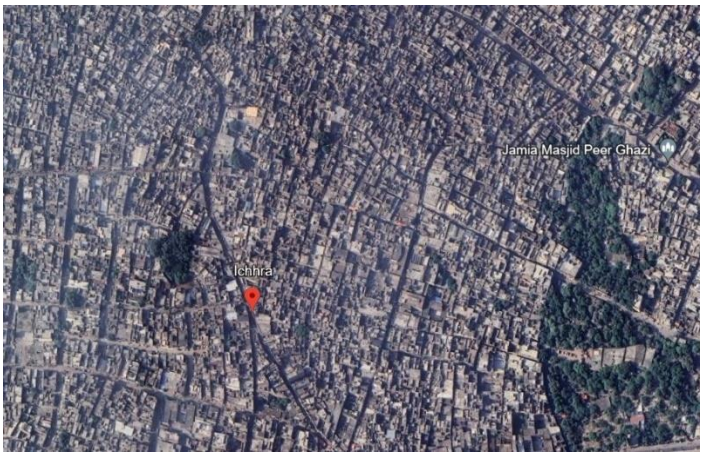


Figure 9.2: Dense growth pattern - Ichra

This extension emphasizes Ichra's population and area metrics, highlighting its significant population density of approximately 15,569 people per square kilometer. These figures underscore the efficiency of Ichra's compact design in maximizing urban space and fostering a sustainable living environment amidst a rapidly growing urban population.

9.1. Cost Analysis of providing public utilities: Gajju Matta vs Ichra

9.1.1. Road Infrastructure

Gajju Matta, characterized by urban sprawl, presents challenges in road infrastructure. The extensive road network, comprising local, metro, primary, and secondary roads, entails substantial costs. The per kilometer cost of road construction varies for different road types, reflecting the financial burden on the local authority.

Table 9.1.1.: Per Kilometer Cost of Road in Gajju Matta (2023)

Road Type	**Cost (PKR)**
Shingle Road	6,350,983.5
Shingle Truck-able	6,818,023.0
Expressway	13,722,388.7

9.1.1. Per Kilometer Cost of Road Construction: Compact Development vs. Sprawled Development

To facilitate meaningful comparisons, a detailed exploration of the per kilometer cost of road construction is essential. The dataset obtained from urban experts, similar to the one used for Gajju Matta, has been analyzed for Ichra – Samnabad Lahore.

Year	**Per Km Cost of Road Construction (Compact Development)**	**Cost of Road per km in Plain Areas (Sprawled Development)**
2023	5,154,890	5,230,118

Table 9.1.1.1.: Per Kilometer Cost of Road in Ichra (2023) *Source: Field data*

The per kilometer cost of road construction in the Ichra differs notably from that of Gajju Matta, emphasizing the potential economic benefits of efficient urban planning.

Road Infrastructure: A representative from the urban planning department shed light on the distinctive aspects of road construction costs in Ichra as compared to Gajju Matta. According to the interviewee,

"The per kilometer cost of road construction in Ichra significantly deviates from that observed in Gajju Matta. This discrepancy underscores the pronounced economic advantages associated with meticulous urban planning. In Ichra, the emphasis on efficient land use and integrated development has led to a more cost-effective approach to road construction. Unlike Gajju Matta, where sprawling growth necessitated extensive road networks, Ichra's compact design and strategic infrastructure placement have resulted in notable savings in road construction expenses."

9.1.2. Per Kilometer Cost of Sewage System Construction: Compact Development vs. Sprawled Development

To enable a meaningful comparison, we conducted an in-depth exploration of the per kilometer cost of sewage system construction, similar to the methodology applied for Gajju Matta. The dataset obtained from urban experts has been analyzed for Ichra, and the findings are summarized in Table 9.1.2.

Service	Cost per km in Compact Development (2023)	Cost per km in Sprawled Development (2023)
Sewerage System	245,000,000 PKR	665,000,000 PKR

Table 9.1.2: Per KM Cost Comparison of Sewage System Construction 2023 *Source: Field Data*

The per kilometer cost of sewage system construction in the compactly developed area is significantly lower than that in Gajju Matta, underscoring the potential economic benefits of efficient urban planning.

This analysis highlights a substantial cost difference in sewage system construction between compactly developed and sprawling urban areas. Efficient urban planning in the compact development area results in a considerably lower per kilometer cost, emphasizing the economic advantages associated with well-designed and organized urban infrastructure. The findings suggest that investing in compact development can lead to more cost-effective sewage system construction, presenting a strong case for the adoption of efficient urban planning practices.

Sewerage System Cost Efficiency: The qualitative interview with the WASA Official delved into the intricacies of the sewerage systems in Ichra and Gajju Matta, revealing a significant contrast in cost efficiency. In Ichra, officials highlighted a strategic and modernized approach to sewerage planning, resulting in a notably efficient and cost-effective system. This was attributed to meticulous urban planning that optimized the infrastructure layout. Conversely, Gajju Matta faced financial challenges due to the extensive network of sewers, leading to high construction, maintenance, and disposal costs. Officials admitted to the outdated and ineffective nature of the system, contributing to problems like overflowing sewers. The comparative analysis illuminated the economic benefits of efficient sewerage planning, emphasizing the pressing need for strategic urban development practices to mitigate financial burdens associated with infrastructure in sprawling urban areas.

"Because of the need for a massive network of sewage construction and maintenance, sewage disposal in Gajju Matta is expensive. Additionally, the sewage system is also outdated and ineffective, which causes issues like overflowing sewers and sewage backups."

9.2. Cost Analysis of Public Buildings: A Comparative Study

This chapter explores the cost implications of constructing public buildings through a comparative analysis between the sprawling area of Gajju Matta and a carefully selected compact development area, Ichra. The analysis delves into the costs per square foot of building construction, expenses associated with transmission lines and street lights per kilometer, as well as the cost of gas pipelines per kilometer in both scenarios.

9.2.1. Cost per Square Foot of Building Construction: Compact Development vs. Sprawled Development

To facilitate a meaningful comparison, an analysis of the cost per square foot for building construction in a compactly developed area has been undertaken. The dataset obtained from urban experts is presented in Table 9.2.1.

Year	Per square cost with normal specifications in Compact Development	Per square cost with high-quality specifications in Compact Development
2023	3,456.5	11,986.2

Table 9.2.1: Per Square Foot Cost of Building Construction *Source: Field Data*

The per square foot cost of building construction in the compactly developed area is consistently lower than that observed in Gajju Matta, emphasizing the economic benefits of compact urban planning.

Construction costs for public buildings in Gajju Matta have witnessed a steady increase over the past two decades. The per square foot cost, varying between normal and high-quality specifications, highlights the financial implications of sprawled development.

The impact of compact development: A local contractor stated that;

"The impact is quite clear. Sprawled development in Gajju Matta has led to increased costs for constructing public buildings. The need for more space and the challenges posed by the dispersed layout has implications for both normal and high-quality specifications. It's not just

about the initial construction; the ongoing maintenance and operational costs also increase. In contrast, areas with compact development, like Ichra, showcase a more cost-effective approach. The efficient use of available space and proximity to key facilities contribute to a lower per square foot cost, underlining the economic benefits of compact urban planning."

Building Specification	**Cost (PKR)**
Normal	4,956.0
High Quality	17,224.0

Table 9.2.1.1: Per Square Foot Cost of Buildings in Gajju Matta (2023) *Source: Field data*

This additional information provides insights into the construction costs for public buildings in Gajju Matta in the year 2023. The comparative analysis underscores the economic advantages associated with compact urban planning, as evidenced by consistently lower construction costs in the compactly developed area.

9.3. Cost of Transmission Lines and Street Lights Per Kilometer: Compact Development vs. Sprawled Development

Table 9.3.1 illustrates the cost of transmission lines and street lights per kilometer in both compact and sprawling developments, providing insights into the economic differences.

Service	**Cost per km in Compact Development (2023)**	**Cost per km in Sprawled Development (2023)**
Transmission Lines	14,238,965.5 PKR	17,019,780 PKR
Street Lights	8,082,916.5 PKR	12,165,833 PKR

Table 9.3: Cost of Transmission Lines and Street Lights Per Kilometer *Source: Field Data*

The cost of transmission lines and street lights per kilometer in the compactly developed area is notably lower than that observed in Gajju Matta, reflecting the cost-effectiveness of compact urban planning.

This comparative analysis highlights the substantial differences in the costs of transmission lines and street lights per kilometer between the compactly developed area and Gajju Matta. The lower costs in the compact development underscore the economic advantages associated with efficient urban planning.

Public Utility	**Per unit cost of provision - Gajju Mata/Sprawled Development (PKR)**	**Per unit cost of provision - Ichra/Compact Development (PKR)**	**Comparative Difference**
Cost of Road per km	13,722,388.70	5,230,118	128.61%
Sewerage System	665,000,000	245,000,000	119.71%
Normal Specification Building	4,956.00	3,456.50	43.39%
High Quality Specification Building	17,224.00	11,986.20	30.43%
Transmission Lines	17,019,780	14,238,965.5	10.45%
Street Lights	12,165,833	8,082,916.5	31.25%

Table 9.3.1: Comparative difference of delivering different public utilities in Gajju Matta and Ichra *Source: Field Data*

The table compares the per unit cost of delivering different public utilities in two areas: Gajju Mata (sprawled development) and Ichra (compact development). The comparative difference indicates the additional cost of delivering the same service in the sprawled development area in comparison to the compact area. The table demonstrates that all utilities are more costly to offer in Gajju Mata. More precisely:

- In Gajju Mata, the cost of road per km is 128.61% higher than in Ichra.
- The sewerage system in Gajju Mata costs 119.71% more than in other areas.
- In Gajju Mata, a construction of standard specifications costs 43.39% more.
- In Gajju Mata, a high-quality standard building costs 30.43% more.
- Transmission lines cost 10.45% more in Gajju Mata.
- Street lights in Gajju Mata are 31.25% more costly.

These findings suggest that it is significantly more cost-effective to provide public utilities in areas of compact development compared to those of sprawled development.

The table provides a detailed comparison of the per unit costs of providing different public utilities in two distinct areas: Gajju Mata (representing sprawled development) and Ichra (representing compact development). The costs are given in Pakistani Rupees (PKR). The comparative difference column indicates how much more costly it is to render the same service in Gajju Mata relative to Ichra.

The cost of road construction per kilometer is significantly higher in GajjThu Mata, with a comparative difference of 128.61%. This could be due to a variety of factors such as more complex terrain, lower population density requiring longer roads to access all residences, or less efficient infrastructure development practices in sprawled areas.

The cost of implementing a sewerage system in Gajju Mata is also significantly higher, with a comparative difference of 119.71%. This might be due to the larger geographical area that needs to be covered in sprawling developments, resulting in more materials and labor being required.

Normal and high-quality specification buildings are 43.39% and 30.43% more expensive, respectively, in Gajju Mata. This might be due to higher construction costs in less densely populated areas due to factors like longer transportation distances for materials and workers, or potentially less competition among construction firms.

Transmission lines and street lights are 10.45% and 31.25% more expensive, respectively, in Gajju Mata. The higher costs here could be related to the more extensive infrastructure needed to cover the larger area of sprawled developments, as well as potentially higher maintenance costs due to the larger geographic area.

Overall, these figures suggest that providing public utilities in areas of compact development like Ichra is significantly more cost-effective compared to sprawled development areas like Gajju Mata. This could have implications for urban planning policies, indicating a potential benefit for encouraging compact development to conserve resources and public funds.

Cost disparities: An urban expert from LDA provided insights as;

"Several factors play a role in these cost disparities. In sprawling developments, the need for extensive transmission lines and street lights to cover the dispersed urban landscape leads to higher costs. The longer distances and increased infrastructure requirements contribute to elevated expenses. On the other hand, compact development allows for more efficient use of resources, reducing the need for extensive infrastructure. The proximity of facilities and services in compact areas reduces the length of transmission lines and street lighting, resulting in lower costs. Additionally, the overall planning and design considerations in compact developments contribute to better cost-effectiveness, as reflected in the provided figures."

This comprehensive analysis examine the economic implications of infrastructure development in two contrasting urban models, exemplified by Gajju Matta's sprawled development and Ichra's compact development in Lahore. The findings provide valuable insights into the financial landscape shaped by urban planning decisions.

In the context of road infrastructure, Gajju Matta's sprawling growth imposes a substantial financial burden on the local authority, evident in the varying per kilometer costs for different road types. In contrast, Ichra's compact design showcases the economic benefits of meticulous urban planning, resulting in notable savings in road construction expenses. The 2.22 km metro in Ichra, featuring underground markets, exemplifies the efficiency and innovation inherent in compact urban planning.

The cost analysis extends to the construction of sewage systems, where the compact development in Ichra demonstrates significant cost efficiency compared to Gajju Matta. This is attributed to strategic and modernized sewerage planning, optimizing infrastructure layout. The qualitative interview with a WASA Official underscores the economic benefits of efficient sewerage planning, emphasizing the need for strategic urban development to mitigate financial burdens associated with sprawling areas.

The examination of public building construction costs reaffirms the economic advantages of compact development. Ichra consistently demonstrates lower per square foot costs compared to the sprawling Gajju Matta, emphasizing the efficiency of space utilization and proximity to key facilities in compact urban planning.

Further, the analysis of transmission lines and street lights per kilometer illustrates the cost-effectiveness of compact development. Ichra's lower costs, attributed to efficient resource use and proximity of facilities, contrast sharply with the elevated expenses in Gajju Matta's sprawling landscape.

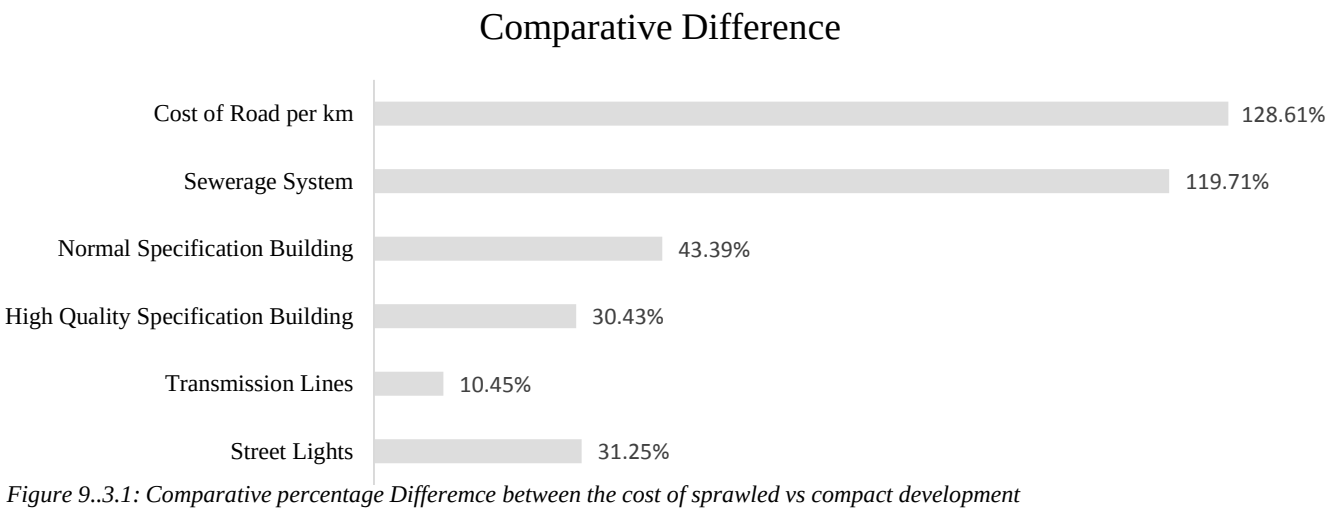


Figure 9..3.1: Comparative percentage Differemce between the cost of sprawled vs compact development

Demographics of Gajju Mata

Populatio

63,736

Total Area

9 Sq. Km

Population Density

7,081

Cost of Public Utilities

1,535.93 Million

Per Capita Cost of Public Utilities

24,098

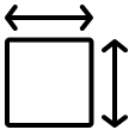
With a population of 63,736 residents residing within a 9-square-kilometer area, Gajju Matta exhibits a low population density of 7,081 people per square kilometer, indicative of a low density populated urban area. Moreover, the cost of public utilities in Gajju Matta amounts to 1,535.93 million rupees, translating to a per capita cost of 24,098 rupees.

Demographics of Ichra

Population

26,000

Total Area



1.67 Sq.

Population Density

15,569

Cost of Public

272.56 Million

Per Capita Cost of Public

10,598

With a population of 26,000 residents occupying a compact 1.67 square kilometers, Ichra boasts a remarkably high population density of 15,569 people per square kilometer. This density reflects a concentrated urban environment indicative of efficient land use and integrated development. Moreover, the substantial cost of public utilities in Ichra, totaling 272.56 million rupees, translates to a per capita cost of 10,598 rupees.

Comparing Gajju Mata's sprawled development with Ichra's compact development reveals contrasting urban paradigms with significant implications for economic efficiency and resource utilization. Gajju Mata, characterized by its dispersed layout, exhibits a lower population density and a larger built-up area, spanning 9 square kilometers with a population of 63,736. In contrast, Ichra, occupying a mere 1.67 square kilometers, accommodates 26,000 residents, boasting a notably higher population density of 15,569 people per square kilometer. This stark difference in

spatial organization reflects varying approaches to urban planning and land use optimization. Furthermore, the cost of public utilities in Gajju Mata, amounting to 1,535.93 million rupees, contrasts with Ichra's expenditure of 272.56 million rupees. Despite Gajju Mata's larger area, the per capita cost of public utilities remains substantially higher compared to Ichra, indicating potential inefficiencies in infrastructure provision and maintenance exacerbated by sprawled development. In contrast, Ichra's compact design enables more efficient resource allocation, resulting in lower per capita costs despite its higher population density. This comparative analysis underscores the economic advantages of compact urban development models, emphasizing the need for strategic planning to mitigate the financial burdens associated with sprawling urban landscapes.

In light of the contrasting urban paradigms observed in Gajju Mata and Ichra, it becomes imperative to take into account the economic implications of infrastructure provision within these developmental frameworks. By examining the per capita cost of providing each public utility in both developments, we can elucidate the tangible financial ramifications of their respective urban designs.

The following discussing highlights the per capita cost of providing the above discussed utilities. By juxtaposing the per unit costs of public utilities alongside the respective populations of Gajju Mata and Ichra, it is aimed to unravel the economic efficiencies and inefficiencies inherent in sprawling and compact development models. This discussion can decipher the economic ramifications of urban planning decisions and their implications for sustainable urban growth and resource utilization in the context of developments like Gajju Matta and Ichra.

Utility	Per Capita Cost of Utility - Gajju Matta (mil. Pkr)	Per Capita Cost of Utility - Ichra (mil. Pkr)
Road	**215.3004377**	**201.1583846**
Sewerage System	**10433.66386**	**9423.076923**
Building (Normal)	**0.077758253**	**0.132942308**
Building (High)	**0.270239739**	**0.181007692**

Transmission Lines	**367.0355843**	**247.6525192**
Street Lights	**290.8785145**	**210.8814038**
Population	**63,736**	**26,000**

Table 9.3.2: Per unit cost of delivering different public utilities in Gajju Matta and Ichra.

The analysis of the provided numbers sheds light on the economic dynamics underlying the development models of Gajju Mata and Ichra. Firstly, the significantly higher per unit costs of road construction and sewerage systems in Gajju Mata compared to Ichra indicate inefficiencies inherent in sprawling development. The substantial investments required per unit underscore the challenges posed by dispersed urban layouts, where infrastructure must cover larger areas to serve relatively smaller populations. Consequently, this leads to higher per capita costs of these utilities in Gajju Mata, implying a heavier financial burden on residents. Conversely, Ichra's compact development model demonstrates more efficient resource allocation, reflected in lower per unit costs and subsequently lower per capita costs of road and sewerage infrastructure. Additionally, the analysis reveals disparities in building construction costs between the two areas, with Gajju Mata incurring higher expenses for high-quality specification buildings compared to Ichra. These findings underscore the economic advantages of compact urban development, emphasizing the importance of strategic planning in optimizing resource utilization and promoting sustainable economic growth.

In conclusion, this comparative analysis underscores the overarching economic benefits of compact urban planning. It emphasizes the need for strategic, efficient, and innovative urban development practices to ensure not only cost-effectiveness but also sustainable and resilient urban environments. As cities continue to evolve, these findings contribute to the discourse on shaping urban landscapes that balance economic viability with social and environmental considerations.

9.4. Per square kilometer cost difference between Gajju Matta and Ichra

Understanding the disparity in per square kilometer cost between Gajju Matta and Ichra is crucial for evaluating the efficiency and effectiveness of urban development strategies. By comparing the costs of public utilities in these two distinct developments, we gain valuable insights into the financial implications of different urban planning approaches. This analysis helps policymakers,

urban planners, and stakeholders make informed decisions to optimize resource allocation, promote sustainable development, and enhance the quality of life in urban communities.

To calculate the difference in per square kilometer cost between Gajju Matta and Ichra, we need to compare the cost of public utilities per square kilometer in both areas. Given the information provided, we can compute this as follows:

1. **Cost in Gajju Matta**:
    - Total cost of public utilities in Gajju Matta: 1,535.93 million PKR
    - Total area of Gajju Matta: 9 square kilometers
    - Per square kilometer cost in Gajju Matta = Total cost / Total area = 1,535.93 million PKR / 9 square kilometers = **170.66 million PKR per square kilometer**
2. **Cost in Ichra**:
    - Total cost of public utilities in Ichra: 272.56 million PKR
    - Total area of Ichra: 1.67 square kilometers
    - Per square kilometer cost in Ichra = Total cost / Total area = 272.56 million PKR / 1.67 square kilometers ≈ **163.28 million PKR per square kilometer**

Now, to find the difference in per square kilometer cost between Gajju Matta and Ichra:

Difference = Per square kilometer cost in Gajju Matta - Per square kilometer cost in Ichra
Difference = 170.66 million PKR per square kilometer - 163.28 million PKR per square kilometer
Difference ≈ **7.38 million PKR per square kilometer**

So, the per square kilometer cost in Gajju Matta is approximately 7.38 million PKR higher than in Ichra.

	Gajju Matta	Ichra	Percentage Difference
Population	63,736	26,000	145.1%
Total Area (Sq. Km.)	9	1.67	439%
Population Density	7,081	15,569	-54.5%
Cost of providing Public Utilities (millions)	1,535.93	272.56	463.6%
Per Capita Cost of Utilities	24,098	10,598	127.4%
Per Sq. Km. Cost (millions)	170.66	163.23	4.52%

Table 9.3.1: Percentage difference between Gajju Matta and Ichra urban demographics

The table provides a comparative analysis between Gajju Matta and Ichra, two urban areas in Lahore, highlighting key metrics to underscore the differences in urban development and public utility costs. Gajju Matta, with a population of 63,736, is significantly larger than Ichra, which has a population of 26,000, reflecting a 145.1% higher population. Covering an area of 9 square kilometers compared to Ichra's 1.67 square kilometers, Gajju Matta exhibits a 439% greater total area. However, Gajju Matta's population density is considerably lower at 7,081 people per square kilometer, which is 54.5% less than Ichra's density of 15,569 people per square kilometer.

In terms of public utility costs, Gajju Matta incurs a total cost of 1,535.93 million PKR, a stark contrast to Ichra's 272.56 million PKR, marking a 463.6% higher expenditure. This disparity is further highlighted in the per capita cost of utilities, with Gajju Matta's per capita cost standing at 24,098 PKR, which is 127.4% higher than Ichra's 10,598 PKR. Additionally, the per square kilometer cost of providing public utilities in Gajju Matta is 170.66 million PKR, slightly higher by 4.52% compared to Ichra's 163.23 million PKR. These figures illustrate the financial burdens and inefficiencies associated with urban sprawl, as exemplified by Gajju Matta, in contrast to the more compact and cost-effective urban development model represented by Ichra.

Chapter 10

Proposing a Way Forward

10.1. Implications of Findings:

The research findings from Chapter 7 and Chapter 8 have several significant implications for the theoretical understanding of urban sprawl and its impact on the cost of public utilities provision in both the development, i.e, sprawled and compact in Lahore. These implications include:

10.1.1. Implications for Theory

- **Urban Sprawl and Cost Escalation**: The study has provided empirical evidence of a strong correlation between urban sprawl and rising costs associated with public utilities. This supports and reinforces the theoretical framework that urban sprawl tends to lead to increased financial burdens on local governments.
- **New Urbanism Principles**: The increasing per capita cost of providing public utilities highlights a challenge to the principles of New Urbanism, which promote compact and sustainable urban development. The findings underscore the need for a reevaluation of urban planning strategies to align more closely with these principles.

10.1.2. Implications for Practice

Compact and Mixed-Use Development

Promoting compact and mixed-use development strategies should be a central theme of urban planning efforts in Gajju Matta. The need for more infrastructure and utilities can be significantly decreased by:

- **Diverse Land Uses**: Encouraging diverse land uses within a compact space can reduce the need for extensive utility networks. Policies should be implemented to create compact, walkable communities that combine residential, commercial, and recreational areas.
- **Denser Development**: Increasing population density within urban areas can lead to more efficient infrastructure systems and a reduction in the per capita cost of public utilities.

Smart Growth Initiatives

Smart growth initiatives should complement compact development strategies. These initiatives should prioritize:

- **Sustainable and Effective Urban Planning**: The integration of infrastructure, land use, and transportation planning can build more livable and environmentally responsible communities. Concepts like transit-oriented development should be employed to reduce transportation costs and extend infrastructure life spans.
- **Less Reliance on Private Vehicles**: By promoting public transportation and mixed-use development centered around transportation hubs, Gajju Matta can significantly reduce infrastructure costs and improve access to public services.

10.1.3. Implications for Policy

The study's findings have direct relevance for urban policy formulation in Gajju Matta:

Urban Growth Boundaries

The setting up of urban growth boundaries is an essential technique for managing and limiting urban growth. These boundaries should be established to:

- **Prevent Urban Sprawl:** By restricting the parameters for urban development, these boundaries encourage more compact, effective expansion.
- **Promote Infill Construction:** Urban growth boundaries promote infill construction within already-developed urban areas, maximizing the utilization of available space.
- **Reduce Infrastructure Extensions:** By shortening utility networks and simplifying their design, significant cost reductions can be gained.

10.2. Efficiency Measures and Cost Reduction Strategies

This section can focus on examining various strategies and programs aimed to increase public utility efficiency while reducing per-capita cost of providing public utilities.

- **Infrastructure Planning and Design:**

Effective infrastructure planning and design are essential for reducing the per-capita cost of providing public utilities in Gajju Matta's public utilities. By carefully considering factors such as population density, land use patterns, and future growth projections, utility providers can optimize the placement and capacity of infrastructure components. This strategy ensures that utility services are evenly dispersed throughout the area while reducing duplication and wasteful spending. Effective planning also allows for scalability, accommodating future population growth without incurring significant additional costs for infrastructure expansion.

- **Technology Integration:**

  The integration of cutting-edge technologies has enormous potential for improving Gajju Matta's public utilities' effectiveness. Utility companies can improve resource management and save operating costs by utilizing smart grids, metering systems, and automated monitoring solutions. Smart grids enable real-time data analysis and intelligent load balancing, resulting in efficient distribution of electricity and reduced energy wastage. Automated monitoring systems can identify water or sewer line leaks quickly, reducing water loss and maintenance costs. These technologies enable proactive maintenance, early fault detection, and streamlined operations, ultimately leading to cost savings for utility providers.

- **Demand-Side Management:**

  Managing the rising population's resource demands and lowering utility prices require the use of demand-side management solutions. Utility providers can initiate water conservation campaigns, promote energy-efficient lighting programs, and encourage waste reduction among residents. The overall demand for utilities can be reduced by raising awareness and encouraging sustainable behaviors including responsible waste management, energy-saving equipment adoption, and water efficiency. This promotes a culture of conservation and sustainability throughout the community while easing the load on the infrastructure and lowering the need for expensive upgrades.

- **Collaborative Partnerships:**

  Utility companies, local governments, and community stakeholders working together can dramatically save costs and deliver services more effectively. By working together, utility providers can reduce individual operational costs by pooling their resources, knowledge,

and infrastructure. By permitting cost-sharing agreements and maximizing the use of existing resources, collaborations can also facilitate cooperative infrastructure development initiatives. Getting involved with community stakeholders encourages a sense of ownership and engagement, which improves resource management techniques and increases the cost-efficiency of public utilities.

- **Long Term Financial Planning:**

  For the management of the per-capita cost of providing public utilities in Gajju Matta, long-term financial planning is essential. Utility providers should engage in rigorous revenue forecasting and cost-benefit analysis to ensure sustainable financing. Utility providers can distribute resources efficiently by comprehending future financial requirements and coordinating investment priorities. Utility providers can decide on infrastructure improvements, maintenance schedules, and technological expenditures with the help of long-term financial planning, assuring cost-effective service delivery while satisfying the population's expanding needs.

- **Maintenance and Asset Management:**

  Cost reduction for public utilities is greatly aided by proactive maintenance and efficient asset management techniques. Utilizing asset tracking systems, condition-based monitoring approaches, and preventative maintenance programs can all assist identify and manage maintenance needs before they escalate into expensive breakdowns or repairs. By adopting these practices, utility providers can extend the lifespan of infrastructure assets, minimize downtime, and optimize maintenance efforts, ultimately reducing operational costs and ensuring uninterrupted utility services for the population.

Utility suppliers can traverse the challenges presented by growing populations, maximize effectiveness, and guarantee cost-effective service delivery to the citizens of Gajju Matta by taking into account these many factors. In order to maintain strong and dependable public utilities for a population that is expanding quickly, proactive planning, technical breakthroughs, sustainable practices, collaborative efforts, and effective financial management are critical.

Policy Recommendations:

In terms of policy recommendations, the following measures can be considered:

1. **Develop comprehensive urban planning policies:**

   Formulate and implement urban planning policies that integrate considerations of economic efficiency, environmental sustainability, and social equity. These policies should address urban sprawl and promote compact, connected, and inclusive urban development. Comprehensive master plans and zoning regulations can guide future development, ensuring that infrastructure provision aligns with long-term sustainable goals.

2. **Establish growth boundaries and urban growth boundaries:**

   Define growth boundaries or urban growth boundaries to restrict urban sprawl beyond certain limits. These boundaries can help contain urban development within designated areas and prevent the excessive expansion of infrastructure networks. Careful consideration should be given to setting these boundaries based on rigorous analysis of population projections, land availability, and environmental factors.

3. **Promote affordable housing and mixed-income neighborhoods:**

   Implement policies that promote the development of affordable housing options within well-connected urban areas. Affordable housing initiatives can help address the socio-economic disparities exacerbated by urban sprawl and reduce the need for long-distance commuting. Mixed-income neighborhoods can contribute to social cohesion and ensure equitable access to public services and amenities.

4. **Strengthen public-private partnerships:**

   Foster partnerships between the public and private sectors to leverage resources and expertise for infrastructure development. Public-private partnerships can provide additional funding sources, technical expertise, and innovative approaches to infrastructure provision. Clear guidelines and frameworks should be established to ensure transparency, accountability, and the long-term viability of these partnerships.

5. **Conduct regular monitoring and evaluation:**

Establish a monitoring and evaluation framework to assess the effectiveness of policies and initiatives aimed at mitigating the economic impacts of urban sprawl on public utility provision. Regular monitoring can help identify potential challenges, assess the outcomes of implemented measures, and inform adaptive policy-making processes.

Limitations of the study

While the research has shed light on several critical aspects, it's essential to acknowledge the limitations that may have influenced the findings:

- **Data Sources:** The study relied on data provided by urban experts and the Urban Unit. Future research could benefit from more comprehensive data sources, including real-time data collection and access to local government records.
- **Scope of Study:** The research focused on Gajju Matta and Ichra in Lahore, which is just one urban area. Expanding the study to include a more diverse range of urban areas could offer broader insights into the implications of urban sprawl.

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|ANNEX-A|

LAHORE'S GAJJU MATTA URBAN SPRAWL: ASSESSING THE COST OF PUBLIC UTILITIES' PROVISION

INTERVIEW GUIDE

RESPONDENT INFORMATION

Name: _____

Organization/institution: _____

Designation: _____

INTERVIEWER INFORMATION

Date of interview
(DD/MM/YY): _____

Interview timing: _____

Data Collection method:

1. Audio Recording
2. Field Notes
3. Both

SCHOOL OF DEVELOPMENT STUDIES
PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
ISLAMABAD, PAKISTAN

Respected Sir/ Ma'am:

Thank you for participating in this questionnaire, which is part of a research study examining Lahore's Gajju Matta Urban Sprawl: Assessing the Cost of Public Utilities' Provision. Your input is essential in understanding the challenges and opportunities associated with providing public services in rapidly expanding urban areas. This questionnaire aims to gather data from professionals involved in urban planning, infrastructure development, and public utility provision. The findings will contribute to informed decision-making, resource allocation, and the promotion of sustainable infrastructure design. Your responses will be treated confidentially, and the data collected will be used for research purposes only. Your participation is greatly appreciated.

1. Based on your expertise, how would you describe the current state of urban sprawl in Lahore and its implications for public utility provision?
2. From your experience, what are the key challenges faced in ensuring efficient and equitable delivery of public utilities in areas affected by urban sprawl?
3. In your opinion, what strategies or measures can be implemented to optimize the financial allocation for public utility provision in urban sprawl areas?
4. How can urban planning and development policies better incorporate sustainable infrastructure design to address the infrastructure needs arising from urban sprawl?
5. From your perspective, what role can your specific professional background and organization play in promoting sustainable infrastructure development and addressing the impacts of urban sprawl on public utilities?
6. Based on your expertise, what role do you believe different stakeholders, such as urban planners, infrastructure development authorities, and government officials, should play in mitigating the economic impacts of urban sprawl on public utility provision?
7. From your experience, what are the major disparities between current and target urban areas in terms of public utility provision, considering factors like population density, commuting distances, and transportation infrastructure?
8. In your view, what alternative approaches or strategies can be adopted to address the economic implications of urban sprawl and promote sustainable infrastructure development?

|ANNEX-B|

Data Request from Regulatory Authorities

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
Post Box No. 1091, Islamabad, Pakistan

Pakistan Institute of Development Economics

Tel : 92-51-9248036
Mob : 92-332-5200728
E-mail : abid.rehman@pide.org.pk
Web : www.pide.org.pk

TO WHOM IT MAY CONCERN

I am writing this in support of Mr. Abdullah Bin Afzal to request you for the following data for UC-145, Gajju Matta Lahore. As a Research Fellow at Pakistan Institute of Development Economics (PIDE), Islamabad, Pakistan, I am supervising Mr. Abdullah Bin Afzal for the MPhil dissertation entitled "The Financial Cost of Providing Public Infrastructure in Sprawled Area, Gajju Matta, Lahore".

This table provides the variable that represents the supply side cost of developing sprawl in Lahore.	
Construction Cost of Public Utilities in UC – 145 Lahore	
Public Utility	Variables
Roads	Per km cost of constructing road.
Parks	Per Sq. meter cost of constructing a park.
Sewage System and Water Pipes	Per km cost of proving water and drainage
Gas	Per km cost of providing gas pipelines
Electricity and lighting	Per km cost of providing electric meters and streetlights
Local *Mandi* (Public Markets)	Per sq. meter cost of construction of a market
Running/Management Cost of Public Utilities in UC – 145 Lahore	
Roads	Wear and tear cost over the last 10 years
Parks	Management and upgradation costs last 10 years
Sewage System and Water Pipes	New connections cost over the last 10 years
Gas	New connections cost over the last 10 years
Electricity and lighting	New connections cost over the last 10 years and new pole lights
Local *Mandi* (Public Markets)	Cost of municipal management of local mandis

To achieve the objective of estimating the Financial Cost of Providing Public Infrastructure, the list of the following variables is pertinent. We will be happy to share results of our study with urban unit and may be it can help you in policymaking.

I sincerely hope that you will give him a favourable consideration by providing him required data. If you would like further information, please feel free to contact me.

Sincerely,

Dr. Abid Rehman
Research Fellow
PIDE, Islamabad

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Gas	New connections cost over the last 10 years
Electricity and lighting	New connections cost over the last 10 years and new pole lights
Local *Mandi* (Public Markets)	Cost of municipal management of local mandis

To achieve the objective of estimating the Financial Cost of Providing Public Infrastructure, the list of the following variables is pertinent. We will be happy to share results of our study with Lahore Development Authority (LDA) and may be it can help you in policymaking.

I sincerely hope that you will give him a favourable consideration by providing him required data. If you would like further information, please feel free to contact me.

Sincerely,

Dr. Abid Rehman
Research Fellow
PIDE, Islamabad