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Spatial Distribution and Accessibility of Public Urban Green Spaces in Nagarjun Municipality, Kathmandu

by

Sanjay Kumar Rokka

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DECLARATION

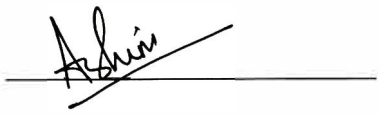
I hereby declare that the thesis entitled **"Spatial Distribution and Accessibility of Public Urban Green Spaces in Nagarjun Municipality, Kathmandu"** submitted to the Department of Architecture and Urban Planning in partial fulfillment of the requirement for the degree of Master Science in Urban Planning, is a record of an original workdone under the guidance of **Assoc. Prof. Dr. Ashim Ratna Bajracharya**. This thesis contains only work completed by me except for the consulted material which has been duly referenced and acknowledged.

Sanjay Kumar Rokka

PUL079MSURP017

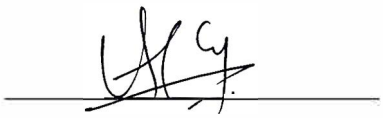
CERTIFICATE OF THESIS APPROVAL

The undersigned certify that they have read and recommended for acceptance, a dissertation entitled "**Spatial Distribution and Accessibility of Public Urban Green Spaces in Nagarjun Municipality, Kathmandu**", submitted by **Sanjay Kumar Rokka** in partial fulfillment of the requirements for the degree of **Masters of Science in Urban Planning**.

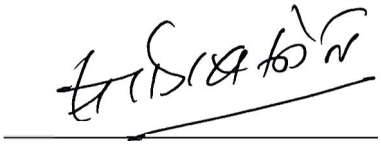


Assoc. Prof. Dr. Ashim Bajracharya
Supervisor
Department of Architecture IOE,
Pulchowk Campus

Er. Chakravarti Kanth
External Examiner
Joint Secretary
Ministry of Urban Development, GON



Dr. Ajay Chandra Lal
Program Coordinator
Department of Architecture IOE,
Pulchowk Campus



Er. Saroj Basnet
Senior Urban Planner

Date: 8th APRIL, 2025

ABSTRACT

This study aims to examine the distribution and accessibility of public urban green spaces (PUGS) in Nagarjun Municipality, Kathmandu, Nepal, and identify any inequalities in access across different socio-economic groups. As Nagarjun rapidly urbanizing, challenges arise in planning and maintaining green spaces, which affects the well-being and quality of life of residents. This study uses GIS mapping and community surveys to assess green spaces. The research will map out where public urban green spaces are located and measure how easy it is for people to access them. Additionally, the study will gather feedback from the community through surveys and interviews to understand their experiences with green spaces. The goal is to identify areas that lack access to green spaces and provide recommendations for fairer distribution. The findings will offer useful guidance to urban planners, helping to create a more inclusive and sustainable environment where all residents have equal access to green spaces.

Keywords: Public Urban Green Space, Spatial Equity, Accessibility, Urban Planning

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

DUDBC	Department of Urban Development and Building Construction
FAO	Food and Agriculture Organization
GIS	Geographic Information Systems
IUDP	Integrated Urban Development Plan
LGOA	Local Governance Operation Act
KII	Key Informant Interview
LISA	Local Government Institutional Capacity Self-Assessment
NSO	National Statistics Office
NUDS	The National Urban Development Strategy
PUGS	Public Urban Green Spaces
SDG	Sustainable Development Goals
UGS	Urban Green Spaces
UN	United Nations
WHO	World Health organization

CHAPTER ONE: INTRODUCTION

1.1 Background

As a result of urbanization, the world's population has become increasingly concentrated in cities. In 1940, only one in eight people lived in urban center, this increased to one in three by 1980 (*Report of the World Commission on Environment and Development: Our Common Future*, 1987). Currently, 55% of the world's population resides in urban areas, and this figure is projected to rise to 68% by 2050 (*World urbanization prospects*, 2019). Urbanization frequently transforms green spaces into residential, commercial, or industrial zones. As cities grow, natural habitats, parks, and open green areas disappear, resulting in a loss of biodiversity and ecological functions. This rapid growth of urban centers, driven by population increases, has huge environmental and socioeconomic consequences, including a notable disconnection between humans and the natural environment. Urbanization has negatively impacted green spaces within cities and continues to do so.

Urban green spaces (UGSs) are essential components of cities, contributing significantly to ecological stability, public health, and social cohesion. These areas include parks and reserves, sporting fields, riparian areas like stream and river banks, greenways and trails, community gardens, street trees, and nature conservation areas (Wolch et al., 2014b). Public urban green spaces (PUGS) are publicly accessible, government-managed areas which include a diverse range of places such as parks, gardens, forests, woods, riverside greenbelts, greening squares and plazas, greenways, and sport ground (Fan et al., 2017). They provide crucial benefits such as temperature regulation, surface runoff reduction, essential ecosystem services, and climate adaptation, enhancing urban sustainability and residents' quality of life (Gill et al., 2007). Green space availability is an important indicator necessary to explore urban complexity to improve human health and wellbeing and one component of intricate social-ecological interactions within cities (Kabisch et al., 2016). However, accessibility is a significant factor influencing urban residents' willingness to use urban green spaces (UGSs), with the physical characteristics of these space, such as their location and size, affecting how accessible they are perceived to be (Atiqul Haq et al., 2021). Wolch et al., 2014b advocate for the concept of "just green enough" cities, emphasizing the importance of equitable green space development to prevent green gentrification and ensure inclusivity. For urban areas like Nagarjun Municipality, located within the Kathmandu Valley, green spaces are becoming increasingly

crucial in mitigating the impacts of rapid urbanization, including overcrowding, environmental degradation, and diminished access to natural areas.

Despite their recognized importance, the equitable distribution and accessibility of PUGS remain elusive goals in many cities. Socio-economic disparities often influence the availability and quality of green spaces, with marginalized communities typically having less access to well-maintained parks and recreational areas (Rigolon, 2016).

Green spaces play a multifaceted role in urban settings. Environmentally, they improve air quality, aid in cooling urban heat islands, reduce surface water rain off, and support biodiversity by providing habitats for various species (Gill et al., 2007). Socially, green spaces are gathering places that foster community cohesion and social interaction, offering inclusive areas where people from diverse backgrounds can meet and engage in shared activities (Peters et al., 2010). Furthermore, the health benefits of green spaces are well-documented; access to nature has been associated with reduced stress, enhanced mental well-being, and increased opportunities for physical activity, which can lower the risks of chronic diseases such as obesity and cardiovascular disease(Maas, 2006; Mitchell and Popham, 2008). Open spaces and parks in urban areas serve three key purposes: improving air quality and providing breathing spaces, improving the physical, social, and psychological well-being of residents, and functioning as critical evacuation areas during disasters such as earthquakes (National Urban Development Strategy (NUDS), Part B, 2017).These spaces are vital for urban livability, aesthetics, social interaction, and recreation. Urban planning should prioritize equitable access to such spaces, shaping the urban landscape accordingly. Despite these benefits, the rapid pace of urbanization in many municipalities, including Nagarjun, has led to an uneven distribution of green spaces, often with significant accessibility gaps for residents in certain neighborhoods. As urban density increases, open areas are often converted to residential, commercial, or industrial uses, reducing the availability of accessible green spaces for residents (Wolch et al., 2014b). The National Urban Development Strategy, 2017 (NUDS, 2017) recommends that 2.5% of land in existing urban areas and 5% of land in new urban areas at the ward level should be allocated for urban green spaces. However, the lack of proper land use planning and urban sprawl in municipalities like Nagarjun often deviates from these standards, necessitating detailed geospatial analysis to evaluate current practices.

Nagarjun Municipality, located on the periphery of Kathmandu, has seen significant population growth and urban sprawl over the past decade. While development

brings economic benefits, it also strains natural resources and green infrastructure. Research indicates that maintaining a balance between built-up areas and green spaces is key to sustainable urban living (Badiu et al., 2016). Green spaces enhance urban resilience by offering numerous benefits, including temperature regulation, surface runoff reduction, essential ecosystem services, and climate adaptation, enhancing urban sustainability and residents' quality of life (Lorenzo-Sáez et al., 2021). However, data on the current state of UGSs in Nagarjun Municipality are limited, highlighting the need for a comprehensive analysis. In the context of urban planning, understanding the distribution and availability of UGS is crucial. Previous studies have shown that uneven distribution of green spaces can exacerbate environmental and social inequalities (Kabisch et al., 2016). This is particularly relevant for fast-growing urban areas like Nagarjun Municipality, where development pressures can lead to insufficient planning for UGSs.

This proposal aims to bridge that gap by employing geospatial analysis to map and assess the availability and distribution of PUGS in Nagarjun Municipality. Geospatial analysis not only aids in identifying gaps in green space distribution but also helps in formulating data-driven policies. By understanding where PUGS are lacking or unevenly distributed, urban planners can prioritize areas for development and enhancement. Through spatial analysis, the study provides Nagarjun's urban planners with actionable data that can guide policy decisions and resource allocation. The importance of green spaces is reflected in the United Nations' Sustainable Development Goals (SDGs), particularly SDG 11 "Sustainable Cities and Communities". The spatial distribution and accessibility of green spaces is critical to ensuring that all residents can enjoy these benefits, regardless of their socioeconomic status.

However, unequal access to PUGS is a persistent issue in many cities, raising concerns about environmental justice. This is particularly important in rapidly urbanizing cities, where the demand for land for housing and infrastructure can put pressure on existing PUGS (Odhengo et al., 2024). Research has shown that lower-income communities and minority groups often have less access to parks and green spaces, contributing to health disparities and reduced quality of life (Boone et al., 2009a; Phillips et al., 2022; Wolch et al., 2014b). According to NUDS,2017: The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) recommend a minimum availability of 9 square meters per person of green open space in cities, while many developed cities aim for higher standards, such as 20 m^2 per person (Kabisch et al., 2016).

This study not only contributes to Nagarjun's local urban planning efforts but also adds to the broader body of knowledge on sustainable urban development and social equity.

1.2 Nagarjun Municipality

1.2.1 Geographical Overview

Nagarjun Municipality is situated in Bagmati Province, Nepal, within the Kathmandu Valley. Spanning 29.8 sq. km, it lies between 85°12' E to 85°17' E longitude and 27°40' N to 27°44' N latitude, with an elevation ranging from 1,300 meters to 2,500 meters above sea level. The municipality is bordered by Kathmandu Metropolitan City (east), Dhunibesi Municipality (west), Tarkeshwor Municipality (north), and Chandragiri Municipality (south). Its northern regions include sections of Shivapuri Nagarjun National Park, featuring rich biodiversity, dense forests, and elevated hilltops that provide stunning panoramic vistas of the mountains . Administratively, it comprises 10 wards, established in 2017 after merging five former Village Development Committees (Bhimdhunga, Ichangu Narayan, Ramkot, Syuchatar, and Sitapaila) in 2014 (ERMC, 2019)..

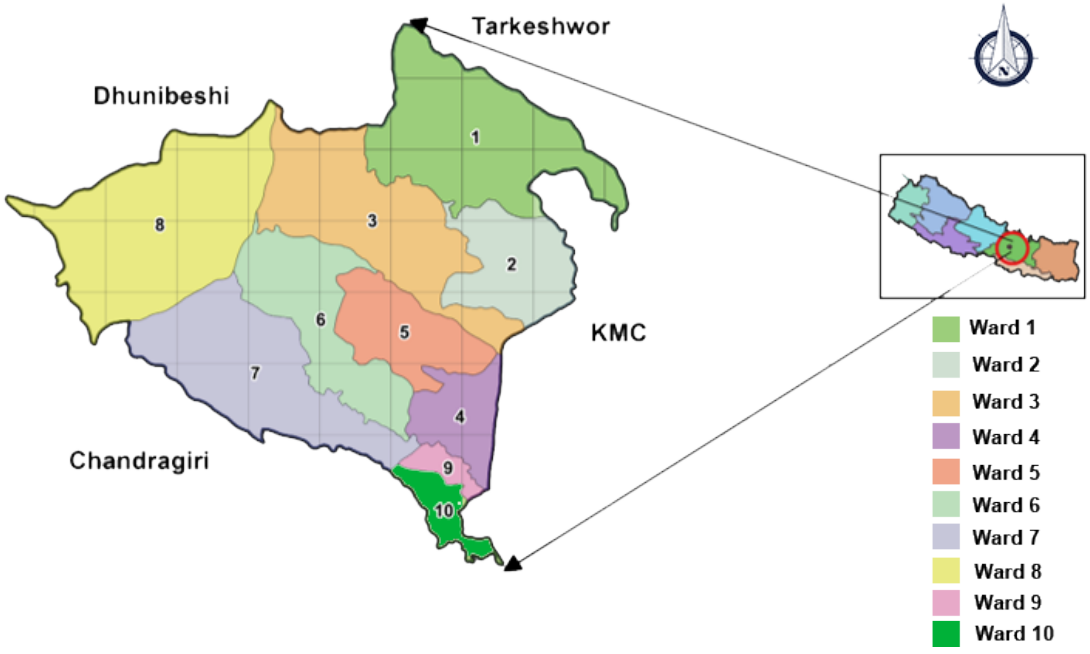


Figure 1.1: Map of Nagarjun Municipality

To understand the land use patterns in the municipality, a GIS map was taken from the 2016 Integrated Urban Development Plan (IUDP) report. Figure 1.2 shows

the existing land use in Nagarjun Municipality, including areas for built-up, forests, agriculture, and green spaces. This map helps to see how the land is used across the municipality and where public green spaces are located compared to other areas like homes and roads.

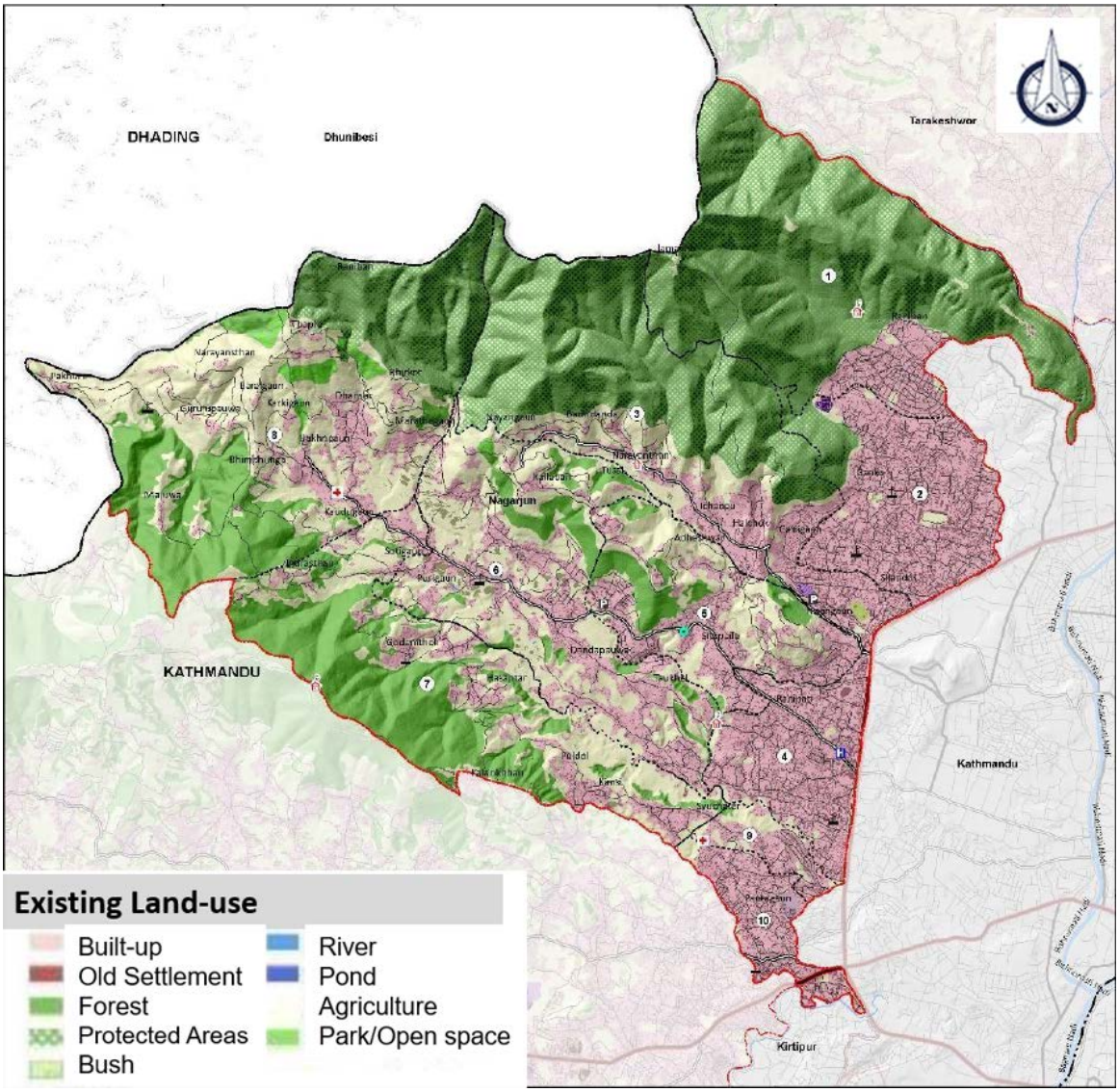


Figure 1.2: GIS map showing Existing Landuse
Source: Preparation of IUDP 2076

The map in Figure 1.2 shows that a large part of the northern area is covered by forests, mainly within the Shivapuri Nagarjun National Park, which occupies 30.28% of the municipality's land. Restricted access to Shivapuri Nagarjun National Park limits its use as a public green space. In the southern and central parts, there are more built-up areas (30.61%) and cultivation area (24.383%). This land use pattern

Table 1.1: Land Use Distribution

S.No.	Description	Area (Ha)	Percent
1	Builtup	913.45	30.611
2	Cultivation	727.56	24.383
3	Barren Land	0.031	0.001
4	Bush	24.14	0.809
5	Forest	413.5	13.857
6	Protected Forest	903.52	30.279
7	Pond	0.176772	0.006
8	Recreational	1.567725	0.053
9	River	0.031852	0.001
10	**Total**	**2984**	**100**

helps to understand why some wards, like Ward 4, might have less green space for residents, while others, like Ward 8, might have more because they are closer to forested areas. The map gives a starting point for looking at how green spaces are spread out and how easy they are to reach for people living in different wards.

1.2.2 Demographic Profile

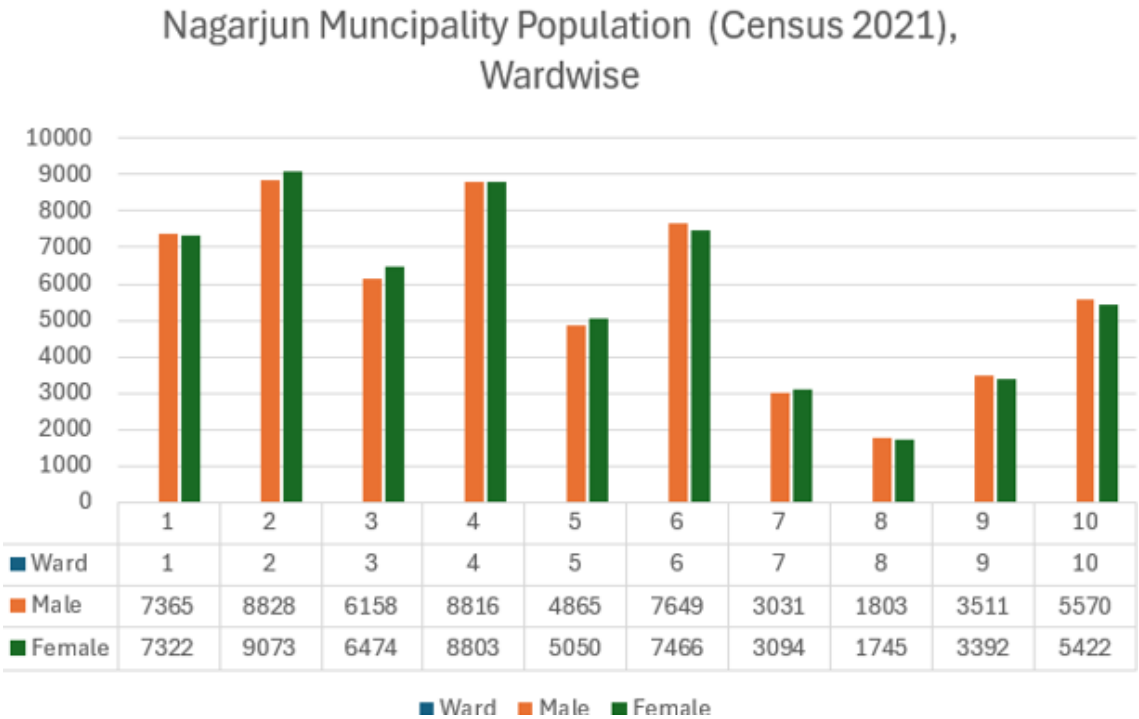
As per the 2021 census, Nagarjun Municipality has a population of 115,437, with 57,596 males and 57,841 females, reflecting a near-balanced gender ratio. The population growth rate stands at 5.19% annually, indicative of rapid urbanization. The municipality's administrative structure is divided into 10 wards (revised from an initial 14 in 2017), with wardwise population distribution detailed in Table 1.2. This demographic expansion underscores increasing demands for housing, infrastructure, and public services.

Nagarjun Municipality is an integral part of the Kathmandu Valley, which serves as Nepal's administrative, political, and cultural hub. The municipality's proximity to Kathmandu Metropolitan City makes it a critical provider of residential areas and infrastructure for the capital's growing population. It is also strategically located along the proposed Outer Ring Road, positioning it as a potential growth corridor for urbanization, particularly in Wards 4, 5, 6, and 9.

1.2.3 Urbanization Trends

Nagarjun Municipality is undergoing rapid urbanization, reflecting trends across the Kathmandu Valley. Its closeness to Kathmandu Metropolitan City makes it an

Table 1.2: Wardwise Population of Nagarjun Municipality (Census 2021)



	1	2	3	4	5	6	7	8	9	10
Ward	1	2	3	4	5	6	7	8	9	10
Male	7365	8828	6158	8816	4865	7649	3031	1803	3511	5570
Female	7322	9073	6474	8803	5050	7466	3094	1745	3392	5422

attractive option for residents and businesses escaping the crowded capital. The upcoming Outer Ring Road, cutting through Wards 4, 5, 6, and 9, is driving development in these areas, with new housing and commercial projects transforming the landscape. The GIS map in Figure 1.2 (Section 1.2.1) shows that built-up areas cover more than 30% of Nagarjun Municipality, which explains why green spaces are being reduced as more houses and roads are built. Growth is most noticeable along an east-west corridor, as the municipality absorbs overflow from Kathmandu, often turning farmland or open land into developed zones.

This growth presents competing priorities. While infrastructure development and economic opportunities are critical, preserving green spaces, agricultural land, and ecological resources —such as the Shivapuri Nagarjun National Park in the northern hills—remains a pressing concern. The municipality's annual population growth rate of 5.19% intensifies demands for housing, utilities, and public services, straining efforts to balance urban expansion with environmental conservation.

Local communities encounter issues like farmland loss, limited access to natural areas, and strain on resources due to urban growth. Urban planners and policymakers must tackle these challenges with sustainable development strategies. Critical con-

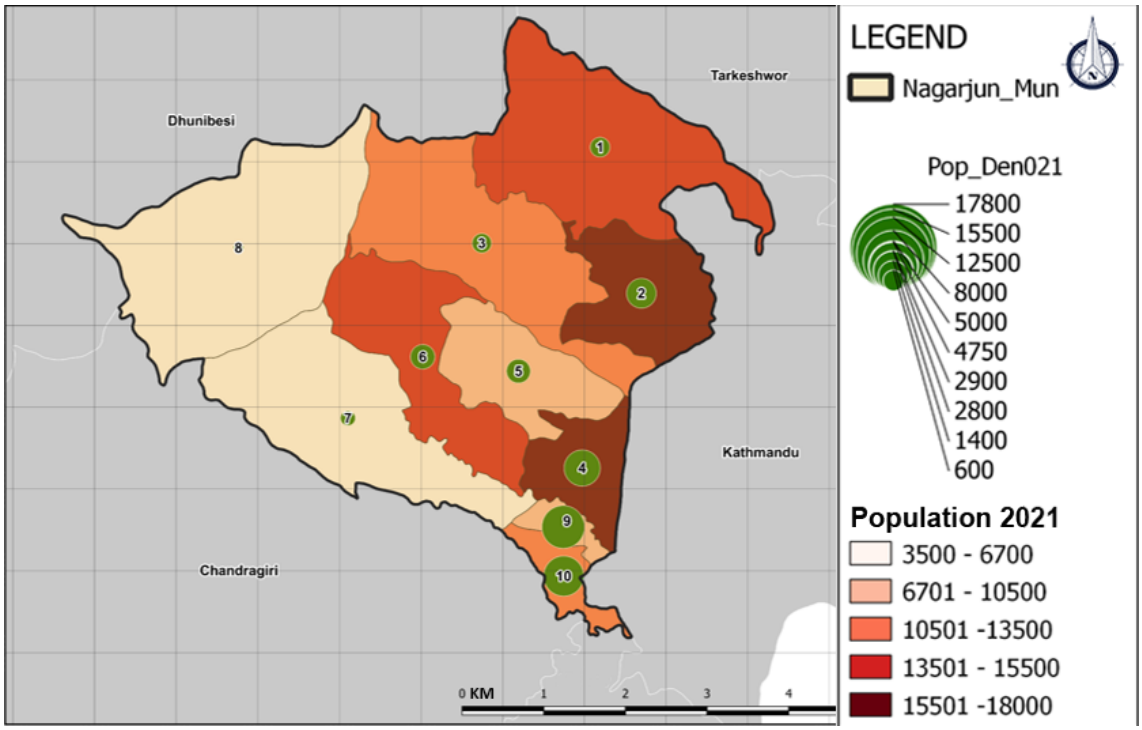


Figure 1.3: Population Density (Ward wise)

cerns include managing population growth without harming forests, parks, or air quality, and ensuring fair access to green spaces in densely urbanized areas.

Nagarjun's approach to managing these tensions—particularly its integration of ecological preservation into urban planning—could serve as a model for sustainable urban development strategies in similar high-growth regions across Nepal.

This study will focus on the municipality's existing green space distribution, its accessibility for residents, and its alignment with future urbanization trends, making it an ideal case for analyzing urban green space dynamics in a rapidly urbanizing context.

1.3 Need of the Research

The rapid pace of urbanization presents significant challenges for maintaining adequate green spaces. Cities experiencing fast growth, such as Nagarjun Municipality, often prioritize economic development and expansion at the expense of environmental considerations. This trend can result in the neglect or loss of PUGSs, which are essential for mitigating urban problems like heat islands, air pollution, and reduced quality of life (Kabisch et al., 2016). The imbalance in urban development without

a comprehensive plan for green spaces can lead to inequities in access, contributing to social and health disparities among residents.

The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) recommend a minimum availability of 9 square meters per person of green open space in cities. Kathmandu Valley's by-laws mandate community open space as an integral part of any land measuring 0.25 hectares or more. These by-laws also outline provisions for community open space in planned residential zones based on land size, ranging from 5% to 2.5% of the total land area. The Building by-laws for Kathmandu Valley (2064) stipulate open space requirements within plots. The Department of Urban Development and Building Construction (DUDBC) Planning Norms and Standards (2013) recommend a minimum designated open space of 2.5% of the sub-metro city area and 5% of the metro-city area. Nepal lacks a clear national policy regarding public urban green spaces. Existing provisions are fragmented and embedded within other policies and regulations.

Being adjacent to Kathmandu Metropolitan City, Nagarjun Municipality is undergoing substantial urban transformation, with residential and commercial developments increasingly encroaching upon available open spaces. We need to accurately find and map green spaces in urban areas using scientific methods so that we can use these areas in emergencies caused by natural or human-made hazards (M. S. Thapa & Poudel, 2018). Studies have demonstrated that access to green spaces is linked to improved physical and mental health, social integration, and environmental resilience. However, despite its importance, the issue of equitable distribution of PUGSs has not been sufficiently addressed in current urban policies.

Research on the spatial distribution of PUGSs using geospatial technologies has shown promising results in other urban contexts. For example, Singh, 2018 highlighted that planned urban areas often maintain a higher density of green spaces compared to unplanned regions. The need to replicate such analyses in Nagarjun Municipality is critical to identify gaps and guide future urban planning efforts. Addressing the disparity in green space distribution can foster a more inclusive urban environment and promote public well-being.

This study uses geospatial analysis to shed light on the current distribution of public urban green spaces (PUGS) in Nagarjun Municipality. The findings can guide urban planners and local authorities in making informed, evidence-based decisions.

Promoting equitable access to PUGS aligns with World Health Organization recommendations and advances Sustainable Development Goal objectives.

Green space accessibility is closely tied to health and quality of life. Research shows that proximity to green spaces supports physical activity, reduces stress, and promotes mental well-being (Mitchell & Popham, 2008). For urban residents, especially in high-density areas, access to green spaces can act as a buffer against urban stressors, providing spaces for exercise, relaxation, and socialization (Maas, 2006). The Constitution of Nepal, 2015, states that every citizen has the right to live in a clean and healthy environment, highlighting the importance of environmental sustainability and public well-being.The Local Governance Operation Act (2017), states that at the local level, each ward should have provisions for open spaces, parks, and gardens. Thus, green space accessibility is essential for fostering a more inclusive urban environment.

Nagarjun Municipality's fast urban growth creates challenges in balancing infrastructure needs with accessible green spaces. Its varied topography—flat and hilly complicates access, especially for residents in hilly areas who may lack nearby walkable green spaces due to natural barriers. This particularly impacts vulnerable groups, like the elderly or those with mobility issues. Geographic Information Systems (GIS) provide a valuable solution by offering detailed spatial data on green space distribution and access, helping planners identify and fix service gaps (Jankowski & Nyerges, 2001). However, despite the utility of GIS, limited research has applied this technology to analyze green space accessibility specifically in Nagarjun's unique urban and topographic context. This highlights an urgent need for localized, data-driven research to support equitable green space planning in the municipality.

Ensuring access to green spaces is key to promoting sustainability and social equity. This aligns with United Nations Sustainable Development Goal 11, specifically target 11.7, which focuses on creating inclusive, safe, resilient, and sustainable cities by providing universal access to green areas (United Nations, 2015). To meet these objectives, planners need data on the location and accessibility of green spaces for all city residents, enabling informed decisions for equitable and resilient urban development.

Furthermore, green spaces offer environmental benefits that are critical for urban resilience in the face of climate change. By improving air quality, reducing surface

temperatures, and managing stormwater, green spaces help mitigate some of the adverse effects of urbanization, such as urban heat islands and flood risks (Gill et al., 2007). In rapidly urbanizing areas like Nagarjun, where built-up areas are expanding, maintaining green spaces is key to creating a livable, sustainable urban environment. Research on green space accessibility can inform policies that balance urban development with environmental sustainability, ensuring that green spaces remain integral to Nagarjun's infrastructure even as the city grows.

1.4 Importance of the Research

Urban green spaces are increasingly recognized as essential components of sustainable, healthy, and equitable urban environments. They provide a wide range of benefits, including enhancing air quality, mitigating urban heat, offering recreational opportunities, and supporting social cohesion (Gill et al., 2007; Wolch et al., 2014b). However, as urbanization accelerates in cities like Nagarjun Municipality, located within the Kathmandu Valley, the accessibility and equitable distribution of green spaces are becoming increasingly constrained. Rapid urban expansion often prioritizes residential and commercial development over open spaces, resulting in a reduction of available green spaces (Kabisch & Haase, 2014).

Green space accessibility is closely tied to health and quality of life. Research shows that proximity to green spaces supports physical activity, reduces stress, and promotes mental well-being (Mitchell & Popham, 2008). For urban residents, especially in high-density areas, access to green spaces can act as a buffer against urban stressors, providing spaces for exercise, relaxation, and socialization (Maas, 2006). Yet, studies indicate that disadvantaged neighborhoods often face limited access to green spaces, which contributes to health disparities and limits opportunities for recreational and social engagement (Boone et al., 2009b). In Nagarjun, where urban density and socio-economic diversity are high, understanding and addressing these inequalities in green space accessibility is essential for fostering a more inclusive urban environment.

Nagarjun Municipality's rapid urban development presents unique challenges in balancing the demand for built infrastructure with the need for accessible green spaces. The municipality's topography, with its mix of flat and hilly terrain, adds to these challenges by influencing accessibility. Residents living in hilly areas may have fewer walkable green spaces, facing natural barriers that affect ease of access, particularly for vulnerable populations, such as the elderly or those with mobility limitations.

Geographic Information Systems (GIS) offer a powerful tool to address these challenges by providing precise spatial data on green space distribution and accessibility, allowing urban planners to identify and address gaps in service (Jankowski & Nyerges, 2001). However, despite the utility of GIS, limited research has applied this technology to analyze green space accessibility specifically in Nagarjun's unique urban and topographic context. This highlights an urgent need for localized, data-driven research to support equitable green space planning in the municipality.

Addressing green space accessibility is also essential for achieving broader sustainability and social equity goals. As part of the United Nations Sustainable Development Goal (SDG) 11, which aims to make cities inclusive, safe, resilient, and sustainable, target 11.7 emphasizes the importance of universal access to green spaces, particularly for vulnerable groups such as children, older adults, and individuals with disabilities (United Nations, 2015). Achieving these goals requires data on where and how green spaces are accessible to all urban residents, allowing planners to make informed decisions that support an equitable and resilient urban infrastructure.

Furthermore, green spaces offer environmental benefits that are critical for urban resilience in the face of climate change. By improving air quality, reducing surface temperatures, and managing stormwater, green spaces help mitigate some of the adverse effects of urbanization, such as urban heat islands and flood risks (Gill et al., 2007). In rapidly urbanizing areas like Nagarjun, where built-up areas are expanding, maintaining green spaces is key to creating a livable, sustainable urban environment. Research on green space accessibility can inform policies that balance urban development with environmental sustainability, ensuring that green spaces remain integral to Nagarjun's infrastructure even as the city grows.

1.5 Problem Statement

Nagarjun Municipality's rapid growth(with annual growth rate of 5.19%, Census 2021) poses significant challenges to sustainable urban planning, especially regarding the allocation and maintenance of urban green spaces. This 5.19% growth rate is higher than Nepal's national average of 0.92%, showing rapid urban pressure. The municipality's development trajectory shows a focus on infrastructural expansion, with limited emphasis on preserving or enhancing PUGS. This creates potential imbalances in the distribution of green spaces, impacting the overall quality of life and environmental health of the region.

The rapid urbanization occurring in Nagarjun Municipality, as part of the broader Kathmandu Valley, has significantly reshaped the urban landscape, often at the expense of green spaces. As residential, commercial, and infrastructural developments increase to accommodate a growing population, the availability and equitable distribution of accessible green spaces have become increasingly constrained. NUDS, 2017 underscores the importance of allocating a minimum of 2.5% of land in existing urban areas and 5% in new urban areas at the ward level for urban green spaces. However, these standards should be reviewed and verified against current urban planning policies and practices to confirm their applicability and implementation in Nagarjun Municipality. According to LISA (2079/080), Nagarjun Municipality appears to be inefficient in terms of physical infrastructure and environmental conservation. Green spaces, such as parks, gardens, and recreational areas, play a crucial role in supporting physical health, mental well-being, social interaction, and environmental sustainability. However, in Nagarjun, green space access varies considerably across neighborhoods, often leaving densely populated areas with limited proximity to these essential urban amenities.

Figure 1.4: Local Government Institutional Capacity Self-Assessment (LISA) of Nagarjun Municipality (2079/080)

In Nagarjun Municipality, the research highlights several critical health issues among the elderly population. About 60.91% of the elderly with non-agricultural occupations have mental health problems, and 50% of respondents reported experiencing at least one mental health issue. Respiratory diseases are observed in 20.63% of the elderly, possibly due to higher levels of air pollution. Hypertension is prevalent at 36.90%, while heart disease affects 10.31% of the elderly. The most common chronic illness is joint pain, affecting 67.20%, followed by hypertension or BP at 39.60%, and eye problems at 20.90%. These findings underscore the diverse health challenges faced by the elderly in Nagarjun Municipality.(Thaneshwor, 2021). Factors such as limited access to green spaces, and lack of social engagement exacerbate these issues, impacting their overall well-being and quality of life .Research indicates that environmental benefits, such as improved air quality and urban cooling, are often disproportionately distributed, leaving certain areas vulnerable to urban heat effects and pollution (Gill et al., 2007). These issues underscore the importance of ensuring that all residents have equal access to green spaces, particularly as urbanization accelerates and climate-related challenges grow.

Despite the well-documented importance of green spaces, limited research has focused on assessing green space accessibility within smaller, rapidly urbanizing municipalities like Nagarjun. Existing studies often concentrate on large metropolitan areas, particularly in developed countries, where data availability and urban infrastructure are markedly different from those in cities in developing regions (Rigolon, 2016). Furthermore, while Geographic Information Systems (GIS) have proven valuable in measuring spatial accessibility and analyzing urban resource distribution (Jankowski & Nyerges, 2001), there is a lack of GIS-based studies specifically tailored to the unique challenges of Nagarjun's varied topography diversity, and rapid urban expansion.

This research gap highlights the need for localized studies that can provide detailed insights into green space accessibility within the context of smaller, densely populated municipalities undergoing fast-paced development. Without such data, it is challenging for urban planners in Nagarjun to make informed decisions about green space allocation, potentially exacerbating existing accessibility disparities and limiting the social, environmental, and health benefits that green spaces offer. By focusing on the spatial distribution of green spaces in Nagarjun this study aims to fill this research gap and contribute to equitable urban planning efforts.

To address these issues, this study will employ a combination of GIS technology and qualitative analysis to map the current green spaces in Nagarjun, measure accessibility in terms of travel distances, and analyze how accessibility varies across neighborhoods. By overlaying demographic data onto GIS maps, the study will identify accessibility disparities. Additionally, the research will incorporate community interviews and surveys to gather residents' perspectives on green space accessibility and usage. This approach will provide a comprehensive understanding of both the spatial and experiential dimensions of green space accessibility. The findings will offer Nagarjun's urban planners actionable insights that can guide future land use policies and promote a more inclusive approach to green space distribution.

In summary, the primary problem addressed in this study is the uneven distribution and accessibility of green spaces within Nagarjun Municipality. This research seeks to quantify these disparities and develop evidence-based recommendations for urban planning. By filling the existing research gap with localized data, this study aims to support Nagarjun in creating a more equitable and sustainable urban environment where all residents have fair access to green spaces, contributing to the municipality's long-term resilience, health, and social inclusivity.

1.6 Research Objective

The main objectives of this research are:

Primary Objective

To assess the spatial distribution and accessibility of PUGS in Nagarjun Municipality.

Secondary Objectives

- To analyze the spatial distribution of public urban green spaces (PUGS) across wards.
- To measure accessibility of PUGS for residents of different socio-economic groups.
- To identify factors affecting the use of PUGS.

These objectives aim to contribute data-driven insights for Nagarjun Municipality, helping planners prioritize green space investments that align with community needs and support sustainable development goals.

1.7 Validity of the topic

This study examines the distribution and accessibility of public green spaces in Nagarjun Municipality, Kathmandu, highlighting their significance for sustainable urban living. As urbanization expands, green spaces often diminish, impacting the environment and residents' well-being. Green areas help reduce pollution, cool temperatures, support biodiversity, and offer spaces for recreation and social interaction. However, rapid urban growth often leads to uneven green space distribution, limiting access for some residents. Using GIS mapping and community surveys, this research provides accurate data on green space availability and identifies accessibility challenges. It aligns with global goals such as the UN's Sustainable Development Goal 11 and Nepal's National Urban Development Strategy, both of which emphasize inclusive and sustainable urban planning. The findings can guide policymakers in addressing disparities, ensuring equitable green space distribution, and improving urban resilience. Here urban resilience refers to a city's ability to adapt to challenges like climate change and population growth. While many studies focus

on major cities, smaller municipalities like Nagarjun remain understudied. This research fills that gap by offering localized insights for better urban planning. By advocating for accessible and well-distributed green spaces, this study contributes to a healthier, more sustainable urban environment for all residents.

1.8 Limitations

This study has a few challenges:

- **Restricted Park Access:** The Shivapuri Nagarjun National Park is not fully open to the public, limiting the green spaces we could study.
- **Data Issues:** Some information about green spaces was missing or unclear, which might affect our results.
- **Varied Landscape:** The municipality's mix of flat and hilly areas makes it hard to measure access consistently.
- **Social Factors:** We couldn't cover all the ways income or community differences affect green space use.
- **Mapping Tools:** The mapping software used had some limits, which could impact how precise our findings are.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents a comprehensive review of the literature on the spatial distribution and accessibility of public urban green spaces, with a specific focus on Nagarjun Municipality, Kathmandu. It also examines the socio-economic disparities influencing the availability and use of these spaces. The review is structured into the following sections:

1. **Theoretical Framework** – Provides insights into the planning theories and models that underpin urban green space development.

2. **Spatial Distribution of Green Spaces** – Discusses global, regional, and local trends in green space distribution.

3. **Accessibility of Green Spaces** – Explores various factors that determine the ease of access to urban green spaces.

4. **Socio-Economic Disparities** – Analyzes how income, class, and demographic differences affect green space availability and usage.

Each section draws from both global literature and local studies, incorporating theories, methodologies, and empirical findings from different contexts.

2.1 Theoretical Framework

The development and distribution of urban green spaces are guided by urban planning theories and green space management models. These frameworks help understand how and why green spaces are distributed in certain ways and what factors influence public access to these spaces.

2.1.1 Urban Planning Theories

Urban planning theories have evolved over time to emphasize the role of green spaces in city planning. Some of the key theories that influence green space distribution include:

Garden City Movement
Proposed by Ebenezer Howard (1898), the Garden City concept envisions a balanced

approach to urban planning, integrating green spaces, residential areas, and commercial hubs within a self-sufficient city. Howard's model advocated for greenbelts surrounding cities, ensuring that green spaces were evenly distributed to all urban residents. While this idea has influenced many modern cities, challenges remain in implementing such designs in rapidly urbanizing areas like Kathmandu, where land availability is limited.

Ecological Urbanism

Ecological urbanism, as described by Mostafavi & Doherty (2010), promotes the integration of ecological principles into urban development. This approach highlights the importance of green infrastructure, sustainable land use, and climate resilience. In rapidly urbanizing cities, ecological urbanism is increasingly used to reintroduce green spaces into dense urban fabrics to mitigate pollution, reduce the urban heat island effect, and improve public health.

New Urbanism

New Urbanism is a human-centered approach to city planning that focuses on walkability, accessibility, and mixed-use development. This theory emphasizes that green spaces should be accessible within a short walking distance for all urban residents. In the context of Nagarjun municipality, this concept is particularly relevant, given the increasing urban sprawl and encroachment of open spaces for commercial and residential developments.

Just City Theory

Fainstein's Just City Theory (2010) argues for equitable distribution of urban resources, including green spaces. This theory is highly relevant to municipality like Nagarjun, where disparities in land ownership, urban development policies, and socio-economic factors create unequal access to green spaces. The Just City approach suggests prioritizing marginalized communities in urban planning to ensure they have access to green spaces for recreation and well-being.

2.1.2 Green Space Theories

Several theories beyond urban planning focus specifically on the role of green spaces in cities. These theories explore why people need green spaces, how they interact with them, and their impact on mental and physical well-being.

Biophilia Hypothesis

Proposed by E.O. Wilson (1984), this theory suggests that humans have an innate connection to nature. Green spaces in urban areas satisfy this psychological and biological need by providing a setting for relaxation, stress reduction, and improved mental health. Studies have shown that residents living near green spaces report lower levels of stress and anxiety compared to those in areas with limited greenery.

Attention Restoration Theory (ART)

Developed by Kaplan et al., 1989, ART argues that exposure to natural environments helps restore cognitive function and mental energy. Green spaces provide a break from the overstimulation of urban environments, allowing people to recover from mental fatigue. This theory is particularly relevant for densely populated urban areas like Kathmandu, where access to green spaces can serve as an essential resource for mental well-being.

Stress Reduction Theory (SRT)

Ulrich et al., 1991 proposed that natural environments have a calming effect on people, helping reduce stress and improve mood. Research has found that patients recovering from surgery heal faster when they have a view of greenery compared to those in windowless hospital rooms. This theory underscores the health benefits of ensuring accessible green spaces in urban environments.

Social-Ecological Model

This model, proposed by Folke et al., 2003, examines how social factors (such as income, education, and culture) interact with environmental factors to determine green space access and utilization. It suggests that urban green spaces should be planned with community engagement, ensuring that they are culturally relevant, accessible, and well-maintained.

2.1.3 Green Infrastructure and Sustainability Models

In addition to theoretical perspectives, green space development is also shaped by urban sustainability models.

Green Infrastructure Approach

Green infrastructure refers to networks of natural spaces and semi-natural systems that provide environmental benefits. These include:

- Parks and urban forests
- Green rooftops
- Wetlands and stormwater management systems

This approach promotes climate resilience and urban sustainability by integrating green spaces into city planning (Gill et al., 2007).

Compact City Model
The Compact City Model promotes high-density urban development with integrated green spaces. The aim is to reduce urban sprawl, improve land use efficiency, and ensure equitable green space distribution. However, the challenge in cities like Kathmandu is that rapid urbanization has outpaced green space planning, leading to encroachment on open spaces and a lack of accessible public green spaces.

2.2 Spatial Distribution

2.2.1 Spatial Distribution: Concepts and Relevance

Spatial distribution refers to the way physical features, services, or phenomena are arranged across geographic space. In urban planning, it is often used to analyze how amenities such as public services, green spaces, infrastructure, or population are located and accessed by residents (Zhang et al., 2022). It provides a critical lens to examine patterns of development, identify service gaps, and inform decisions on land use planning.

A balanced spatial distribution is fundamental to achieving urban equity. Uneven distribution can lead to disparities in access, where certain groups or neighborhoods benefit from better proximity to public services, while others remain underserved (Nesbitt et al., 2019). In cities experiencing rapid urbanization, spatial distribution patterns often reveal socio-economic divides, historical planning biases, or unregulated expansion.

Scholars have noted that spatial distribution is shaped by several factors, including population density, land values, planning regulations, topography, and historic settlement patterns. For instance, central urban areas often have better service concentration due to legacy planning, while peripheral or newly urbanizing zones may lack adequate public amenities (Wei et al., 2022).

In rapidly growing cities, spatial distribution also changes dynamically with development pressures. Informal settlements may emerge in poorly served areas, while green spaces and other public facilities are frequently replaced by private developments (Gupta et al., 2016). Such transformations reinforce spatial inequity, particularly for low-income or marginalized populations.

The concept of spatial distribution is closely tied to spatial justice, a term that describes how spatial organization affects fairness and opportunity. As Soja (2010) explains, spatial justice seeks not only equal access but also the right to shape the spatial character of one's environment. From this perspective, assessing spatial distribution is essential to ensure all communities are equitably served.

Recent advances in Geographic Information Systems (GIS) have improved the ability to study spatial distribution in detail. GIS allows planners to visualize, measure, and model spatial patterns and relationships, making it a vital tool in evidence-based urban decision-making (Jankowski & Nyerges, 2001).

2.2.2 Spatial Distribution of Green Spaces

Urban green spaces, encompassing parks, gardens, urban forests, and informal green patches, exhibit uneven distribution across cities, shaped by historical planning, socio-economic factors, rapid urbanization, and environmental pressures. Remote sensing techniques, GIS mapping, and landscape metrics have been widely utilized to analyze these patterns, offering insights into land use dynamics and the transformation of green spaces, as demonstrated in studies like that of Kathmandu Valley (R. B. Thapa & Murayama, 2009). Such approaches reveal trends that resonate at global, regional, and local scales.

Global Perspectives

Globally, the spatial distribution of urban green spaces reveals stark contrasts between cities in developed nations and those in rapidly urbanizing regions. In many cities of Europe and North America, decades of planning have often resulted in more systematic and equitable green space provision. For example, European capitals typically integrate large, centrally located parks and well-connected green corridors that ensure residents have routine access to nature (Kabisch & Haase, 2013). This integrated planning helps mitigate issues like the urban heat island effect, supports recreational needs, and enhances overall urban livability.

In contrast, many cities in Asia, Africa, and Latin America face challenges resulting from rapid, and sometimes unplanned, urban expansion. These cities often struggle to preserve or create sufficient green space amid rising population pressures and informal development. Studies have found that in such contexts, green spaces tend to be fragmented and unevenly distributed—frequently concentrated in wealthier or historically planned neighborhoods, while peripheral or informal areas are left with little to no green cover (Wolch et al., 2014a; Bhandari and Zhang, 2022). For instance, remote sensing analyses of cities like Kathmandu reveal that overall per capita green space is well below internationally recommended standards, and the spatial patterns show clear disparities between central areas and rapidly expanding fringes (Pokhrel, 2019).

Recent global assessments underscore that while green space is acknowledged as crucial for urban health and resilience, its provision remains one of the most pressing environmental justice issues worldwide (Wolch et al., 2014b). As climate change and environmental degradation accelerate, the need for integrated green infrastructure has become even more critical—a need that is not being met equally across all global regions.

Regional Studies

At the regional level, the spatial distribution of urban green spaces is shaped by local planning traditions, regional urbanization dynamics, and socio-economic forces that vary from one part of the world to another. In South Asia, for example, rapid urban growth has often led to a significant loss of green space. Cities such as Delhi and Kathmandu have experienced extensive fragmentation of green areas due to unplanned expansion and the conversion of agricultural or peri-urban lands into built-up areas (Pokhrel, 2019). Here, systematic mapping using GIS shows that while central business districts may retain well-planned parks, peripheral and informal settlements often lack accessible green space.

Similarly, in Latin America, historical land-use patterns and socio-economic inequalities contribute to highly uneven green space distribution. In many Latin American cities, wealthier neighborhoods enjoy large, well-maintained parks and tree-lined streets, whereas low-income communities face a scarcity of green infrastructure, exacerbating social inequities (Wolch et al., 2014b). These studies emphasize a common trend across regions: in fast-growing cities, urban green spaces are frequently

considered a luxury. This leads to an uneven distribution, where some areas are lush with greenery while others have very limited access.

Local Studies

Local-scale analyses provide the most detailed insights into how urban green space distribution affects everyday life and community well-being. In Kathmandu, local studies have demonstrated that green space coverage can vary dramatically even between adjacent neighborhoods. Studies reveal that many parts of Kathmandu fail to meet the WHO's recommended minimum green space per capita. In low-income areas and informal settlements, not only is the total green space reduced, but its spatial configuration is also less connected and more fragmented (Pokhrel, 2019). Studies using remote sensing data have shown that the remnants of larger historical green areas are often encroached upon by unregulated construction and infrastructure projects. Such encroachment not only reduces the total area available for recreational and ecological purposes but also increases the isolation of these patches from each other, further diminishing their overall ecological and social benefits.

Moreover, local studies frequently highlight how historical legacies—such as the traditional public open space known as Tundikhel in central Kathmandu—continue to serve as crucial "green lungs" despite their gradual reduction over time due to urban pressure (Rajopadhyaya, 2020). These case studies underscore the critical need for local policies that protect existing green spaces and promote the equitable distribution of new green infrastructure. They also stress the importance of community participation in monitoring and maintaining these spaces to ensure that local residents have reliable access to the benefits of nature in their immediate environment.

2.2.3 Challenges in the Spatial Distribution of Urban Green Spaces

Even as global, regional, and local studies have documented the benefits of urban greenery, a number of challenges hinder the equitable spatial distribution of these areas. One prominent challenge is the impact of rapid urbanization and unplanned development. In many cities—especially those in the Global South—informal settlements and high-density developments consume land that might otherwise serve as green space. Studies from Kathmandu have shown that uncontrolled expansion results in patchy, fragmented green spaces, with informal neighborhoods experiencing the most severe deficits (Pokhrel, 2019). Moreover, infrastructural development often takes precedence over green space preservation. For example, Guthrie, 2024 re-

cently highlighted that even in cities with growing populations, financial constraints and the prioritization of housing over parks lead to further reductions in available urban greenery. This trend is exacerbated by local regulatory frameworks that fail to enforce minimum standards for green space provision, resulting in spatial inequity across different socio-economic groups (Wolch et al., 2014a). Another challenge is the absence of integrated planning across different scales. While many cities have green spaces, their spatial configuration and connectivity are often poorly designed. Studies using landscape metrics show that although large parks may be present, smaller green areas are typically fragmented and disconnected, limiting their overall ecological value. For instance, a bibliometric analysis by Guinaudeau et al., 2023 underlined the importance of considering not just the total area, but also the spatial arrangement, connectivity, and accessibility of green spaces—a point further supported by studies that use remote sensing data to analyze the heterogeneity in green space distribution (R. B. Thapa & Murayama, 2009).

Socio-economic differences also have a significant impact. In many cities, richer neighborhoods enjoy more and better-quality green spaces, while poorer areas often have little to no green infrastructure. This unequal spread leads to environmental injustice, where benefits like reduced temperatures and cleaner air from urban greenery are not available to everyone(Wolch et al., 2014b).

2.2.4 Strategies to Improve the Spatial Distribution of Urban Green Spaces

Given these challenges, several strategies have been proposed and, in some cases, implemented to improve the spatial distribution and functionality of urban green spaces.

Integrated Urban Planning

A key strategy is the adoption of integrated urban planning approaches that balance development with the preservation and creation of green spaces. Cities such as Oslo and Singapore serve as examples where long-term urban strategies ensure that green spaces are woven into the fabric of urban design. Oslo, for instance, has invested in extensive networks of green corridors and restored natural waterways to maintain connectivity between urban parks (Beatley, 2012). Similarly, Singapore's commitment to a "city in a garden" concept has led to policies that integrate green roofs, vertical gardens, and expansive park networks into dense urban environments (Ling, 2016).

Multi-Criteria GIS-Based Planning

Technological advancements in GIS and remote sensing have allowed urban planners to adopt multi-criteria decision-making (MCDM) approaches to assess the suitability of land for green space development. The analytical hierarchy process (AHP), for example, has been used to weigh factors such as population density, land use, existing infrastructure, and environmental conditions to identify optimal locations for new green spaces (Pokhrel, 2019). These methods not only pinpoint areas most in need of green space but also help monitor changes over time. Research by Guinaudeau et al., 2023 emphasizes that a multi-dimensional framework is essential to capture the complex interplay between green space availability and urban population distributions.

Policy and Regulatory Interventions

Local governments can also play a transformative role through policy and regulatory measures. Establishing minimum green space standards, as recommended by the World Health Organization, can provide a benchmark for urban planners (Organization, 2017). Moreover, zoning laws that protect or require green space in new developments are critical. In some cities, initiatives like the "one ward, one park" program have been launched to ensure equitable green space distribution. However, these efforts must be supported by consistent enforcement and community participation to be effective (Wolch et al., 2014b).

Community-Led and Participatory Approaches

Another promising strategy involves community engagement and participatory planning. Local residents often have the best insights into the needs and potential uses of their neighborhoods. Participatory Geographic Information Systems (PPGIS) have been employed to gather local data and community feedback, ensuring that new green spaces not only fill spatial gaps but also meet local cultural and recreational needs (Battiston & Schifanella, 2023). By involving communities in the planning process, cities can foster a sense of ownership over green spaces, which in turn encourages better maintenance and long-term sustainability.

2.3 Accessibility

2.3.1 Accessibility: Concepts and Definitions

Accessibility is a fundamental concept in urban planning, geography, and social policy, often defined as the ease with which individuals can reach and make use of services, activities, and destinations (Geurs & van Wee, 2004). It encompasses more

than just physical distance or travel time—it includes social, economic, temporal, and psychological dimensions that influence a person's ability to participate in urban life.

At its core, accessibility answers the question: *"How easily can people reach the opportunities they need?"* These opportunities may include workplaces, schools, healthcare, recreational areas, or community facilities. The concept is central to ensuring equity and inclusivity in planning decisions, as differences in accessibility often reflect broader social inequalities.

2.3.2 Key Components of Accessibility

Accessibility is commonly broken down into four interrelated components(Geurs & van Wee, 2004) :

- **Land-use component**: The spatial distribution of opportunities or destinations.
- **Transport component**: The availability, quality, and cost of transport systems enabling movement.
- **Temporal component**: Time-based constraints, such as opening hours or personal schedules.
- **Individual component**: Personal abilities, resources, and perceptions—such as mobility limitations, financial capacity, or safety concerns.

In addition to its technical aspects, accessibility is increasingly understood through a human-centered perspective, where factors like safety, comfort, dignity, and social inclusion are considered just as important as infrastructure (Lucas, 2012). For instance, two individuals might have the same physical proximity to a location, but one may face greater barriers due to age, disability, gender, or economic hardship.

Enhancing accessibility in urban planning involves both improving physical infrastructure—such as roads, walkways, and public transport—and addressing broader socio-economic and institutional barriers. As such, accessibility is not only a spatial issue but also a matter of equity and social justice.

2.4 Accessibility of Green Spaces

This chapter explores the importance of urban green spaces and their accessibility to city residents. Green spaces provide social, psychological, and environmental benefits, but these can only be fully achieved if people can easily reach and use them. Accessibility includes both how close these spaces are to residents and how simple it is for people to get to them. The chapter discusses key ideas, ways to measure accessibility, and real-world examples. It highlights new research methods and practical ways to plan green spaces effectively.

2.4.1 Concepts and Definitions

Accessibility in the context of urban green spaces is a multi-dimensional construct. It encompasses:

- **Physical Proximity:** How near a green space is to people's residences, often measured as the distance or travel time (e.g., within a 5- or 10-minute walk) (Organization, 2017).
- **Functional Accessibility:** The degree to which green spaces are equipped with amenities (e.g., paths, seating, lighting) that facilitate their use by diverse groups, including children, seniors, and people with disabilities.
- **Perceived Accessibility:** Residents' subjective feelings about whether a green space is welcoming, safe, and easy to reach. This factor can be influenced by social, cultural, and environmental conditions.

Factors Affecting Accessibility of Green Spaces

Factors affecting the accessibility of green spaces:

- **Physical Proximity:** How near a green space is to people's residences, often measured as the distance or travel time (e.g., within a 5- or 10-minute walk) (Organization, 2017).
- **Functional Accessibility:** The degree to which green spaces are equipped with amenities (e.g., paths, seating, lighting) that facilitate their use by diverse groups, including children, seniors, and people with disabilities.

- **Perceived Accessibility:** Residents' subjective feelings about whether a green space is welcoming, safe, and easy to reach. This factor can be influenced by social, cultural, and environmental conditions.

- **Spatial Connectivity::** How well green spaces are integrated into the broader urban fabric, including the presence of green corridors and networks that link parks with neighborhoods (Beatley, 2012).

These dimensions highlight that accessibility is not simply about distance. Instead, it involves an interplay between physical distance, infrastructure quality, safety, social perceptions, and connectivity.

2.4.2 Measurement Techniques

Researchers have developed a variety of methods to assess the accessibility of urban green spaces. Several key techniques include:

Geographic Information System (GIS) Analysis

GIS is a powerful tool for measuring green space accessibility. Researchers use GIS to map green space locations, overlay them with residential and transportation data, and analyze spatial patterns. Typical GIS methods include:

- **Euclidean Distance Analysis:** Measuring the straight-line distance between residents and the nearest green space.

- **Network Analysis:** Evaluating the travel time or distance along actual roads and paths rather than straight-line (Euclidean) distances. This method accounts for barriers, route connectivity, and pedestrian networks (Guinaudeau et al., 2023).

- **Two-Step Floating Catchment Area (2SFCA) Method:** A widely used approach that considers both the supply of green space and the demand by the local population. The first step identifies the green space catchment for each facility (e.g., park), and the second step calculates an accessibility score by summing the available green space per capita for each residential area within a defined catchment (Battiston & Schifanella, 2023).

Remote Sensing and Satellite Imagery

High-resolution land cover data can be obtained from satellite imagery, including Sentinel-2, enabling the calculation of vegetation indices such as the Normalized Difference Vegetation Index (NDVI). NDVI values help identify and classify green spaces across large areas. When combined with population data in GIS, these techniques can offer a measure of per capita green space accessibility (R. B. Thapa & Murayama, 2009).

Mixed-Methods Approaches

Given that accessibility has a strong perceptual component, mixed-methods studies are increasingly used to complement quantitative GIS analyses. Surveys, interviews, and participatory mapping (often through Public Participation Geographic Information Systems, or PPGIS) gather resident opinions on how accessible and safe they perceive local green spaces to be. This information can help planners understand potential barriers that are not evident in quantitative data alone (Battiston & Schifanella, 2023)

2.4.3 Case Studies on Accessibility

Case Study: Urban Green Space Accessibility in Brussels

In a study of Brussels, researchers combined GIS-based network analysis with resident surveys to evaluate how different data sources affect the understanding of green space accessibility. They found that while traditional Euclidean distance measures suggested a relatively even distribution of parks, network analysis revealed significant disparities—especially in older, more densely populated districts. This study underscored the need for considering real-world travel routes when planning urban green infrastructure (Wolch et al., 2014b).

Case Study: Accessibility Challenges in Kathmandu Valley

Local studies in Kathmandu have shown that despite a historical legacy of open spaces, rapid urban expansion has led to a stark decline in per capita green space. In particular, areas such as Nagarjun Municipality suffer from highly fragmented green space distribution. Studies have demonstrated that many low-income and informal settlements in the Valley lack sufficient walking distance access to parks or public lawns, and residents must often travel longer distances to reach larger green

areas. These findings emphasize the importance of improving both the quantity and connectivity of green spaces in rapidly urbanizing contexts.

Case Study: Integrative Approaches in European Cities

Many European cities have pioneered integrative approaches that combine high-resolution mapping with participatory planning. For example, cities like Oslo and Paris have developed comprehensive networks of green corridors that link large parks with smaller neighborhood green spaces. These networks improve overall accessibility by ensuring that most residents live within a short walk of a park. Such examples serve as benchmarks for cities worldwide facing similar challenges (Kabisch & Haase, 2013).

2.4.4 Challenges in Green Space Accessibility

Despite methodological advances and successful case studies, several challenges persist:

2.4.5 Strategies for Enhancing Accessibility

To address these challenges, several strategies have emerged:

- **Improved Connectivity**: Establishing green corridors and pedestrian-friendly pathways can help integrate scattered green spaces, making them more accessible to residents even if they are not located directly next to residential areas.
- **Inclusive Urban Planning**: Incorporating community feedback through participatory approaches can help ensure that new green spaces are designed to meet the needs of local populations, addressing both physical and perceptual accessibility barriers.
- **Multi-Criteria Assessment Tools**: Using advanced GIS-based methods such as the 2SFCA method helps planners identify priority areas for intervention by considering both supply and demand factors.
- **Policy Interventions**: Implementing and enforcing zoning regulations and minimum green space standards are essential. Governments can require that

new developments include dedicated green space accessible to residents and invest in the renovation of existing parks to improve safety and functionality.

2.5 Socio-Economic Disparities

Urban green spaces are valued for their environmental, social, and health advantages, yet their distribution and quality are often unequal. Socio-economic differences significantly affect who benefits from these areas. This chapter explores these disparities, examining unequal access, usage patterns, and the factors shaping how various socio-economic groups interact with green spaces.

2.5.1 Access Inequality

Historical and Structural Roots

In many urban areas, the inequitable distribution of green spaces is deeply rooted in historical planning decisions and discriminatory policies. For example, practices such as redlining in the United States have contributed to lower investments in infrastructure—including parks and green corridors—in predominantly minority and low-income neighborhoods (Wolch et al., 2014a). These policies have long-lasting effects, as neighborhoods with a legacy of underinvestment often continue to lack sufficient greenery. Such historical legacies are not unique to North America; cities in Latin America and Asia also display stark contrasts between affluent areas and marginalized communities.

Current Patterns of Inequality

Recent research using GIS and remote sensing reveals that wealthier neighborhoods typically have more green space per person, better-maintained parks, and well-connected green networks compared to low-income areas. For example, in Kathmandu Valley, rapid, unplanned urban growth has resulted in scattered green spaces mostly found in central or affluent zones, leaving informal settlements on the city's edges with little access. Similarly, in cities like New York, research has highlighted that neighborhoods formerly affected by redlining exhibit significantly lower tree canopy coverage than more affluent areas. These disparities mean that residents in low-income areas not only have fewer green spaces available but also endure the additional burden of urban heat and poor air quality (Wolch et al., 2014b).

2.5.2 Utilization Patterns

Differential Use by Socio-Economic Status

Access to green spaces does not automatically translate into usage. Utilization patterns of urban green spaces vary significantly across socio-economic groups. Wealthier communities, with better-maintained and safer parks, tend to use these spaces more frequently for leisure activities, exercise, and social gatherings (Kabisch & Haase, 2013). In contrast, residents in economically disadvantaged neighborhoods often face barriers that discourage regular use. For example, even if a park exists nearby, issues such as poor lighting, lack of maintenance, and perceptions of safety can lead to underuse by local residents.

Perceived Quality and Usability

The quality of green spaces is a major factor influencing their utilization. Studies have found that residents' perceptions of safety, cleanliness, and aesthetic appeal strongly affect whether they choose to spend time in a park or green area (Wolch et al., 2014b). In low-income areas, where parks may be neglected or poorly designed, residents might be less inclined to use these spaces, even if they are physically close. This creates a cycle where underused green spaces receive even less attention and funding, further diminishing their quality and usability.

Cultural and Social Influences

Cultural values and social norms also play a role in how green spaces are utilized. In some contexts, green spaces serve as important venues for community gatherings, festivals, and informal social interactions. However, the design and programming of these spaces may not always reflect the cultural practices or needs of marginalized communities. For example, parks that cater primarily to Western ideals of recreation may not offer the facilities or programming that resonate with local cultural practices in diverse urban settings. Ensuring that green spaces are inclusive and adaptable to the cultural context of their users is crucial for maximizing their utilization across socio-economic groups.

2.5.3 Factors Influencing Utilization

Infrastructure and Design

The physical design of urban green spaces greatly influences how they are used. Key design elements such as pathways, seating, playgrounds, and lighting are critical

in making a space accessible and inviting. High-quality infrastructure not only improves the functional aspects of a park but also enhances its aesthetic appeal. In contrast, parks with minimal amenities or poor design are less likely to be frequented by residents, particularly those from lower-income communities.

Safety and Maintenance

Perceived safety is another essential factor in determining park utilization. Areas with higher crime rates or inadequate maintenance tend to discourage public use. Maintenance issues, such as litter, vandalism, or dilapidated facilities, are more prevalent in underfunded parks—often those in marginalized neighborhoods—thereby reducing their appeal. Ensuring that parks are well-maintained and secure can significantly improve their usage (Wolch et al., 2014b).

Economic and Policy Influences

Economic factors, including local government funding and investment priorities, also influence both the distribution and the utilization of green spaces. Municipalities with greater financial resources are better able to invest in high-quality parks and green infrastructure. In contrast, cities facing budget constraints may struggle to allocate sufficient resources to maintain existing parks or create new ones, particularly in low-income areas. Policy interventions, such as zoning regulations that require a minimum percentage of green space in new developments, have the potential to address these inequities, but their effectiveness depends on robust enforcement and community engagement.

Social Capital and Community Engagement

Social capital—the networks and trust within communities—can also influence how green spaces are used. When local communities are actively involved in the planning and maintenance of their parks, these spaces tend to be better cared for and more widely used. Participatory planning methods, such as PPGIS (Public Participation Geographic Information Systems), can help incorporate local insights and foster a sense of ownership among residents, which in turn enhances park utilization (Battiston & Schifanella, 2023).

2.5.4 Addressing Socio-Economic Disparities

Taking into account the varied aspects of economic and social disparities ti in green space access and utilization, a combination of approaches is needed to bridge the gap:

- **Policy Reforms**: Governments should implement and enforce regulations that guarantee a minimum standard of green space for all urban residents. This includes revisiting zoning laws and development guidelines to ensure that new projects incorporate adequate green space.
- **Targeted Investment**: Directing public funds and resources towards improving green infrastructure in historically underserved neighborhoods is essential. Initiatives such as "one ward, one park" can help ensure that even low-income communities have access to quality green spaces.
- **Community Engagement**: Empowering residents through participatory planning processes can help ensure that parks meet local needs and preferences, thereby improving utilization rates.
- **Innovative Financing**: Leveraging innovative financing mechanisms, including public–private partnerships and environmental grants, can provide the necessary funds to develop and maintain green spaces in economically disadvantaged areas.

2.6 National Plans, Policies, and Strategies

Urban green spaces (UGS) play a vital role in enhancing environmental sustainability, public health, and social cohesion in cities. In Nepal, rapid urbanization and haphazard development have intensified the need for policies and strategies to safeguard and expand UGS. This section reviews Nepal's national plans, policies, and institutional frameworks relevant to the spatial distribution and accessibility of UGS, with a focus on Kathmandu Valley and Nagarjun Municipality.

2.6.1 National Urban Development Strategy (NUDS), 2017

The National Urban Development Strategy (NUDS), 2017 serves as Nepal's primary roadmap for sustainable urban development. It emphasizes the integration of green spaces into urban planning to mitigate environmental challenges such as air pollution and urban heat islands. The NUDS sets quantitative targets: 2.5% of land in existing

urban areas and 5% in new urban developments must be designated as publicly accessible green space at the ward level (MoUD, 2017). However, Kathmandu's current green space coverage is alarmingly low—0.48% in Kathmandu and 0.06% in Lalitpur (NUDS, 2017)—highlighting a critical implementation gap. The strategy also stresses the need for standardized definitions of "open spaces" and improved municipal-level data collection to monitor progress.

2.6.2 Land Use Policy 2072 (2015)

The Land Use Policy 2072 addresses urban sprawl and the encroachment of agricultural and public lands. It mandates the development of green belts along roads, rivers, and canals and prioritizes minimum green areas, gardens, and playgrounds in residential zones. This policy underscores the importance of protecting riparian zones and integrating green corridors into land-use plans. However, challenges persist due to weak enforcement and competing land-use demands.

2.6.3 Environment-Friendly Local Governance Framework 2021

Under the Environment-Friendly Local Governance Framework 2021, the document details several key provisions concerning parks. It mandates that public parks and gardens must be equipped with inclusive toilets that cater to the needs of children, differently-abled individuals, and the elderly. Additionally, municipalities are required to create recreational parks, green spaces, and designated rest areas for senior citizens on public or open lands. On a more refined level, the framework calls for the development of biodiversity-friendly parks within municipal areas and advocates for the planting of diverse tree species and flowering plants along roads, footpaths, and other public spaces to enhance urban aesthetics. Furthermore, it emphasizes the importance of incorporating parks and green spaces into urban planning initiatives, with clear measures to safeguard these areas from encroachment.

2.6.4 Planning Norms and Standards (2013)

The Planning Norms and Standards (2013) by the Department of Urban Development and Building Construction (DUDBC) provide technical guidelines for UGS allocation. It stipulates that 5% of metropolitan city areas (e.g., Kathmandu) must be reserved for neighborhood parks, community parks, and green belts (DUDBC, 2013). For smaller municipalities like Nagarjun, these norms are less prescriptive, creating ambiguity in implementation. Case studies from Sinamangal Land Pooling

reveal that only 3–5% of developed land is allocated to UGS, often fragmented and underutilized (RECPHEC, 2016).

2.6.5 Kathmandu Valley Development Authority (KVDA) Initiatives

The KVDA Atlas of Open Spaces (2015) identifies 887 potential green spaces in Kathmandu Valley, including disaster-resilient zones. The Atlas emphasizes community engagement and multi-functional UGS (e.g., playgrounds, evacuation sites) (KVDA, 2015). However, 42% of listed spaces are privately owned, limiting public access. In Nagarjun, similar issues arise, where UGS are concentrated in affluent neighborhoods, exacerbating inequities.

CHAPTER THREE: CONCEPTUAL FRAMEWORK AND METHODOLOGY

This chapter explains the research approach and the ideas behind the study. Covers the background of the study, how the samples were chosen, the tools used for measurement, how the data was collected, and the methods used to analyze the data to draw conclusions.

3.1 Research Philosophy

A paradigm is inclusive of several components that can be categorized as the following: Ontology, Epistemology, Methodology and Methods (Scotland, 2012). This study adopts a pragmatic research philosophy, emphasizing practical solutions by combining different methods to address real-world challenges. The approach focuses on understanding both the physical availability of green spaces and how people experience accessing them, ensuring the findings can guide actionable urban planning strategies. Pragmatism allows for flexibility in research methods, by integrating quantitative spatial analysis with qualitative insights into he lived experiences of residents.

3.1.1 Ontology

Different Ontology can be briefly defined as the nature of reality as given by (Hudson & Ozanne, 1988). The ontological stance recognizes the existence of objective realities concerning the distribution and accessibility of PUGS, measurable through quantitative methods. The study acknowledges that multiple realities shape how people interact with green spaces. These realities are influenced by factors like location (e.g., flat vs. hilly areas), income levels, cultural practices, and physical infrastructure. For instance, a park might be close to a neighborhood on a map, but steep terrain or unsafe pathways could make it inaccessible for elderly residents. By recognizing these varied perspectives, the research captures a fuller picture of accessibility challenges.

3.1.2 Epistemology

Epistemology can be briefly defined as how reality is being known by the researcher as discussed by (Carson, 2001). Hence, epistemology focuses on the methods researchers use to attain knowledge to comprehend reality. Knowledge in this re-

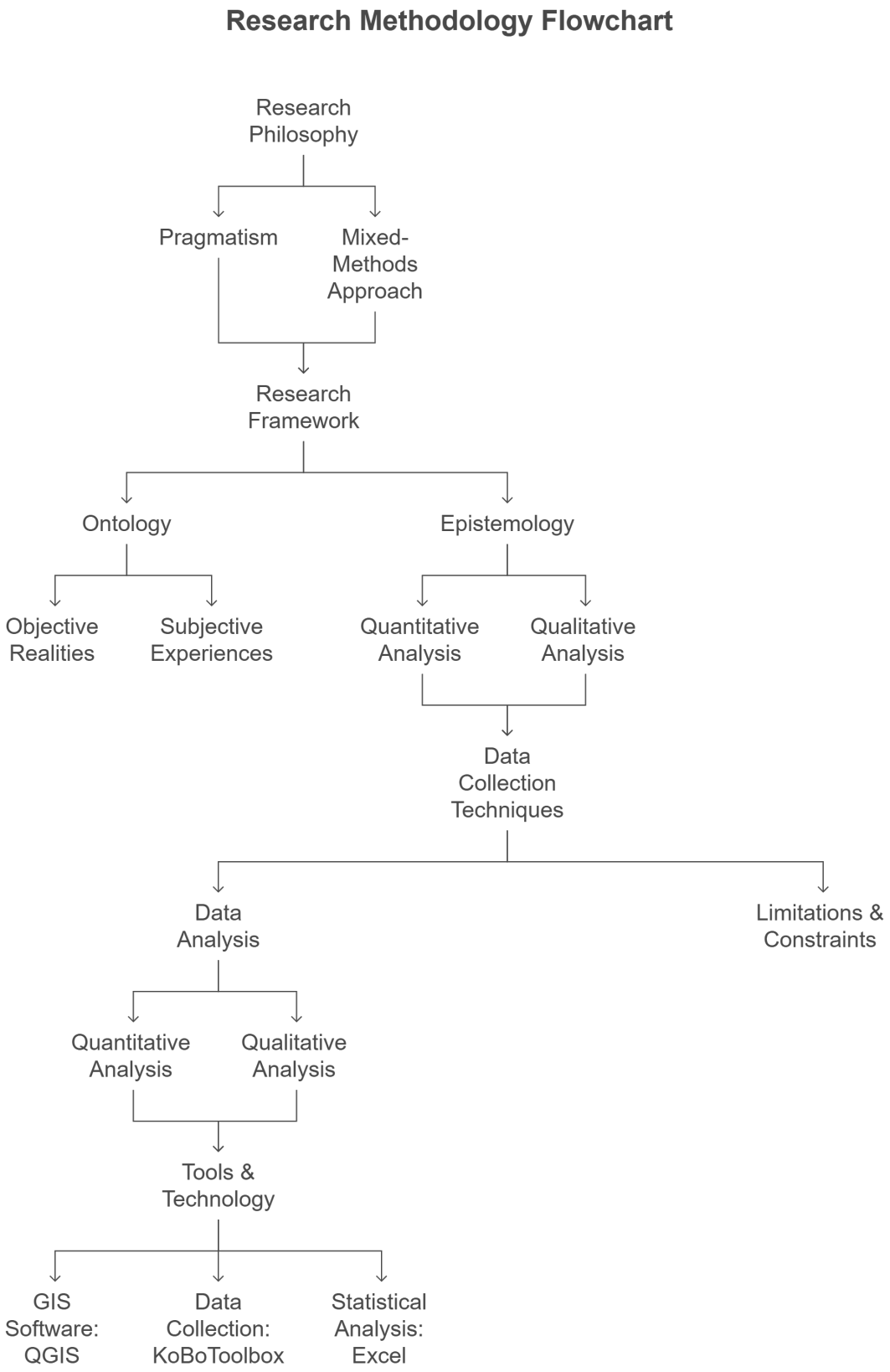


Figure 3.1: Research Methodology

search is built through two complementary approaches: 1. Quantitative Analysis: Geographic Information Systems (GIS) are used to map green spaces and measure distances from residential zones. This provides objective data on distribution and proximity. 2. Qualitative Insights: Surveys and interviews with residents reveal personal experiences, such as safety concerns or cultural preferences, that numbers alone cannot explain.

By blending these methods, the study addresses gaps that arise from using only one approach. For example, GIS might show a park is within a 10-minute walk, but community feedback might highlight poor maintenance or overcrowding that discourages use. This dual focus ensures findings are both accurate and relevant to residents' daily lives.

Positivism, which emphasizes objective measurements and the quantification of phenomena, aligns with the study's use of GIS to map and measure green space accessibility. This data-driven approach relies on tools such as satellite imagery, Geographic Information Systems (GIS), and demographic data to generate insights.

However, the inclusion of physical surveys and questionnaires introduces an interpretivist dimension, allowing the study to explore the subjective experiences, perceptions, and preferences of residents regarding green space accessibility. By combining these approaches, the study aims to construct knowledge through both systematic observation and quantitative analysis, as well as through the interpretation of human experiences and interactions with urban green spaces. This mixed-methods approach enhances the study's depth, credibility, and applicability by integrating diverse perspectives and data types.

3.2 Definition of Term

In this study, PUGS are defined as public parks and playgrounds that are open to the public for recreational and social use. Green spaces associated with institutional properties (e.g., government offices, educational institutes), protected forests, and military spaces are considered inaccessible green spaces and are excluded from the accessibility analysis. This distinction focuses the study on spaces that are practically accessible to the general public.

3.3 Conceptual Framework

The conceptual framework for this study is based on proximity and accessibility theory and principles. The conceptual framework incorporates mixed method by using both quantitative and qualitative dimension to assess public urban green space accessibility. Accessibility theory posits that proximity to resources, such as green spaces, is a fundamental component of livable cities, directly impacting residents' quality of life.

Quantitative Analysis: Accessibility is measured using GIS-based spatial analysis, including tools like NDVI and buffer analysis to determine distances from residential areas to green spaces. By mapping green spaces and measuring accessibility distances, the study evaluates whether green spaces are equitably distributed across different neighborhoods. The overlay of demographic data further highlights disparities in access.

Qualitative Analysis: Community perceptions and experiences regarding green spaces are captured through field surveys and stakeholder interviews. These insights provide context for the quantitative findings, highlighting the social and emotional value of urban green spaces.

A diagram of the conceptual framework would illustrate the relationships between green space distribution, accessibility measurements, and urban planning recommendations. This visual representation reinforces the study's focus on combining quantitative and qualitative elements to address complex urban challenges.

3.4 Data Collection Techniques

The data collection process for this survey was designed to ensure systematic, reliable, and ethical gathering of information on urban green space (UGS) accessibility and usage. Below is a detailed breakdown of the methodology, structured into key subsections:

3.4.1 Preparation Phase

Survey Tool Development

Questionnaire Design: A structured questionnaire was developed with four sections:

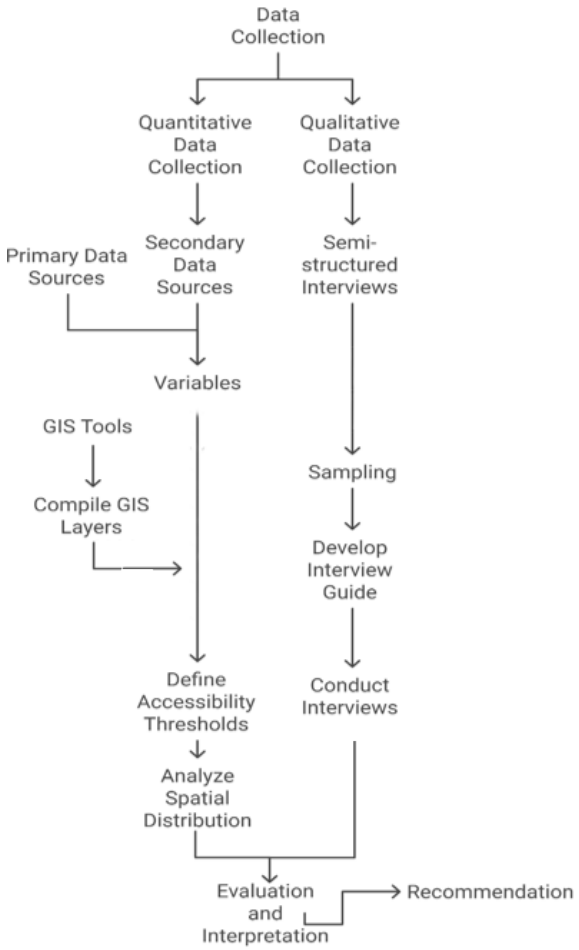


Figure 3.2: Data Collection Workflow

1. Demographics: Age, gender, occupation, household size.

2. Accessibility: Travel time to UGS, frequency of visits, barriers (e.g., distance, safety).

3. Usage Patterns: Activities (e.g., walking, sports), duration, preferred UGS features.

4. Perceptions: Satisfaction with UGS quality, safety concerns, improvement suggestions.

Digital Tools: KoBoToolbox, an open-source mobile data collection platform, was used for real-time data entry and GPS tagging.

Pilot Survey

A pilot survey (10 households) tested questionnaire clarity and logistical workflows. Feedback refined ambiguous questions.

3.4.2 Household Sampling

Buffer zone mapping

GIS-Based Buffers: Using QGIS software, three buffer zones (0–300m, 301–600m, >600m) were created around a selected Public Urban Green Spaces (PUGS) in each ward.
Street Selection: Streets intersecting buffer zones were randomly selected using a stratified random sampling approach.

Systematic Sampling Procedure

Interval Sampling: On selected streets, every 10th household was surveyed (e.g., starting from a randomly chosen point like house 3, then 13, 23, etc.).
Non-Response Protocol: If a household declined participation or was unavailable, the next household in sequence was approached.

3.4.3 Data Collection Process

Door to Door Process

Face-to-Face Interviews: Interviews were conducted in Nepali language to ensure comprehension.
Average Duration: 15–20 minutes per respondent.

Data recording

Digital Entry: Responses were recorded directly into KoBoToolbox to minimize transcription errors.
Geotagging: GPS coordinates of surveyed households were captured to map spatial response patterns.

3.4.4 Ethical Considerations

Informed Consent: Participants were briefed on the study's purpose, confidentiality terms, and their right to withdraw.

Anonymity: No personally identifiable information (e.g., names, addresses) was stored.

3.4.5 Tool and Technology

1. GIS Software: QGIS for buffer zone mapping and spatial analysis.

Buffer distances of 0-300 m, 301-600 m, and >600 m were chosen to measure PUGS accessibility. The 0-300 m buffer, about a 5-minute walk,Organization, 2017 which define it as the ideal range for daily green space use. The 301-600 m range (5-10 minutes) marks a moderate distance where access may decline, especially for vulnerable residents, while >600 m (over 10 minutes) indicates poor access, worsened by Nagarjun's hilly terrain. These intervals align with the study's goal to map spatial disparities and suit GIS analysis for clear ward-wise comparisons.

2. Mobile Data Collection: KoBoToolbox for digital surveys and GPS tagging.

3. Statistical Tools: Excel and XLSTAT for statistical modeling, data visualization, and advanced analytics.

4. Qualitative Analysis Tool: ATLAS.ti for coding, analyzing, and visualizing qualitative data from interviews.

CHAPTER FOUR: CASE STUDY AREA

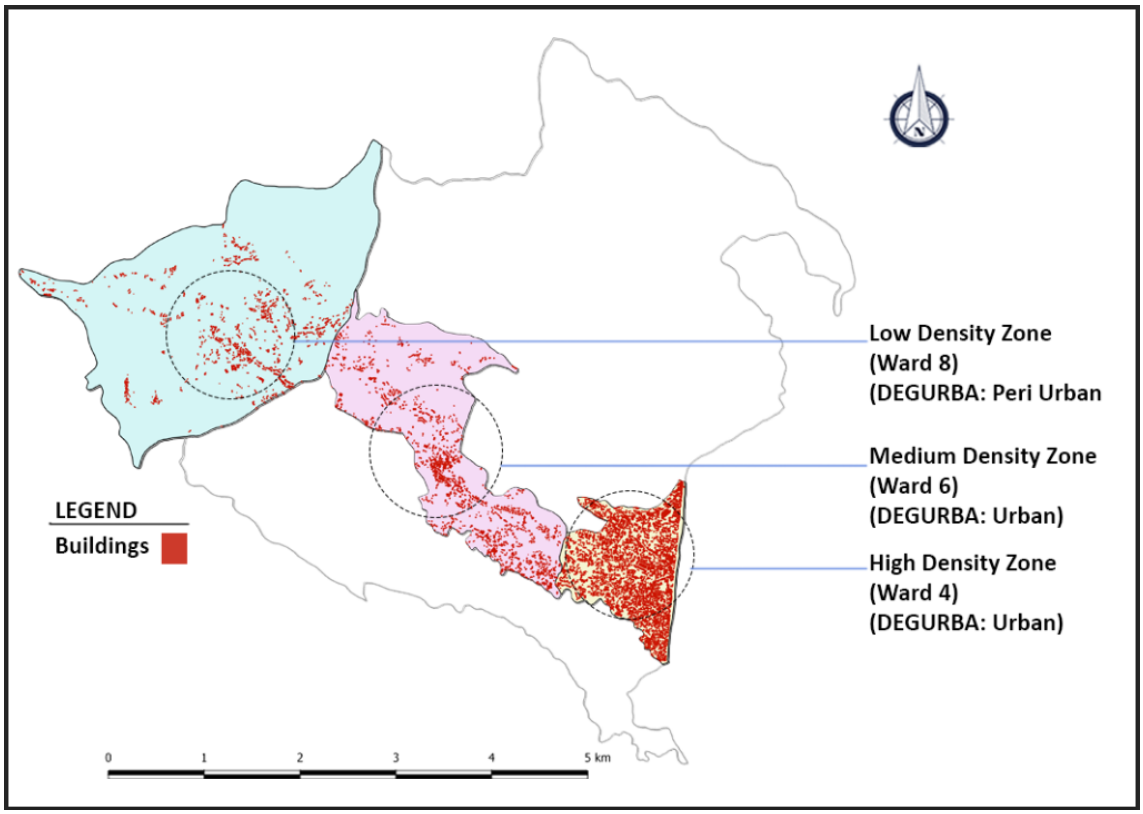


Figure 4.1: Case Study Areas (Ward 4, 6 & 8)

4.1 Selection Criteria

For this study, Ward 4, Ward 6, and Ward 8 of Nagarjun Municipality were chosen as the case study areas because they offer a diverse range of urban settings and challenges related to public urban green spaces (PUGS). These wards represent different levels of urban development, green space availability, and accessibility issues, making them ideal for understanding the overall situation in the municipality.

4.1.1 Urban Development and Land Use:

Ward 4 is a highly developed area with dense residential and commercial buildings, whereas Ward 6 shows a mix of urban development and open green areas. In contrast, Ward 8 has a combination of institutional green spaces and natural areas, which are less accessible to the public. As shown in Figure 1.2 (Section 1.2.1), Ward 4 has a lot of built-up areas, which means there is less space for PUGS. Ward 8, on the other hand, is closer to the forested areas in the north, so it might have more

green spaces. This variety allows us to study how different types of land use affect the distribution and quality of green spaces.

4.1.2 Green Space Availability:

The three wards differ in how much green space is available. In Ward 4, green spaces are limited due to high building density, while Ward 6 has moderate amounts of accessible green areas. Ward 8, however, has a larger share of green areas that are often tied to institutions or protected lands, making them less accessible. These differences help us identify where gaps exist and where improvements are most needed.

4.1.3 Accessibility and Infrastructure:

Accessibility remains a critical issue across the selected wards. In Ward 4, although some areas show relatively better infrastructure, the overall availability of public green spaces is limited due to haphazard urbanization. This disorganized growth has reduced the number of accessible green areas, meaning that even if some infrastructure elements are in place, many residents still struggle to find nearby, quality green spaces.

In contrast, Ward 6 and Ward 8 also face accessibility challenges, including longer travel times to reach available green spaces, uneven pathways, and insufficient lighting. These issues further restrict the use and benefits of the existing green spaces. Together, these factors indicate that all three wards experience significant barriers to accessing public urban green spaces, highlighting the need for improved urban planning and infrastructure development throughout Nagarjun Municipality

4.1.4 Socio-Economic Diversity:

The chosen wards also vary in terms of socio-economic characteristics. They include residents from different income levels and educational backgrounds, which is important for understanding whether green spaces are equally accessible and beneficial to all groups. Past studies have shown that socio-economic factors can greatly influence access to and usage of urban green spaces, so including wards with diverse populations is key to a thorough analysis.

4.1.5 Relevance to Municipal Planning:

Selecting these three wards is also strategic for local policymakers. The insights gained from these areas can help municipal planners target specific challenges—such as infrastructure improvements and better maintenance—where they are most needed. By focusing on wards with varying characteristics, the study aims to provide recommendations that are both practical and tailored to the needs of different communities within Nagarjun Municipality.

In summary, the selection of Ward 4, Ward 6, and Ward 8 allows for a comprehensive examination of the spatial distribution, accessibility, and usage of public urban green spaces. This approach supports the goal of identifying actionable improvements for sustainable urban planning and promoting equitable access to green spaces for all residents.

4.1.6 Existing Scenario

Nagarjun Municipality is located on the periphery of Kathmandu Valley and has experienced rapid urban growth over the past decade. Characterized by a mix of urban settlements and natural landscapes, the municipality has witnessed significant population increases and unplanned development. This rapid urbanization has led to challenges in maintaining public green spaces and providing equitable access to such amenities. Despite its strategic location adjacent to Kathmandu Metropolitan City, Nagarjun faces issues related to haphazard development and inadequate infrastructure, which impact the quality and accessibility of public urban green spaces for its residents.

4.2 Current state of public Green Spaces in Case Study Area

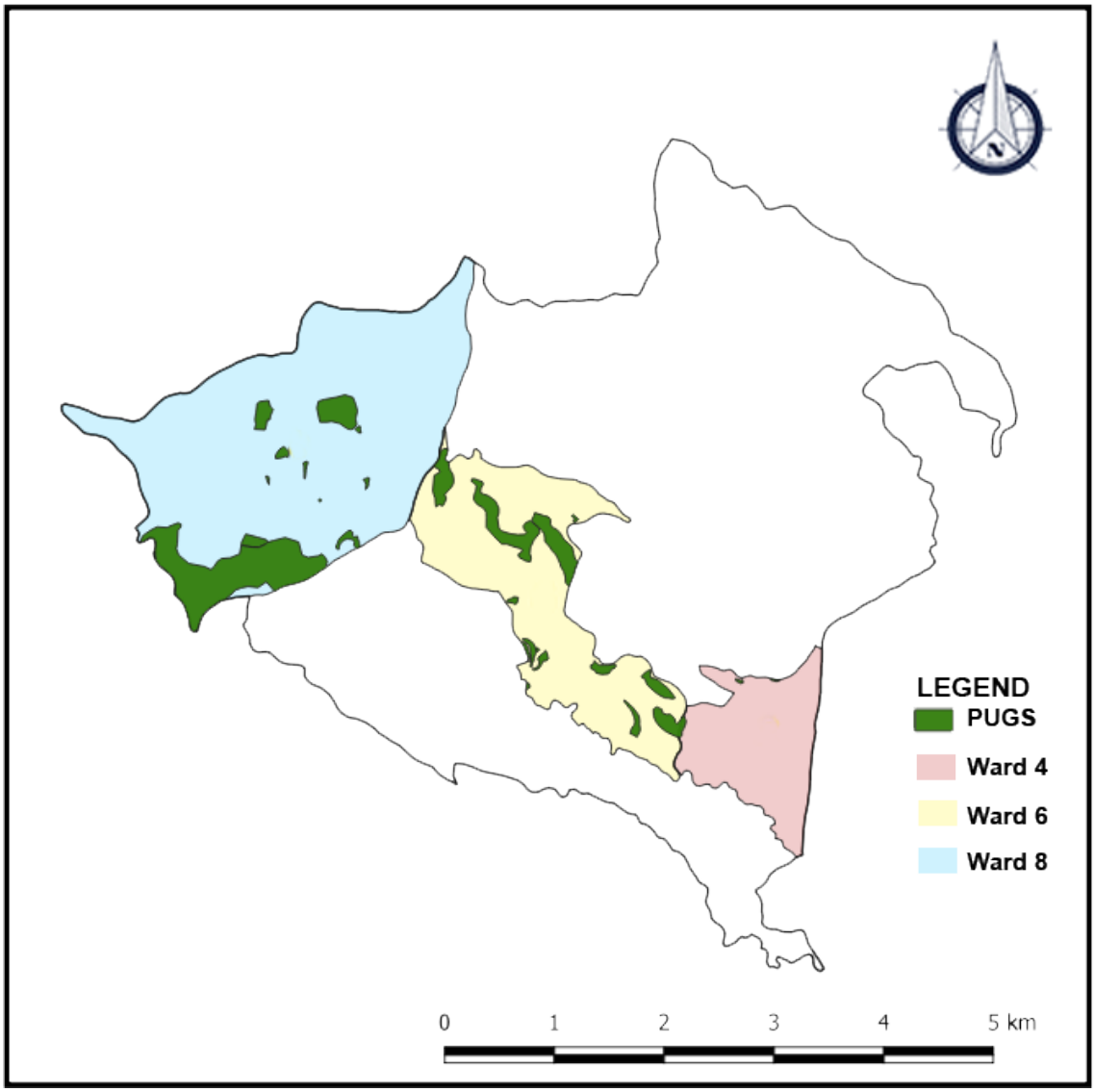


Figure 4.2: Public Green Space Location and Sizes of Case Study Area

(a) PUGS at Ward 4 (b)

PUGS at Ward 8 (Nursery Bhanjyang)

Figure 4.3: Comparison of PUGS in Ward 4 and Ward 8

(a) PUGS at Ward 4

(b) PUGS at Ward 6 (Ganeshman Park)

Figure 4.4: Existing scenario of PUGS in different wards

(a) PUGS at Ward 6 (Ganeshman Park)

(b) PUGS at Ward 8

Figure 4.5: Existing scenario of PUGS in different wards

CHAPTER FIVE: DATA ANALYSIS

5.1 Introduction to Data Analysis

5.1 Introduction to Data Analysis This chapter looks at the data collected to understand the spatial distribution, accessibility, and use of Public Urban Green Spaces (PUGS) in Nagarjun Municipality. The main goal is to find out how easy it is for residents to reach and use these green spaces, what challenges they face, and how these spaces meet their needs. To do this, the study uses both numbers-based and words-based methods to get a full picture of the situation in Wards 4, 6, and 8.

The analysis starts with numbers, using tools like GIS maps and statistics to see where PUGS are located, how far residents live from them, and how often they visit. For example, it checks how many people live within 300 meters of a park and how long it takes them to get there. It also looks at things like household income and age to see if these affect how people use green spaces. Then, the chapter uses a software called ATLAS.ti to study what residents and local officials say about PUGS. This part focuses on their experiences, like problems with pathways or the need for more benches, to understand their views in detail.

By combining these two approaches—numbers and words—the study aims to show the real issues with PUGS in Nagarjun Municipality. This will help in making suggestions later on about how to make green spaces better for everyone, especially for groups like the elderly, families, and those with less money.

5.2 Data Sources and Collection Methods

To study the Public Urban Green Spaces (PUGS) in Nagarjun Municipality, this research used two types of data: primary data, which was collected directly from people, and secondary data, which came from existing reports and records. This section explains how the data was gathered and what sources were used to make sure the study covers all the important details about PUGS in Wards 4, 6, and 8.

5.2.1 Primary Data Collection

Primary data came straight from the people living in the study area. The study used surveys, questionnaires, and interviews to hear directly from residents about their experiences with PUGS. A total of 95 residents from Wards 4, 6, and 8 took part in the surveys. These wards were chosen because they represent different types

of areas in the municipality, like urban, semi-urban, and hilly zones. The residents were grouped based on how far they live from the nearest PUGS: 0-300 meters, 301-600 meters, and beyond 600 meters. This helped to see if distance affects how they use green spaces.

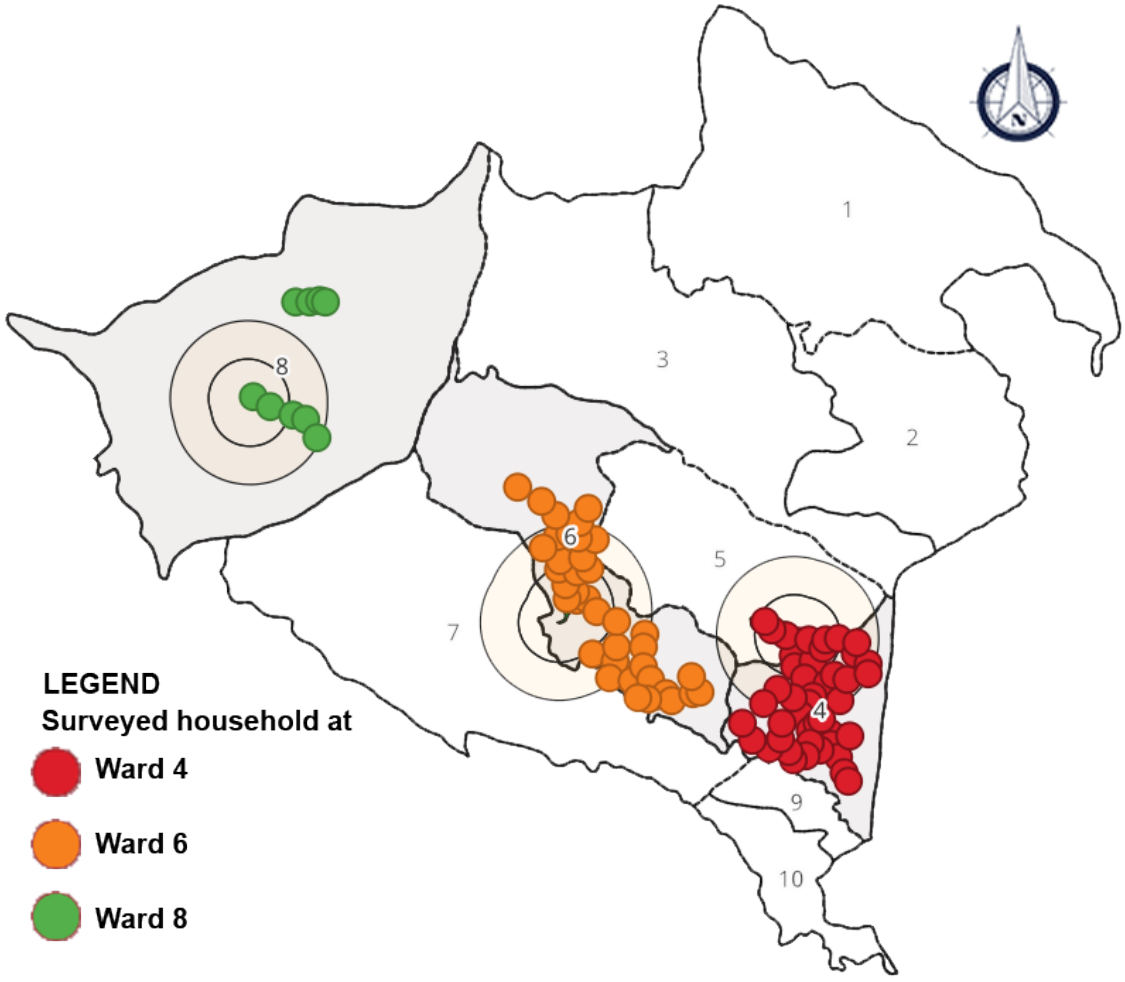
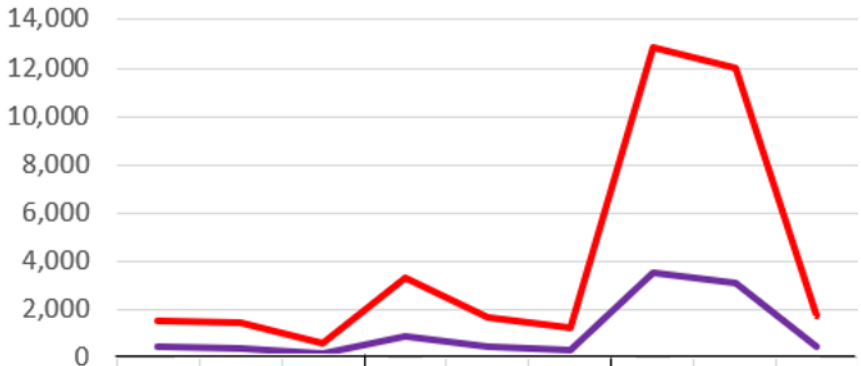


Figure 5.1: Locating respondents in different buffer of each specified PUGS

To decide on the number of residents to survey, a sample size calculation was done using Microsoft Excel. The total population of Wards 4, 6, and 8 is 36,282, based on census data from the National Statistics Office. The calculation used a confidence level of 95% (which means we can be 95% sure the results are accurate) and a margin of error of 10% (which means the results might be off by up to 10%). Using the formula for sample size, which considers the population size and these percentages, the result was 95 respondents. This number was chosen to make sure the survey results could represent the views of the whole population in these wards. The details of this calculation are shown in Appendix D.



Buffer	0-300m			301-600m			>600m		
Ward	4	6	8	4	6	8	4	6	8
Number of households	418	370	138	899	438	294	3526	3119	413
Population	1521	1425	580	3271	1686	1235	12827	12004	1733
Average household size	3.64	3.85	4.20	3.64	3.85	4.20	3.64	3.85	4.20

Figure 5.2: Population Served by Distance

The questionnaire included both closed-ended and open-ended questions. The answers were written down carefully to look for patterns later.

Alongside conducting surveys, the study also carried out Key Informant Interviews (KIIs) with influential individuals. These interviews were less structured, meaning the questions could change based on what the person said. The goal was to learn more about the challenges of managing PUGS, like funding problems or maintenance issues, from the perspective of local leaders. Together, the surveys and interviews gave a clear view of what residents and officials think about green spaces in the municipality.

To further understand the spatial distribution of residents relative to PUGS, Figure 5.2 illustrates the population trends across three buffer zones (0-300m, 301-600m, and >600m) in Wards 4, 6, and 8. Additionally, it also provides a detailed breakdown of the number of households, average household size and population within each buffer zone for these wards. This data highlights the varying levels of proximity to green spaces across the wards, with Ward 4 showing a higher concentration of households in the >600m buffer (3526 households, 12827 people), indicating potential accessibility challenges for a significant portion of its population.

5.2.2 Secondary Data Collection

Secondary data was collected from reports and records that were already available. This included GIS data, census data, and reports from Nagarjun Municipality. GIS data was used to make maps showing where PUGS are located in Wards 4, 6, and 8. It helped to measure distances between people's homes and the nearest green space and to see if some areas have more parks than others. This data came directly from the municipality's records.

Census data was taken from the National Statistics Office (NSO). It gave information about the population in each ward, like how many people live there, their ages, and how many households there are. This helped to understand if crowded areas have enough green spaces for everyone. Finally, reports from Nagarjun Municipality provided details about the current state of PUGS, such as their size and condition, and any plans the municipality has for improving them. Using this secondary data helped to check if the information from the surveys and interviews matched with the actual situation on the ground.

5.3 Quantitative Data Analysis

5.3.1 Spatial Analysis

Spatial analysis techniques were employed to visualize and assess the accessibility of PUGS in the study area. This section provides details on the GIS techniques and mapping processes used in the analysis.

GIS Techniques

GIS techniques such as buffer analysis was applied to determine accessibility levels. These methods helped in identifying areas with limited green space availability and highlighting disparities in accessibility across different wards.

Mapping

Maps were generated to illustrate the spatial distribution of PUGS, accessibility levels, and demographic characteristics of the study area. These visual representations provided valuable insights into how green spaces are distributed and whether they meet the needs of the local population.

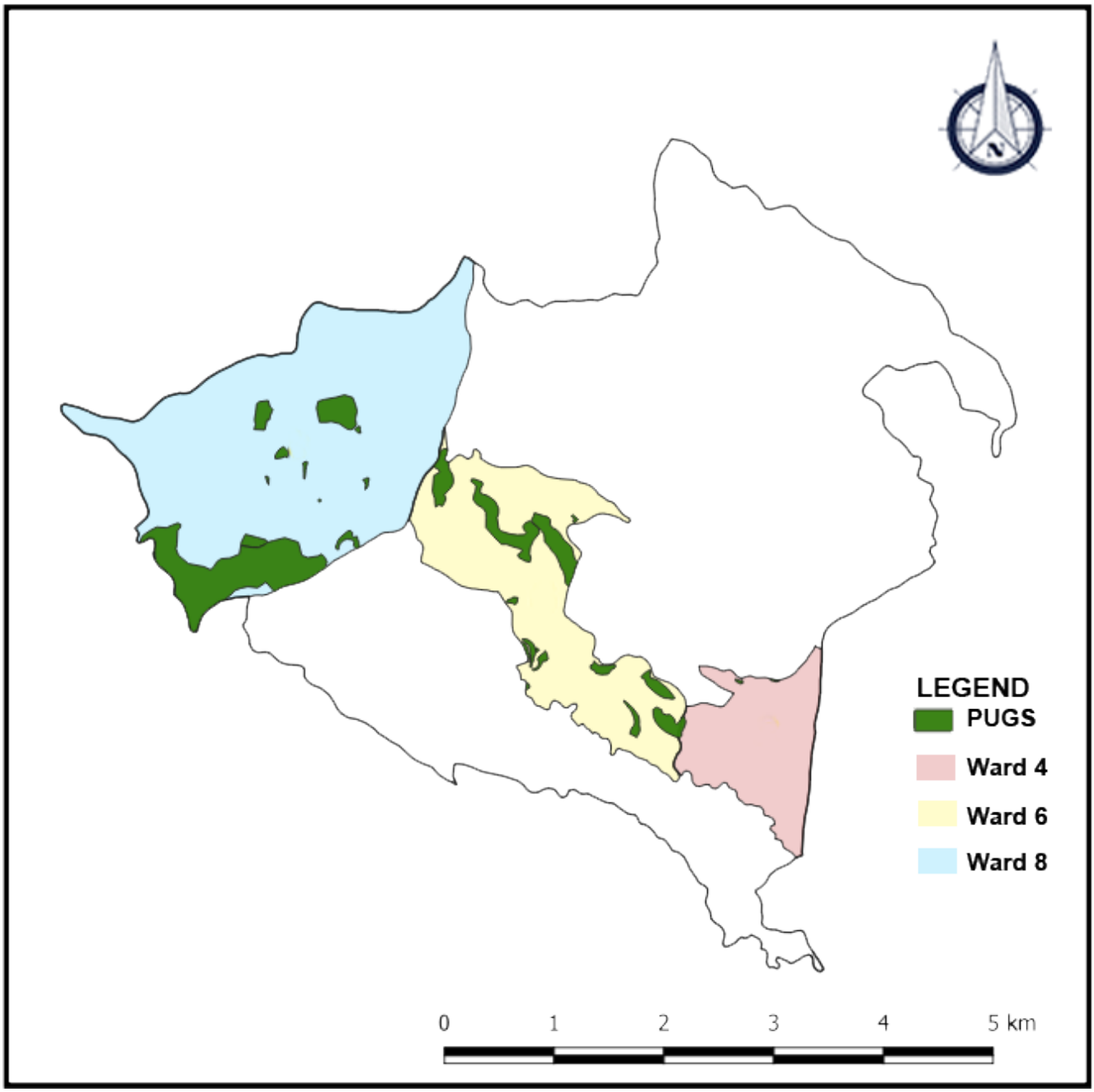


Figure 5.3: Mapping PUGS of Case Study Wards

PUGS Per Capita Analysis

This subsection evaluates the available Public Urban Green Spaces (PUGS) per person in three wards of Nagarjun Municipality. The analysis involves calculating the green space area on a per capita basis in both square meters (m^2) and square feet (ft^2). This measure helps to assess whether the available green space meets international recommendations for urban green area, such as those proposed by the World Health Organization (WHO), which suggest a minimum of approximately 9 m^2 (about 97 ft^2) per person for health and well-being (WHO, 2017).)

Table 5.1: PUGS Per Capita Analysis in Three Wards of Nagarjun Municipality

Ward	PUGS Area (m^2)	PUGS Area (ft^2)	Population	PUGS per Capita (m^2/person)	PUGS per Capita (ft^2/person)
Ward 8	756,000	~8,138,000	3,548	~213	~2,293
Ward 6	397,000	~4,274,000	15,115	~26.3	~283
Ward 4	9,000	~96,875	17,619	~0.51	~5.5

Comparison with International Standards

According to the World Health Organization (WHO, 2017), urban environments should ideally provide a minimum of about 9 m^2 (97 ft^2) of green space per person to support public health. In comparison:

- **Ward 8** exceeds this standard significantly, providing around 213 m^2 (2,293 ft^2) per person.
- **Ward 6** also surpasses the minimum requirement, although its provision of 26.3 m^2 (283 ft^2) per person is substantially lower than that of Ward 8.
- **Ward 4**, however, is critically deficient, with only about 0.51 m^2 (5.5 ft^2) per person, far below the recommended threshold.

Implications for Urban Planning

The significant disparities in green space provision among the wards indicate spatial inequities that need urgent attention. In particular:

- **Ward 4** requires immediate intervention, as the green space per capita is drastically below international standards.
- **Ward 6**, although meeting the minimum, could benefit from additional enhancements to better serve its larger population.

- **Ward 8** demonstrates that high green space provision is achievable and can serve as a benchmark for other areas.

5.3.2 Descriptive Statistical Analysis

Statistical analysis plays a crucial role in understanding the spatial distribution and accessibility of Public Urban Green Spaces (PUGS) in Nagarjun Municipality. Descriptive statistics summarize the basic features of the dataset, providing insights into the demographic characteristics, accessibility patterns, and usage trends of PUGS. Measures such as frequency distribution, mean, median, standard deviation, and percentage distributions are used to describe respondents' demographic profiles and perceptions.

- Demographics: The sample consists of 95 respondents from Wards 4, 6, and 8, categorized based on their distance from PUGS (0-300m, 301-600m, beyond 600m). Variables such as age, gender, education level, and household income are analyzed to understand the socio-economic background of users.

- Accessibility: Descriptive analysis assesses how often respondents visit PUGS, travel time to reach them, and perceived safety and accessibility of the pathways.

- Usage Patterns: This analysis identifies popular activities in PUGS, preferred visiting times, and barriers preventing frequent visits.

- Perceptions of PUGS: Satisfaction levels with cleanliness, safety, amenities, and overall quality are summarized using mean and standard deviation values.

Demographic Profile of Respondents

Understanding the demographic background of respondents is essential for analyzing differences in access and utilization of green spaces.

A. Age and Gender Distribution

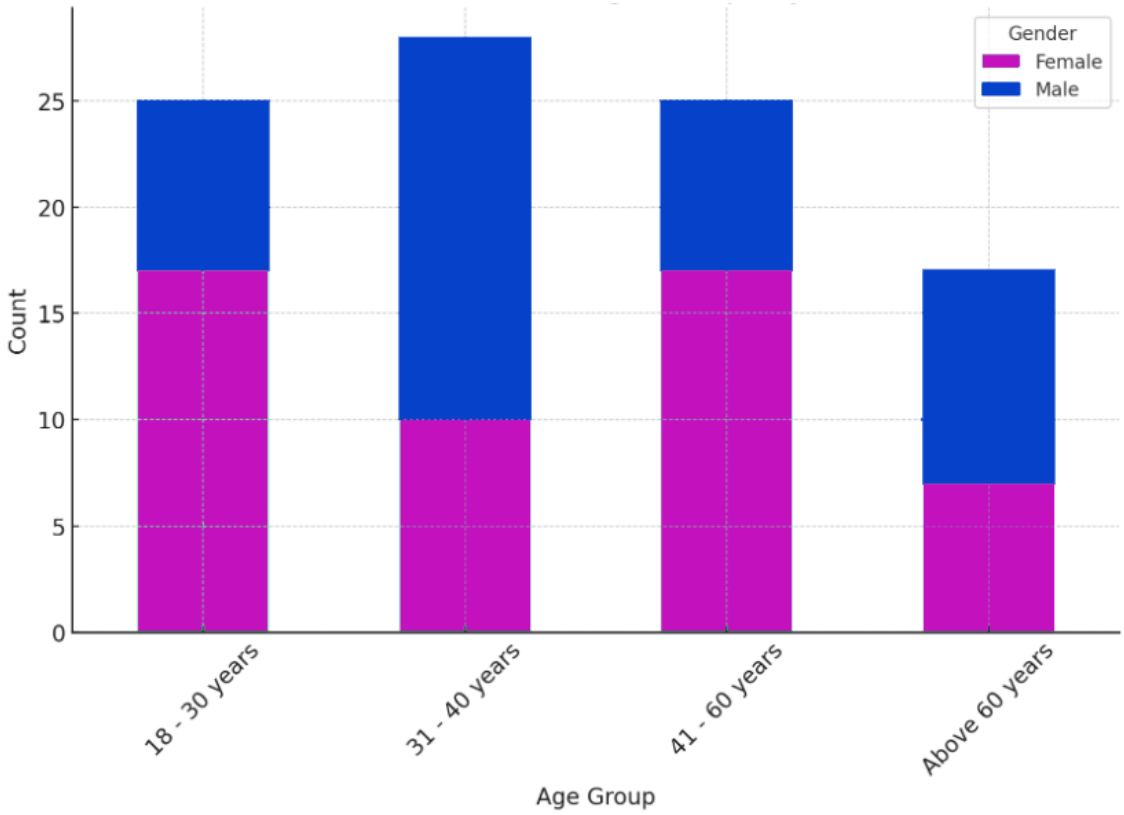


Figure 5.4: Bar charts showing the age and gender distribution

The survey results indicate that the majority of respondents belong to the 31-40 age group, followed by those aged 41–60. This suggests that working-age individuals are more involved in discussions regarding green space accessibility. Gender-wise, the response rate is slightly higher for males, possibly due to cultural factors influencing park visitation patterns.

B. Household Income

Survey data reveals that 32.63% of respondents earn between NPR 30,001 – 50,000 per month, making it the most common income category. Additionally, 26.32% fall within the NPR 15,001 – 30,000 range, while 25.26% of households earn less than NPR 15,000, indicating a significant proportion of lower-income f amilies. Only 14.74% of respondents report earning more than NPR 50,000, suggesting that high-income households make up a smaller share of the surveyed population.

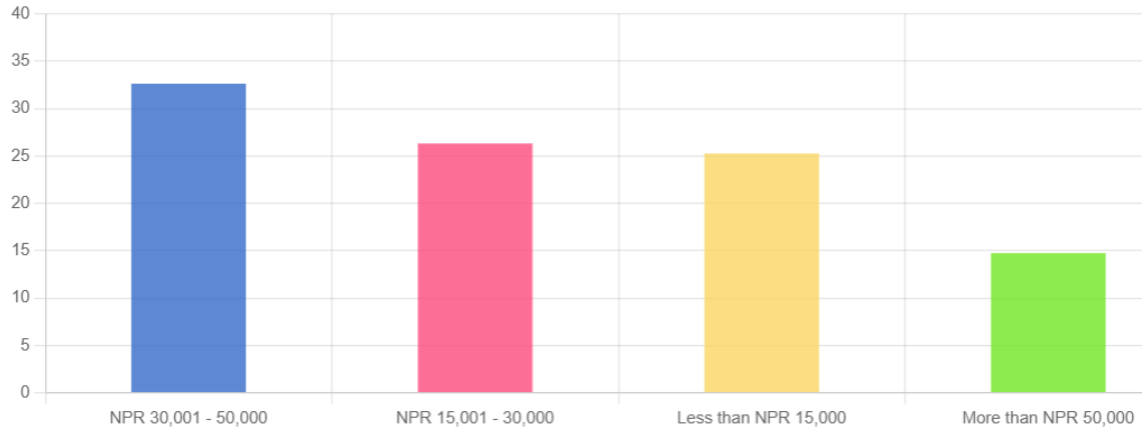


Figure 5.5: Bar Chart showing Household Income

Lower-income households may face challenges such as limited access to well maintained PUGS, greater travel distances, and fewer recreational opportunities. To ensure equitable access for all income groups, urban policies should prioritize developing PUGS in lower-income neighborhoods, improving amenities, and ensuring affordability of recreational activities within green spaces.

Accessibility to Public Urban Green Spaces

A. Distance from Nearest Green Space

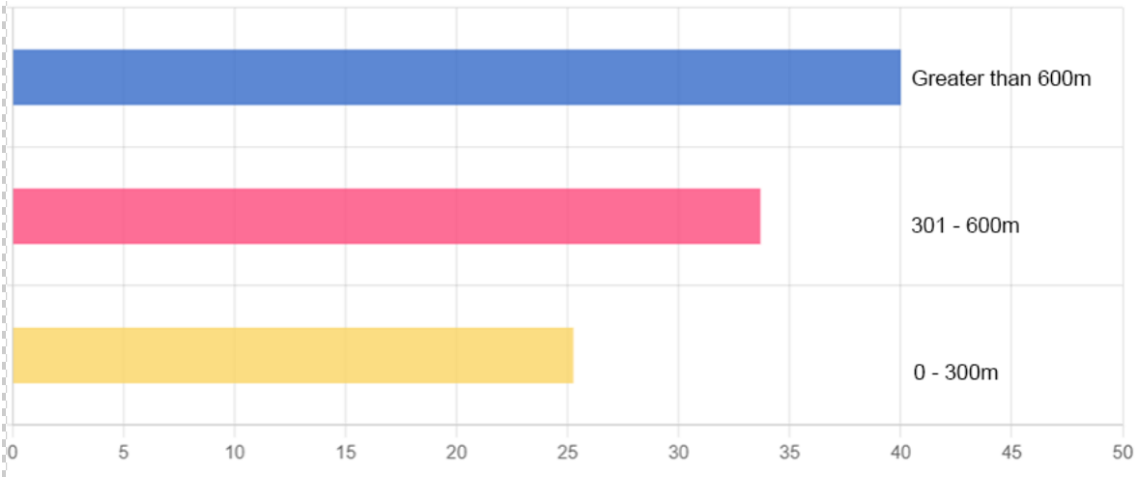


Figure 5.6: Bar chart showing distance from nearest PUGS

Survey data shows that 40% of respondents live over 600 meters from the nearest PUGS, suggesting an accessibility gap. Additionally, 33.68% live within 301–600 meters, and only 25.26% live within 300 meters of green space. This implies that

most residents do not have immediate access to PUGS, potentially discouraging regular visits, especially among children, the elderly, and individuals with limited mobility.

Studies indicate that closer proximity to green spaces boosts usage, yet many residents must travel considerable distances. Urban planning should focus on creating new green spaces in underserved areas, improving pedestrian pathways, and integrating greenery into residential neighborhoods to enhance accessibility.

B. Travel Time to PUGS

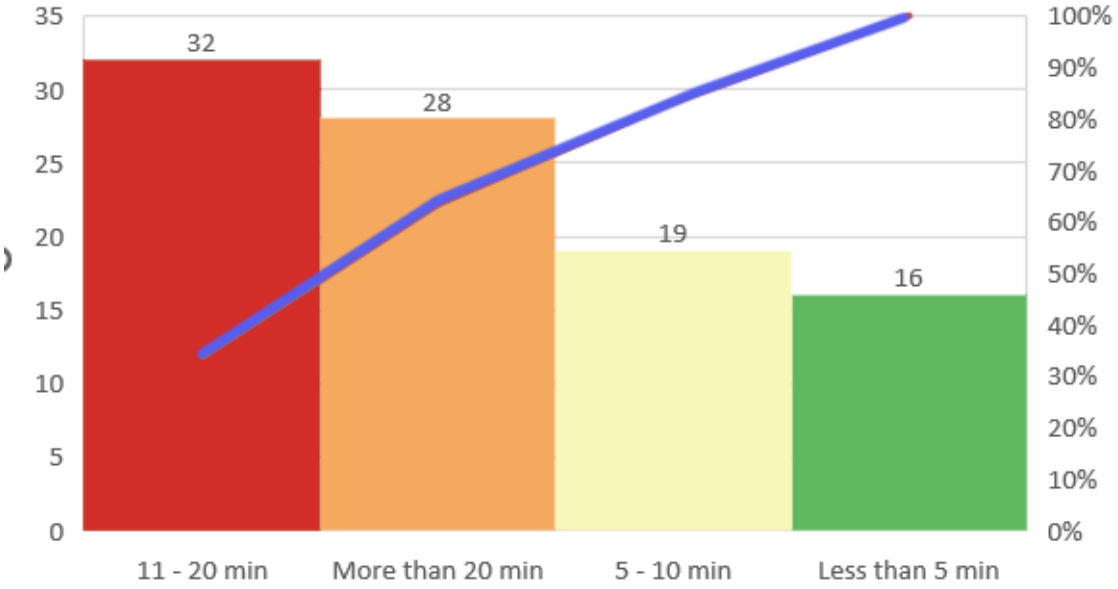


Figure 5.7: Bar chart showing travel time distribution

Survey findings show that 33.68% of respondents take 11–20 minutes to reach the nearest PUGS, the most common travel time. Additionally, 29.47% need more than 20 minutes, indicating significant travel time barriers for nearly one-third of the population.

Only 16.84% can access a PUGS within five minutes, while 20% take 5–10 minutes, highlighting that few residents enjoy convenient access to green spaces.

Longer travel times discourage frequent visits, especially for busy individuals, children, and the elderly. To promote equitable access and higher usage, urban planning should focus on creating new green spaces in under-served areas, improving pedestrian and cycling infrastructure, and ensuring better connectivity to existing PUGS.

C. Visit Frequency

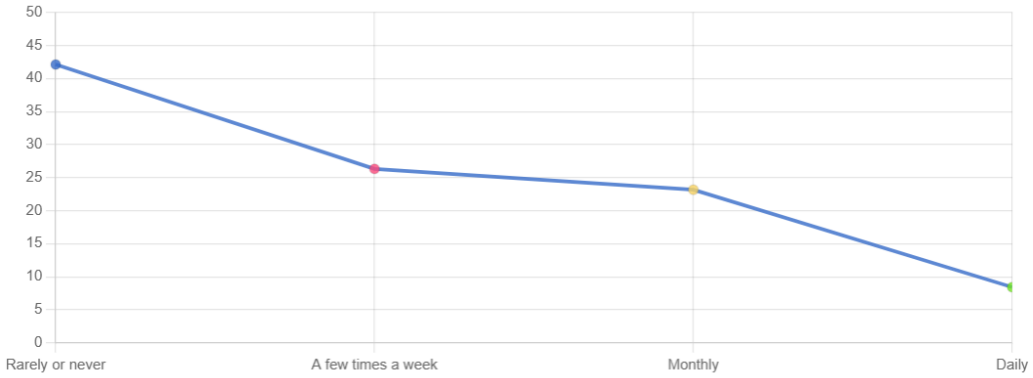


Figure 5.8: Bar chart showing visit frequency to PUGS

Survey results reveal that 42.11% of respondents rarely or never visit PUGS, indicating significant accessibility barriers, lack of facilities, or limited awareness. Only 8.42

Meanwhile, 26.32% visit a few times a week, and 23.16% visit monthly, suggesting that some residents incorporate PUGS into their routine, but many do not visit frequently.

These findings highlight the need for better accessibility, enhanced amenities, and improved maintenance to encourage regular use. Future urban planning should address these barriers to make green spaces more inviting for daily or frequent visits.

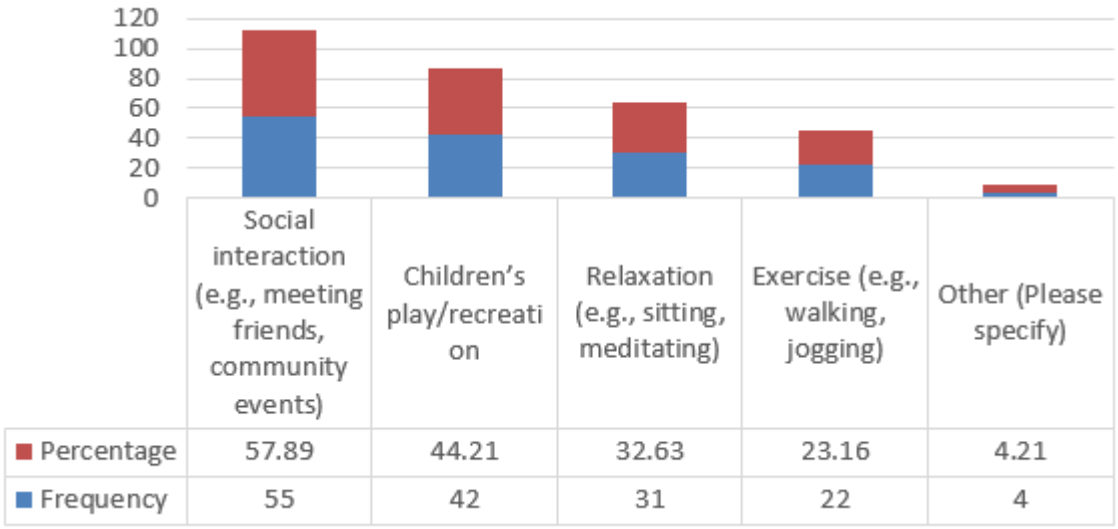
Utilization Patterns of PUGS

The most common activity is social interaction, including meeting friends and participating in community events, reported by 57.89% of respondents. This suggests that PUGS play an essential role in fostering community bonds and social cohesion. Children's play and recreation (44.21%) is the second most common use, emphasizing the importance of child-friendly infrastructure in green spaces.

A. Activities at PUGS

Additionally, 32.63% of respondents visit PUGS for relaxation, such as sitting and meditating, while 23.16% engage in physical exercise, including walking and jogging. This indicates that while PUGS provide opportunities for physical activity, they

are primarily utilized for social and leisure purposes. A small percentage (4.21%) reported engaging in other activities.



	Social interaction (e.g., meeting friends, community events)	Children's play/recreation	Relaxation (e.g., sitting, meditating)	Exercise (e.g., walking, jogging)	Other (Please specify)
Percentage	57.89	44.21	32.63	23.16	4.21
Frequency	55	42	31	22	4

Figure 5.9: Bar chart showing activities at PUGS

To better accommodate diverse user needs, urban planning efforts should focus on enhancing recreational infrastructure, providing dedicated exercise areas, and ensuring inclusive facilities that support both active and passive engagement.

B. Average time spent per visit at PUGS

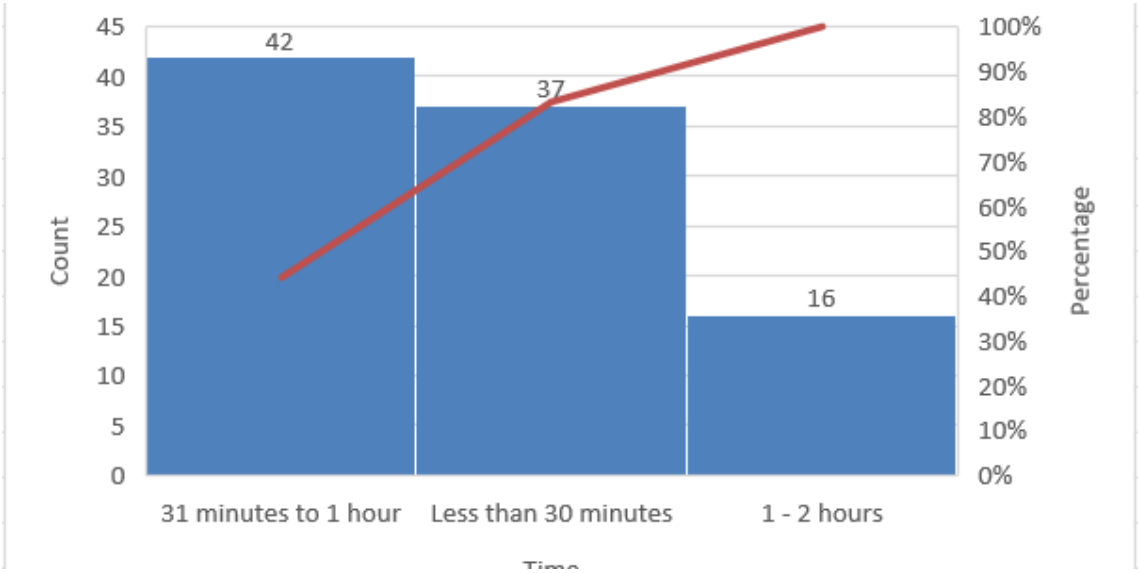


Figure 5.10: Bar chart showing average time spent per visit at PUGS

Most respondents (44.21%) spend between 31 minutes to 1 hour in green spaces, indicating moderate recreational or leisure use. This is closely followed by 38.95% who stay for less than 30 minutes, suggesting shorter, routine visits. Only 16.84% engage with green spaces for 1–2 hours, reflecting limited extended use.

These findings show that most users interact with green spaces for brief to moderate periods, likely due to proximity, convenience, or time constraints. The low proportion of longer stays may signal barriers such as inadequate amenities or accessibility challenges. This underscores the need to assess how spatial accessibility and facility quality influence visitation patterns, aligning with the study's focus on optimizing equitable access and enhancing the functional capacity of green spaces in Nagarjun Municipality.

Preventing factors for visiting PUGS

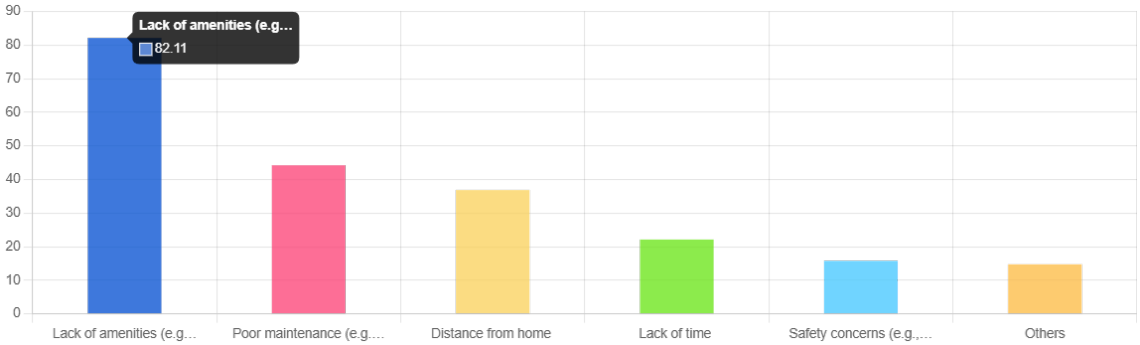


Figure 5.11: Bar chart showing preventing factor to visit PUGS

A survey of residents identified several key reasons for not visiting nearby public urban green spaces. Most respondents (82.11%) noted the lack of basic amenities (seating, restrooms, play areas) as the main deterrent. Additionally, 44.21% mentioned poor maintenance (unclean areas, broken facilities), contributing to safety concerns. Other factors included distance from home (36.84%), lack of time (22.11%), and general safety issues (15.79%). Open-ended responses highlighted problems such as dust, noise from construction, steep roads, and overcrowding. These findings suggest that improving facilities, maintenance, and accessibility could significantly enhance the attractiveness and use of urban green spaces.

5.3.3 Inferential Statistics

Inferential statistics help determine relationships between different v ariables and generalize findings beyond the sample.

- Chi-Square Tests: Used to examine the association between accessibility and usage patterns, such as the relationship between household income and frequency of PUGS visits.

- T-Tests and ANOVA: Applied to compare mean differences in PUGS usage across different buffer zones (0-300m, 301-600m, beyond 600m) and socio-economic groups.

- Correlation Analysis: Evaluates the strength of relationships between accessibility factors (distance, travel time) and satisfaction levels with PUGS.

- Regression Analysis: Used to predict the impact of accessibility barriers on PUGS utilization and determine which factors significantly influence PUGS accessibility.

Computation

Chi-Square Test: Association Between Accessibility and Usage Patterns

The objective of this analysis was to determine whether there is a significant association between accessibility (distance) and usage patterns (frequency of park visits) among residents.

Methodology: A Chi-Square test of independence was performed to analyze the relationship between accessibility and usage patterns. The data was categorized into three accessibility groups based on distance from the park (0-300m, 301-600m, beyond 600m), and the frequency of park visits was categorized into four groups (Daily, A few times a week, Monthly, Rarely/Never). The observed frequencies were recorded and the expected frequencies were calculated.

Table 5.2: Observed Frequency of PUGS Visits by Distance

Distance	**Daily**	**A few times a week**	**Monthly**	**Rarely/Never**	**Total**
0-300m	5	10	4	5	24
301 - 600m	3	11	7	11	32
Beyond 600m	0	4	11	24	39
Total	8	25	22	40	95

Table 5.3: Expected Frequency of PUGS Visits by Distance

Distance	Daily	A few times a week	Monthly	Rarely/Never	Total
0-300m	2.021	6.316	5.558	10.105	24
301 - 600m	2.695	8.421	7.411	13.474	32
Beyond 600m	3.284	10.263	9.032	16.421	39
Total	8	25	22	40	95

Table 5.4: Chi-Square Values by Distance and Frequency of Visits

Distance	Daily	A few times a week	Monthly	Rarely/Never
0-300m	4.3908	2.1491	0.4367	2.5792
301 - 600m	0.0346	0.7898	0.0227	0.4542
Beyond 600m	3.2842	3.8221	0.4290	3.4980

Chi-Square Value and p-Value: The Chi-Square statistic was calculated as 21.89, with 6 degrees of freedom. The p-value obtained from the Chi-Square test was 0.001267.

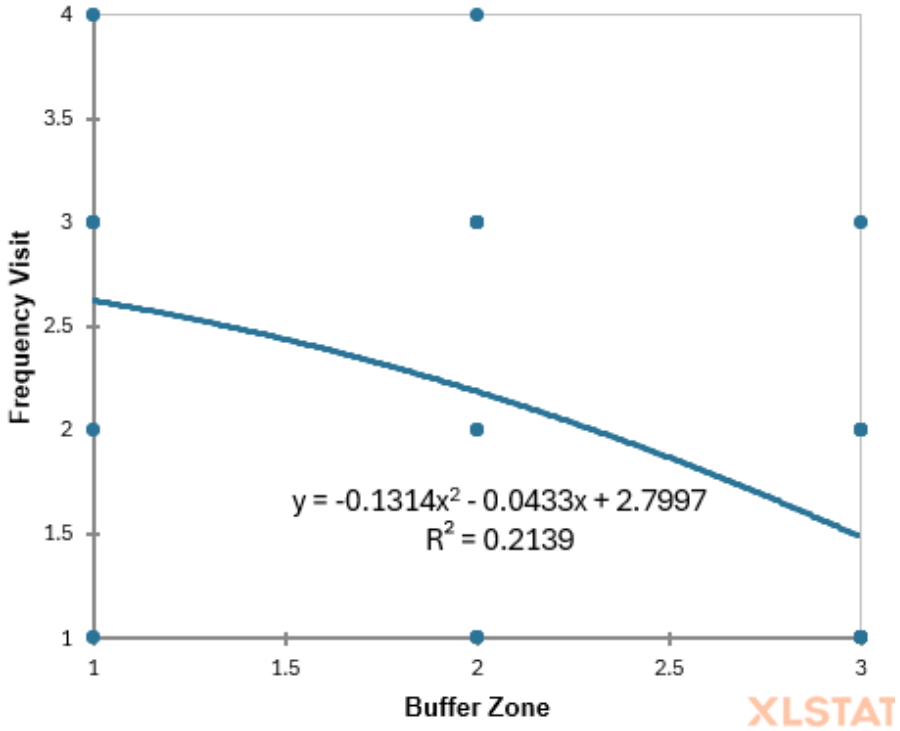


Figure 5.12: Scatter Plot: Visit Frequency vs Buffer Distance

Interpretation: Since the p-value is less than the common significance level of 0.05, we can conclude that there is a significant association between accessibility (distance)

and usage patterns (frequency of park visits). This indicates that distance from the park significantly impacts how frequently individuals visit the park. These findings highlight the importance of proximity in encouraging park usage, which can inform urban planning and policy decisions to enhance accessibility and promote regular visits.

Disaggregate Data into wards

Table 5.5: Effect of Proximity on Visit Frequency Across Wards

Ward	**0–300m (Closest)**	**301–600m (Moderate Distance)**	**>600m (Baseline - Least Visits)**	**Effect of Proximity**
Ward 4	Strongest increase (OR = 14.6, p = 0.001) – People visit significantly more frequently.	High increase (OR = 6.6, p = 0.008) – Still a strong effect, but less than 0–300m.	Baseline (Least visits) – Used as reference for comparison.	Strongest effect of proximity – Distance has a major impact on visit frequency.
Ward 6	Moderate increase – More visits than >600m but not as strong as Ward 4.	Similar to Ward 4 but lower – Some increase, but the effect is weaker.	Baseline (Least visits) – Reference category.	Moderate effect of proximity – Distance matters, but other factors may also influence visits.
Ward 8	Minimal increase – Proximity has little effect on visit frequency.	Slight increase – Some effect, but lower than Wards 4 & 6.	Baseline (Least visits) – Reference category.	Weakest effect of proximity – Distance has a negligible impact on visit behavior.

Discuss the Implications: Follow the table with a discussion of its implications. For example:

The disaggregated analysis reveals significant variations in the effect of proximity across the wards. In Ward 4, a densely populated urban area, proximity has the strongest impact on visit frequency, with residents in the 0–300m buffer being 14.6 times more likely to visit PUGS frequently compared to those in the >600m buffer (OR = 14.6, p = 0.001). This effect remains strong in the 301–600m buffer (OR = 6.6, p = 0.008), underscoring the critical role of distance in a ward with limited green space (0.51 m^2 per person, as noted in Table 5.1). In Ward 6, a transitional

zone, the effect of proximity is moderate, suggesting that while distance matters, other factors—such as terrain or availability of amenities—may also influence visit behavior. Ward 8, with its proximity to forested areas like Shivapuri Nagarjun National Park (213 m^2 per person), shows the weakest effect of proximity, indicating that residents may have alternative green spaces or that distance is less of a barrier due to the ward's semi-urban and ecological context. These findings highlight the need for ward-specific interventions to improve accessibility, particularly in Ward 4, where distance poses the greatest barrier to PUGS usage.

Correlation Analysis: Accessibility vs. Satisfaction and Frequency of Visits

The main goal of this analysis was to examine whether there is a meaningful link between accessibility for all age groups and overall satisfaction with Public Urban Green Spaces (PUGS). This study helps us understand how perceptions of accessibility influence satisfaction levels among users of PUGS.

Methodology

To explore the relationship between accessibility and satisfaction, a correlation analysis was performed using Spearman's method. This approach suits the ordinal data collected from 95 respondents, who rated various aspects of PUGS on a scale of 1 to 5 (1 = Very Unsatisfied, 5 = Very Satisfied). Accessibility for all age groups and overall quality of green space (satisfaction) were the key focus, alongside other factors like cleanliness, amenities, safety, and visit frequency.

Results

The Spearman correlation coefficients between accessibility for all age groups and satisfaction, as well as other aspects of PUGS, are presented below:

Table 5.6: Correlation Between Visit Frequency and Other Variables

Variables	**Cleanliness and Maintenance**	**Availability of Amenities**	**Safety and Security**	**Accessibility for All Age Groups**
Visit Frequency	-0.082	-0.186	-0.345	-0.450

significance level =0.05

The data shows respondents visit green spaces about monthly on average (mean = 2.99, SD = 1.02), with visits ranging from daily (1) to rarely or never (4). Cleanliness and maintenance scored low (mean = 2.01, SD = 0.57), indicating dissatisfaction to neutral views. Availability of amenities received the lowest rating (mean = 1.39,

SD = 0.49), with no scores above 2, reflecting widespread discontent. Safety and security scored highest (mean = 3.08, SD = 0.72), suggesting neutral perceptions, while accessibility averaged 2.11 (SD = 0.57), leaning toward dissatisfaction.

Correlation Findings

Table 5.7: Spearman Correlation p-values

Variables	**Cleanliness and Maintenance**	**Availability of Amenities**	**Safety and Security**	**Accessibility for All Age Groups**
Visit Frequency	0.430	0.072	0.001	<0.0001

The Spearman correlation results highlight key relationships. Accessibility has a strong negative link with the frequency of visits (-0.45, $p < 0.0001$), meaning less frequent visitors rated accessibility lower. Accessibility also shows a positive connection with safety and security (0.43, $p < 0.0001$), suggesting that safer spaces are seen as more accessible. Weaker positive ties exist between accessibility and amenities (0.26, $p = 0.01$) and cleanliness (0.24, $p = 0.02$). Frequency of visits negatively correlates with safety (-0.35, $p = 0.001$), reinforcing that infrequent visitors perceive green spaces less favorably. Safety also relates positively to cleanliness (0.21, $p = 0.04$) and amenities (0.21, $p = 0.04$), though these links are mode

Statistical Significance and Explained Variance

Table 5.8: Spearman Correlation Coefficients of Determination

Variables	**Visit Frequency**	**Cleanliness and Maintenance**	**Availability of Amenities**	**Safety and Security**	**Accessibility for All Age Groups**
Visit Frequency	**1**	0.007	0.034	0.119	0.202
Cleanliness and Maintenance	0.007	**1**	0.038	0.044	0.057
Availability of Amenities	0.034	0.038	**1**	0.044	0.069
Safety and Security	0.119	0.044	0.044	**1**	0.186
Accessibility for All Age Groups	0.202	0.057	0.069	0.186	**1**

P-values confirm most correlations are significant ($p < 0.05$), except for frequency with cleanliness ($p = 0.43$) and amenities ($p = 0.07$), and cleanliness with amenities ($p = 0.06$). The coefficient of determination shows frequency explains 20.2% of accessibility's variance, while safety accounts for 18.6%. Other relationships explain less variance (e.g., 6.9% for accessibility and amenities), indicating weaker influence.

Frequency of Visits to Public Urban Green Spaces

The primary goal of this analysis is to examine the relationship between the frequency of visits to public urban green spaces (UGS) and various socio-economic and spatial factors. Understanding these relationships provides insights into how accessibility and personal characteristics influence visit frequency, which is crucial for urban planning and green space management.

Methodology

To analyze the relationship between visit frequency and other factors, a Spearman correlation analysis was conducted. This non-parametric method is appropriate for ordinal data collected from 95 respondents, who rated factors such as travel time, buffer zone proximity, income range, and education level. The correlation analysis helps determine whether these factors significantly influence how often individuals visit UGS.

Results

The correlation coefficients between visit frequency and other factors are presented below:

Table 5.9: Correlation Between Visit Frequency and Other Variables

Variables	**Education Level**	**Buffer Zone**	**Income Range**	**Travel Time**
Frequency of Visit	-0.246	0.449	-0.346	0.429

Correlation Findings

Education Level (-0.246, $p = 0.016$): A weak negative correlation suggests that individuals with higher education levels tend to visit UGS less frequently. This could be due to time constraints or alternative recreational options.

Buffer Zone (0.449, $p < 0$ .0001): A moderate positive correlation indicates that individuals living closer to UGS tend to visit more frequently, emphasizing the importance of accessibility.

Income Range (-0.346, $p = 0.001$): A moderate negative correlation implies that higher-income individuals visit UGS less often, possibly due to access to private green spaces or different lifestyle preferences.

Travel Time (0.429, $p < 0.0001$): A moderate positive correlation suggests that those with higher travel times still visit UGS, but possibly less frequently than those living closer. This may indicate a strong preference for certain green spaces despite accessibility challenges.

Statistical Significance and Explained Variance

Table 5.10: Coefficients of Determination (Spearman)

Variables	Education Level	Buffer Zone	Income Range	Travel Time	Frequency Visit
Education Level	1	0.009	0.265	0.002	0.061
Buffer Zone	0.009	1	0.006	0.674	0.202
Income Range	0.265	0.006	1	0.016	0.120
Travel Time	0.002	0.674	0.016	1	0.184
Frequency Visit	0.061	0.202	0.120	0.184	1

The p-values indicate that most correlations are statistically significant ($p < 0.05$), confirming reliable relationships. The coefficients of determination (R^2 values) show that buffer zone ($R^2 = 0.202$) and travel time ($R^2 = 0.184$) explain a substantial portion of the variance in visit frequency. Income and education level have weaker relationships, but they still show meaningful trends regarding visitation patterns. The findings suggest that spatial accessibility (buffer zone, travel time) plays a significant role in determining how frequently individuals visit UGS. Meanwhile, socioeconomic factors (income and education) also influence visitation patterns, though to a lesser extent.

Regression Analysis: Socioeconomic and Spatial Factors Influencing Frequency of Visits to Public Urban Green Spaces

This analysis investigates the relationship between visit frequency and various socioeconomic and spatial factors, including mobility issues, education level, buffer zone, income range, travel time, and gender. The goal is to determine which factors significantly impact the frequency of visits to public urban green spaces (UGS).

Methodology

A multiple regression analysis was conducted using the frequency of PUGS visits as the dependent variable. Higher scores on this scale indicate more frequent use. The independent variables included in the model were:

Overview of Variables

The data provides an overview of each variable:

- **Frequency Visit:** Ranges from 1 (rarely) to 4 (very often), with an average of 2.99 and a standard deviation of 1.02. This suggests most people visit slightly less than "often."

- **Mobility Issues:** A yes/no variable (0 = no, 1 = yes), with 23.2% reporting issues (average = 0.23, standard deviation = 0.42).

- **Education Level:** Ranges from 1 to 5 (e.g., high school to postgraduate), averaging 3.37 (standard deviation = 1.05), indicating a moderately educated group.

- **Buffer Zone:** Ranges from 1 to 3 (e.g.,0-300m,301-600m >600m), averaging 2.16 (standard deviation = 0.80), possibly reflecting distance or access to the location.

- **Income Range:** Ranges from 1 to 4, averaging 2.37 (standard deviation = 1.02), suggesting a middle-income sample.

- **Travel Time:** Ranges from 1 (<5min) to 4 (>20min), averaging 2.76 (standard deviation = 1.06).

- **Gender:** A nominal variable (0 = female, 1 = male), with 52.6% male (average = 0.53, standard deviation = 0.50), showing a balanced split.

These figures indicate a diverse sample in terms of education, income, and travel time, with no major imbalances in gender or mobility issues.

Correlation Results

Correlations show how variables relate to each other:

Table 5.11: Correlation Matrix

Variables	Mobility Issues	Education Level	Buffer Zone	Income Range	Travel Time	Gender
Visit Frequency	0.055	-0.225	0.458	-0.335	0.443	-0.052

- **Frequency Visit:** Increases with **Buffer Zone** (0.46) and **Travel Time** (0.44) but decreases with **Income Range** (-0.34). It has weak links with **Mobility Issues** (0.06), **Education Level** (-0.23), and **Gender** (-0.05).

- Other notable relationships include a strong link between **Buffer Zone** and **Travel Time** (0.82), suggesting they measure similar ideas (e.g., distance), and between **Education Level** and **Income Range** (0.54), showing higher education ties to higher income.

These patterns suggest that visit frequency rises with greater buffer zones or travel times but falls as income increases.

Regression Model

Table 5.12: Standardized Coefficients (Visit Frequency)

Source	Value	Standard Error	t	Pr > |t|	Lower Bound (95%)	Upper Bound (95%)
Buffer Zone	0.433	0.088	4.943	<0.0001	0.259	0.607
Income Range	-0.298	0.088	-3.398	0.001	-0.472	-0.124

A regression model was used to predict **Frequency Visit**, selecting **Buffer Zone** and **Income Range** as key factors.

Equation of the model (Visit Frequency):

$$\text{Frequency Visit} = 2.51 + 0.55 * BufferZone - 0.30 * IncomeRange$$

- **Buffer Zone:** Each unit increase raises **Frequency Visit** by 0.55 units ($p < 0.0001$), meaning it has a strong positive effect.

- **Income Range:** Each unit increase lowers **Frequency Visit** by 0.30 units ($p = 0.001$), showing a significant negative effect.

The model explains 29.8% of the variation in **Frequency Visit** ($R^2 = 0.298$), with an adjusted R^2 of 0.283. The overall fit is significant ($F = 19.55, p < 0.0001$), and the error is 0.86 units (RMSE = 0.86).

Other variables like Travel Time and Education Level were not included, possibly due to overlap with Buffer Zone or limited impact.

The results show that Buffer Zone increases visit frequency, which is surprising if it represents distance—higher values might instead reflect better access or need. The model captures nearly 30% of the variation in visit frequency, leaving much unexplained, possibly due to unmeasured factors like personal needs or preferences. The strong link between Buffer Zone and Travel Time (0.82) suggests they may overlap, which could explain why only Buffer Zone was used in the model.

The analysis indicates that Buffer Zone significantly affect how often people visit, with a positive impact. However, the model's moderate fit ($R^2 = 0.298$) suggests other factors also matter.

5.4 Qualitative Data Analysis Using ATLAS.ti

This study used ATLAS.ti to analyze how different issues related to Public Urban Green Spaces (PUGS) in Nagarjun Municipality connect with each other.

5.4.1 Frequency of Key Themes

Table 5.13 shows the frequency of themes identified in the data. 'Seating Needs' (Gr=64) and 'Maintenance Issues' (Gr=49) were the most frequently mentioned, indicating they are major concerns for residents. In contrast, themes like 'No Green Space Policy' (Gr=1) were rarely cited, suggesting less awareness or discussion of policy gaps.

The groundedness (Gr) of a category code is the number of quotations coded by all of its subcodes. A subcode is a code that is sorted under a category code. No further subcodes can be created under subcodes. Each code should only appear once in a code system (ATLAS.ti, 2025). Using ATLAS.ti, all open-ended survey responses, key informant interviews, and observations were systematically coded to identify recurring patterns.

Table 5.13: Frequency of Key Themes

Code	**Groundedness (Gr)**
Seating Needs	64
Maintenance Issues	49
Accessibility Barriers	42
Shaded Spaces	37
Elderly Access Needs	31
Lighting Needs	30
Family Access Needs	29
Distance Barrier	28
Funding Shortage	26
Traffic Issues	24
Open Gym	23
Poor Pathways	22
Terrain Issues	22
Restroom Needs	18
Safety Concerns	17
Accessibility for Disabled	15
Amenity Lack	14
Awareness Gap	14
Water Facilities	14
Play Area Requests	12
Community Engagement Lack	8
Lack of Transport	8
Land Scarcity	7
Planning Gaps	7
Signage Needs	7
Proximity Needs	6
Income Disparity	5
Commercialization Pressure	2
Pocket Parks	2
No Green Space Policy	1

Note:Gr=Groundedness, Number of Quotations Coded

5.4.2 Co-Occurrence Analysis of PUGS Challenges

The co-occurrence table (Table 5.14) shows how often themes, or codes, appear together in the data from interviews and surveys. Each theme is labeled with its 'groundedness' (Gr), which shows how many times it was mentioned in the data. This helps us understand the main challenges residents face and how these problems are linked

Table 5.14: Co-Occurrence of Key Themes Related to Public Urban Green Spaces (PUGS) in Nagarjun Municipality

Codes	**Gr**	**Accessibility Barriers Gr=42**	**Amenity Lack Gr=14**	**Elderly Access Needs Gr=31**	**Funding Shortage Gr=26**
Accessibility for Disabled	15	2	0	4	0
Awareness Gap	14	1	0	0	1
Distance Barrier	28	25	6	0	4
Lighting Needs	30	4	3	5	0
Maintenance Issues	49	15	2	0	8
Poor Pathways	22	3	2	11	0
Seating Needs	64	3	3	6	1
Shaded Spaces	37	3	2	4	1
Terrain Issues	22	11	3	11	0
Traffic Issues	24	1	0	7	0

Source: Generated from ATLAS.ti Code Co-Occurrence Report

The most common issue, "Seating Needs" (Gr=64), often appears with "Shaded Spaces" (28 times), "Elderly Access Needs" (6), and "Family Access Needs" (17). This shows that people, especially the elderly and families, want more seats and shade in PUGS. Another key problem, "Maintenance Issues" (Gr=49), connects with "Accessibility Barriers" (15), "Distance Barrier" (9), and "Terrain Issues" (8). This means poor upkeep makes it harder to reach and use green spaces, especially in hilly areas. "Accessibility Barriers" (Gr=42) links strongly with "Distance Barrier" (25) and "Terrain Issues" (11), proving that distance and rough terrain stop many residents from accessing PUGS.

Lack of facilities also stands out. "Lighting Needs" (Gr=30) ties to "Safety Concerns" (6) and "Elderly Access Needs" (11), showing that dark spaces feel unsafe and affect older people the most. "Restroom Needs" (Gr=18) connects with "Family Access Needs" (8), meaning families need better sanitation to use PUGS comfortably. "Amenity Lack" (Gr=14) pairs with "Distance Barrier" (6), suggesting far-off green spaces often miss basic features like seats or restrooms.

Money and policy issues matter too. "Funding Shortage" (Gr=26) links to "Maintenance Issues" (8) and "Accessibility Barriers" (9), hinting that limited funds hurt PUGS quality and access. "Community Engagement Lack" (Gr=8) shows up with "Awareness Gap" (3) and "Funding Shortage" (2), meaning people don't get involved partly because they don't know the benefits or lacks upport. " Income Disparity" (Gr=5) and "No Green Space Policy" (Gr=1) appear less often but point to bigger social and planning gaps.

These results show how physical barriers, poor facilities, and limited resources work together to limit PUGS use in Nagarjun Municipality. Fixing these issues needs better pathways, more amenities like lights and restrooms, and stronger funding. Getting residents involved could also help. This analysis adds depth to the study's maps and numbers, giving a fuller picture of what needs to change.

5.4.3 Distribution of Themes Across Respondent Groups

To understand how different groups perceive challenges and needs related to Public Urban Green Spaces (PUGS) in Nagarjun Municipality, a Code-Document Table was created using ATLAS.ti. Table 5.15 shows how often key themes appear in survey responses from elderly residents (17 respondents), families (53 respondents), and youth (25 respondents), as well as in Key Informant Interviews (KIIs) with ward and municipal officials (2 in terviews). The table counts the number of times each theme was mentioned in each group, highlighting variations in priorities and concerns.

The results show clear differences across groups. For elderly respondents, "Elderly Access Needs" (16 quotations) and "Seating Needs" (16) were major concerns, reflecting their focus on accessibility and comfort (Table 5.15). Families frequently mentioned "Family Access Needs" (30) and "Amenity Lack" (40), pointing to their need for play areas, restrooms, and other facilities for children. Youth respondents also highlighted "Amenity Lack" (23) but focused more on modern features like open gyms and Wi-Fi. Across all groups, "Accessibility Barriers" (15-45 quotations)

and "Maintenance Issues" (13-29) were common, showing these are widespread challenges. The KIIs echoed these concerns, often mentioning "Funding Shortage" (2) and "Community Engagement Lack" (2) as root causes, which aligns with resident feedback.

Table 5.15: Distribution of Themes Across Data Sources

Code	**Survey Responses (Elderly) (17 Respondents)**	**Survey Responses (Families) (53 Respondents)**	**Survey Responses (Youth) (25 Respondents)**	**Key Informant Interviews**
Seating Needs	16	43	23	2
Shaded Spaces	11	15	10	1
Accessibility Barriers	15	45	21	2
Distance Barrier	5	18	9	2
Terrain Issues	15	20	9	2
Poor Pathways	14	30	13	2
Lighting Needs	5	19	7	2
Elderly Access Needs	16	4	4	1
Family Access Needs	5	30	11	1
Maintenance Issues	13	29	20	2
Funding Shortage	7	17	5	2
Community Engagement Lack	3	7	4	2
Amenity Lack	4	40	23	2
Safety Concerns	9	17	10	1
Awareness Gap	2	12	4	2

In addition to the distribution of themes across respondent groups, further analysis of key informant interviews and open-ended responses provides a detailed breakdown of theme prevalence. Table 5.16 summarizes the frequency of key themes across these data sources, highlighting the prominence of accessibility and community needs in the qualitative data.

Table 5.16: Distribution of Themes Across Key Informant Interviews and Open-Ended Responses

Variables	**KII (Gr = 73)**	**Open-ended Responses/Interviews (Gr = 248)**	**Totals (Gr)**
Accessibility Challenges (Gr = 156; GS = 12)	20	136	156
Community Engagement (Gr = 74; GS = 4)	7	67	74
Community Needs and Preferences (Gr = 157; GS = 10)	21	136	157
Environmental and Contextual Factors (Gr = 42; GS = 3)	7	35	42
Policy and Maintenance Challenges (Gr = 86; GS = 6)	17	69	86
Socio-Economic and Equity Issues (Gr = 80; GS = 5)	17	63	80
Spatial Distribution Challenges (Gr = 17; GS = 4)	13	4	17
Totals	**102**	**510**	**612**

Note: GS=Number of documents in a document group or number of codes in a code group

Accessibility Challenges (n=156) and Community Needs and Preferences (n=157) dominate the qualitative data, with open-ended responses contributing the majority of quotations (n=510), underscoring their significance to residents.

This analysis reveals that while some issues, like poor maintenance and accessibility, affect everyone, specific needs vary by group. Elderly residents prioritize pathways and seating, families want child-friendly amenities, and youth seek recreational features. These findings can guide targeted improvements in PUGS design and management.

5.4.4 Voices of Residents: Key Quotations on PUGS Challenges

To give a clearer picture of the challenges and needs related to Public Urban Green Spaces (PUGS) in Nagarjun Municipality, this section presents selected quotations from survey respondents and key informants. These voices highlight the real experiences of residents and the perspectives of local officials, adding depth to the themes identified in the ATLAS.ti analysis, such as accessibility barriers, maintenance issues, and the lack of amenities. The quotations were chosen to reflect the most common concerns raised across different groups, including elderly residents, families, youth, and ward officials.

One of the biggest issues mentioned by residents is the difficulty in reaching PUGS due to distance and rough terrain. An elderly respondent shared, "The park is too far, and the road to get there is steep—I can't go often" (R4, Male, Above 60 years). This shows how physical barriers like steep paths stop many elderly people from using green spaces. Similarly, a family member noted, "It's far and takes over 20 minutes to reach" (R7, Female, 41-60 years), pointing to the challenge of distance for families who want to visit with children.

Poor pathways and lack of proper lighting also make it hard for residents to feel safe or comfortable visiting PUGS. A young respondent explained, "Creating more flat pathways and better lighting would make it safer and easier to visit, especially in the evening" (R8, Female, 18-30 years). This highlights the need for smoother paths and lighting to encourage evening use, especially for younger people. An elderly resident added, "Fixing the uneven paths would help me and others with mobility issues reach the PUGS more easily" (R13, Male, Above 60 years), showing how uneven terrain affects those with limited mobility.

The lack of basic amenities, such as seating, shade, and restrooms, was another common concern. A family respondent said, "There are not enough benches in the park, so I can't rest when I walk with my kids" (R1, Male, 31-40 years). This reflects the need for more seating to make PUGS comfortable for families. Another resident mentioned, "Public toilets, free Wi-Fi, drinking water stations, and more furniture like benches would make the space more comfortable and useful for daily visits" (R2, Male, 31-40 years), showing a demand for various facilities to improve the overall experience.

Maintenance issues were frequently raised as a reason why PUGS are not appealing. A respondent shared, "The grass is overgrown, and there's trash everywhere; it

doesn't feel nice to visit" (R5, Male, 41-60 years). This points to the problem of poor upkeep, which discourages people from using the spaces. The Ward Chair of Ward 8 confirmed this challenge, stating, "Our parks get dusty, overgrown, or littered because we don't have regular upkeep—budget's always short" (Mr. Suraj Kumar Pokhrel, Ward Chair, Ward 8). This shows that limited funding is a key reason for maintenance problems, as seen by both residents and officials.

Safety concerns, including traffic noise and lack of lighting, also affect how residents use PUGS. A respondent noted, "Nearby traffic and noise make it less appealing to visit" (R55, Female, 18-30 years), highlighting how external factors like noise pollution reduce the appeal of green spaces. Another resident added, "Unlit pathways at night reduce safety and usability" (R90, Female, 41-60 years), emphasizing the need for better lighting to make PUGS safer for evening visits.

Finally, the lack of community involvement and awareness about the benefits of PUGS was mentioned as a barrier to improvement. A respondent said, "Lack of awareness about the benefits of PUGS reduces community support for maintenance" (R15, Male, 31-40 years). This suggests that many residents do not fully understand the value of green spaces, which affects their willingness to help maintain them. The Planning Chief of Nagarjun Municipality agreed, noting, "Awareness might be low too; we haven't done enough to sell the benefits—health, air quality, relaxation" (Er. Kanchan Khanal, Planning Chief, Nagarjun Municipality). This shared view from residents and officials points to the need for awareness campaigns to encourage better use and care of PUGS.

These quotations show the real-life challenges residents face when trying to use PUGS in Nagarjun Municipality. They also match the main themes found in the ATLAS.ti analysis, such as accessibility barriers, maintenance issues, and the need for more amenities. By listening to these voices, the study highlights the specific improvements needed to make PUGS more usable and enjoyable for everyone.

5.4.5 Grouping of Themes into Categories

To better understand the main challenges and needs related to Public Urban Green Spaces (PUGS) in Nagarjun Municipality, the individual codes identified in the ATLAS.ti analysis were grouped into broader categories. This grouping helps to see the bigger patterns in the data by combining related themes. Table 5.17 shows these categories, the codes included in each, and their total groundedness, which is the number of times the codes were mentioned across all data sources, including survey

responses and Key Informant Interviews (KIIs). The categories were created based on the Code-Document Report generated from ATLAS.ti, which organizes the data into seven main groups.

Table 5.17: Categories of Themes Related to PUGS Challenges

Category	**Codes Included**	**Total Groundedness (Gr)**
Accessibility Challenges	Accessibility Barriers, Distance Barrier, Terrain Issues, Poor Pathways, Elderly Access Needs, Family Access Needs	156
Community Engagement	Community Engagement Lack, Awareness Gap	74
Community Needs and Preferences	Seating Needs, Shaded Spaces, Lighting Needs, Restroom Needs, Amenity Lack	157
Environmental and Contextual Factors	Safety Concerns, Traffic Issues, Terrain Issues (shared with Accessibility)	42
Policy and Maintenance Challenges	Maintenance Issues, Funding Shortage, No Green Space Policy	86
Socio-Economic and Equity Issues	Funding Shortage (shared with Policy), Income Disparity, Community Engagement Lack (shared with Community Engagement)	80
Spatial Distribution Challenges	Distance Barrier (shared with Accessibility), Accessibility Barriers (shared with Accessibility)	17

Note: Some codes, like Distance Barrier and Funding Shortage, appear in more than one category due to their relevance to multiple themes. Groundedness (Gr) shows the total number of quotations for each category. Source: Generated from ATLAS.ti Code-Document Report.

The table shows that the most common concerns fall under Community Needs and Preferences (Gr=157) and Accessibility Challenges (Gr=156). The high groundedness of Community Needs and Preferences means that residents often talked about wanting basic features in PUGS, such as seating, shade, lighting, restrooms, and other amenities. For example, a respondent said, “Public toilets, free Wi-Fi, drinking water stations, and more furniture like benches would make the space more comfortable and useful for daily visits” (R2, Male, 31-40 years). This category reflects t he s trong d emand f or b etter f acilities t o m ake P UGS m ore e njoyable for everyone, as seen in the survey responses.

Accessibility Challenges also had a high groundedness (Gr=156), showing that many residents struggle to reach PUGS. This category includes codes like Accessibility Barriers, Distance Barrier, and Terrain Issues, which were often mentioned together in the co-occurrence analysis (Table 5.14). A resident shared, "The park is too far, and the road to get there is steep—I can't go often" (R4, Male, Above 60 years), highlighting how distance and rough terrain create barriers, especially for elderly people. The Planning Chief of Nagarjun Municipality also noted, "Distance is one thing—some residents, especially in hilly wards like 6 and 8, are far from any public park, over 600 meters in some cases" (Er. Kanchan Khanal, Planning Chief, Nagarjun Municipality). This confirms that accessibility is a major issue across the municipality.

Policy and Maintenance Challenges (Gr=86) was another key category, pointing to problems with keeping PUGS in good condition and the lack of resources to support them. This includes Maintenance Issues and Funding Shortage, which were frequently raised by both residents and officials. A respondent explained, "The grass is overgrown, and there's trash everywhere; it doesn't feel nice to visit" (R5, Male, 41-60 years), showing how poor upkeep discourages use. The Ward Chair of Ward 8 added, "Our parks get dusty, overgrown, or littered because we don't have regular upkeep—budget's always short" (Mr. Suraj Kumar Pokhrel, Ward Chair, Ward 8), linking maintenance problems to limited funding.

Socio-Economic and Equity Issues (Gr=80) highlights how income and social factors affect PUGS use. This category includes codes like Income Disparity and Funding Shortage, showing that poorer residents often have less access to quality green spaces. The Planning Chief noted, "Lower income families, often in denser or uphill areas, depend on what's nearby, but those spaces are usually the worst—far, poorly kept, no facilities" (Er. Kanchan Khanal, Planning Chief, Nagarjun Municipality). This matches survey findings, where residents in hilly areas often mentioned distance and poor pathways as barriers.

Community Engagement (Gr=74) focuses on the lack of resident involvement and awareness about PUGS benefits. A respondent said, "Lack of awareness about the benefits of PUGS reduces community support for maintenance" (R15, Male, 31-40 years), pointing to the need for better education about green spaces. The Ward Chair also mentioned, "Awareness? I'd say it's low. We don't talk enough about what green spaces do—clean air, cooling, mental peace" (Mr. Suraj Kumar Pokhrel, Ward Chair, Ward 8), suggesting that more community programs could help.

Environmental and Contextual Factors (Gr=42) includes issues like safety concerns and traffic noise, which make PUGS less appealing. A resident shared, "Nearby traffic and noise make it less appealing to visit" (R55, Female, 18-30 years), showing how external factors affect the use of green spaces. Finally, Spatial Distribution Challenges (Gr=17) had the lowest groundedness, but it still points to uneven access to PUGS across the municipality. The Ward Chair of Ward 8 explained, "The inner settlements, especially uphill, have almost nothing. People living there have to walk a long way—sometimes over 600 meters—through steep paths to reach anything green" (Mr. Suraj Kumar Pokhrel, Ward Chair, Ward 8), confirming that green spaces are not well spread out.

These categories show the main areas where PUGS in Nagarjun Municipality need improvement. The high groundedness of Community Needs and Preferences and Accessibility Challenges suggests that adding basic amenities and improving access should be top priorities. At the same time, Policy and Maintenance Challenges and Socio-Economic and Equity Issues point to the need for better funding and planning to make green spaces fair and usable for all residents.

5.4.6 Visualizing PUGS Challenges: A Word Cloud Overview

A word cloud was created using ATLAS.ti to show the most common words mentioned by residents and key informants when discussing Public Urban Green Spaces (PUGS) in Nagarjun Municipality. The word cloud helps to quickly see which words were used the most in the survey responses and Key Informant Interviews (KIIs), with larger words appearing more often. This visual tool gives a clear picture of the main issues and needs related to PUGS, adding to the earlier analyses like the co-occurrence table, Code-Document Table, and Code Categories.

Figure 5.13: Word Cloud of Key Terms in PUGS Responses

The word cloud shows that words like "spaces," "areas," "people," "green," and "seating" are some of the largest, meaning they were mentioned the most. The word list report from ATLAS.ti confirms this, with "spaces" appearing 62 times, "areas" 60 times, "green" 50 times, "people" 46 times, and "seating" 42 times across all responses. These words point to the focus on green spaces and the need for better areas for people to use, especially with more seating. For example, a resident said, "There are not enough benches in the park, so I can't rest when I walk with my kids" (R1, Male, 31-40 years), which explains why "seating" is so common and matches the high groundedness of Community Needs and Preferences (Gr=157).

Other big words in the cloud include "paths" (39 times), "maintenance" (39 times), "pathways" (16 times), and "distance" (22 times). These words show the challenges of reaching PUGS and keeping them in good condition. A respondent shared, "The park is too far, and the road to get there is steep—I can't go often" (R4, Male, Above 60 years), which connects to the frequent mention of "distance" and aligns with the Accessibility Challenges category (Gr=156, Table 5.15). The Ward Chair of Ward 8 also noted, "Our parks get dusty, overgrown, or littered because we don't have regular upkeep—budget's always short" (Mr. Suraj Kumar Pokhrel, Ward Chair, Ward 8), explaining why "maintenance" stands out in the word cloud and relates to the Policy and Maintenance Challenges category (Gr=86).

Words like "kids" (30 times), "family" (29 times), and "play" (32 times) are also prominent, showing that many residents want PUGS to be better for families and children. A family respondent mentioned, “More seating and play equipment for children would make it a better place for my family to relax” (R7, Female, 41-60 years), which reflects the need for family-friendly spaces. This supports the findings in the Code-Document Table, where Family Access Needs had 30 quotations in the Families group.

Finally, words like "lighting" (26 times), "traffic" (24 times), and "safety" (15 times) highlight concerns about making PUGS safer to use, especially at night. A young resident said, “Creating more flat pathways and better lighting would make it safer and easier to visit, especially in the evening” (R8, Female, 18-30 years), showing why these words appear often. This connects to the Environmental and Contextual Factors category (Gr=42), which includes safety concerns.

To further illustrate the relationships between data sources and thematic categories, Figure 5.14 presents a Sankey diagram generated from ATLAS.ti, depicting the flow of quotations from KIIs and open-ended responses into the identified PUGS challenges.

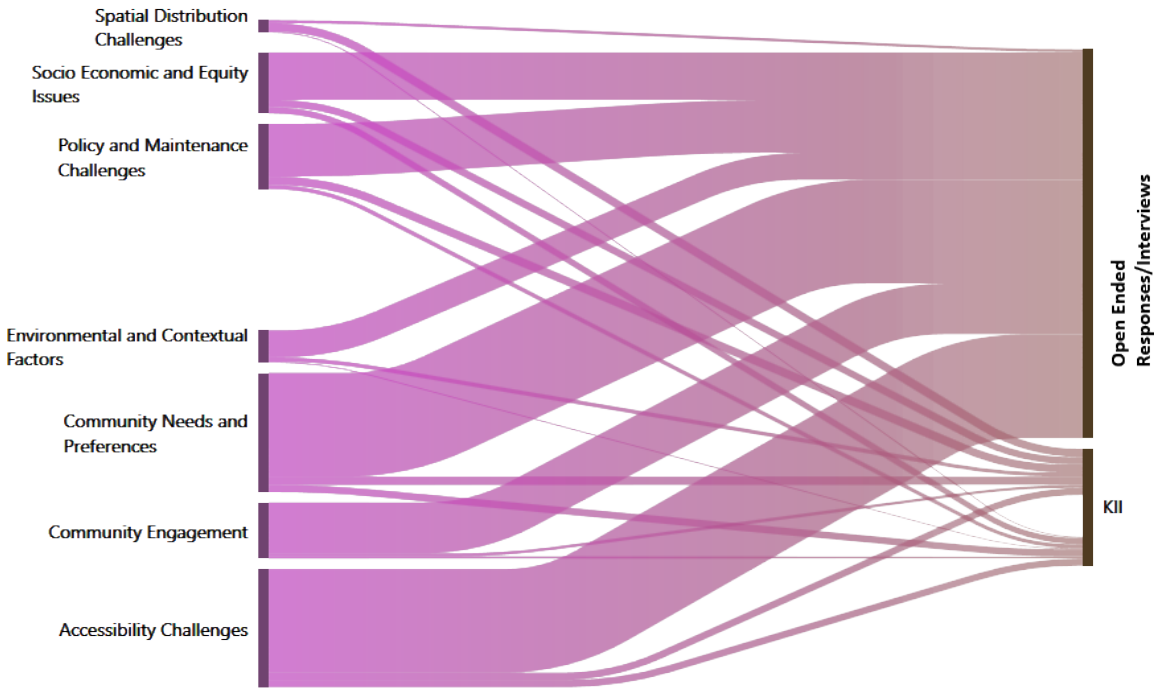


Figure 5.14: Sankey Diagram of Theme Distribution Across Data Sources (Generated from ATLAS.ti)

The word cloud gives a simple way to see the biggest issues with PUGS in Nagarjun Municipality. It shows that residents care a lot about having good spaces with seating, play areas for kids, and better paths to reach them. They also worry about maintenance and safety. Also the Sankey diagram highlights the substantial contribution of open-ended responses (n=510) to themes like Accessibility Challenges and Community Needs, while KIIs provide deeper insights into Spatial Distribution Challenges (n=17).

5.5 Perceptions and Suggestions for PUGS Improvement

5.5.1 Residents' Perceptions of PUGS Distribution and Functionality

A. Perception on equal distribution of PUGS

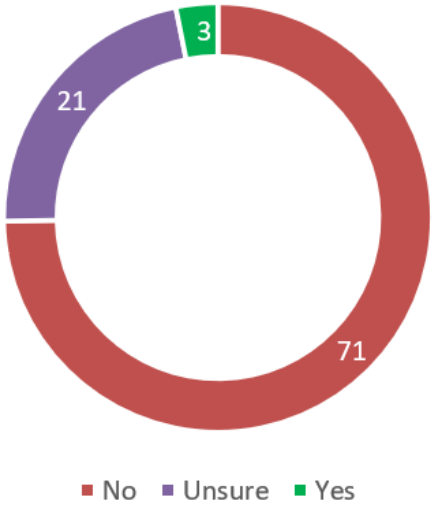


Figure 5.15: Bar chart showing perception of equal distribution

Survey results indicate that a significant majority (74.74%) of respondents believe that PUGS are not equitably distributed within their municipality. This suggests that many residents feel certain areas have better access to green spaces while others remain underserved.

Additionally, 22.11% of respondents were unsure, which may indicate a lack of awareness regarding green space distribution or its impact on different communities. Only 3.16% of respondents agreed that PUGS are fairly distributed, reinforcing concerns about accessibility gaps.

These findings highlight the need for urban planning interventions to address disparities in green space availability. Strategies such as developing new PUGS in underrepresented areas, improving connectivity, and ensuring inclusive planning processes can help create a more balanced and accessible urban environment.

B. Meeting household needs

Survey results reveal that an overwhelming majority (97.89%) of respondents feel that the existing PUGS do not meet the needs of their household. This suggests significant gaps in accessibility, infrastructure, maintenance, or available amenities.

Only 2.11% of respondents believe that PUGS adequately fulfill their household needs, indicating that current green spaces may lack essential features such as play areas, exercise facilities, shaded seating, or proper maintenance.

These findings highlight the urgent need for improvements in PUGS design, better maintenance, and community-driven planning to ensure that green spaces are inclusive and functional for all age groups and household types. Expanding green space amenities and addressing resident concerns should be a priority in future urban development plans.

5.5.2 Suggested Improvements for PUGS Facilities and Accessibility

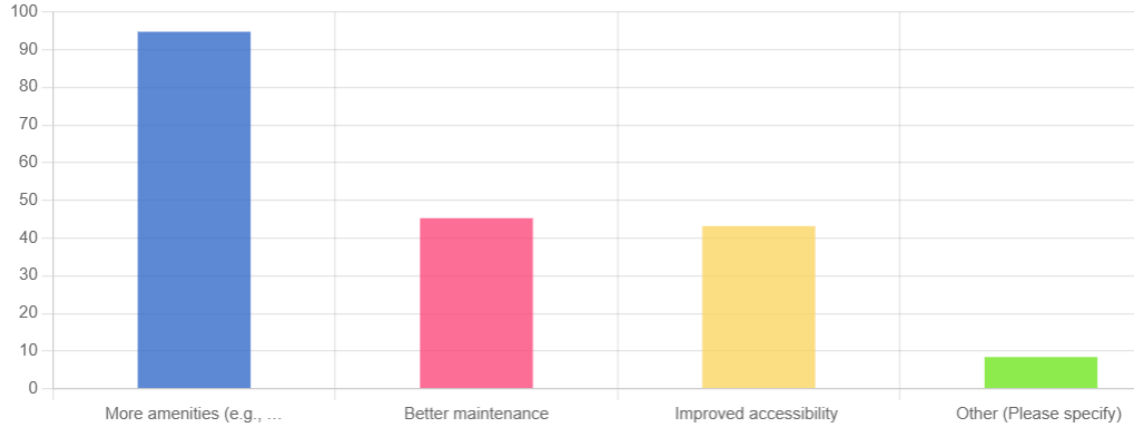


Figure 5.16: Bargraph for Improvement Suggestion

The majority of respondents (94.74%) highlighted the need for more amenities, such as additional seating and play areas, indicating that these basic facilities are currently lacking. Nearly half of the respondents also emphasized the importance

of better maintenance (45.26%) and improved accessibility (43.16%) to enhance the usability of these spaces.

In the "Other" category (8.42%), individual suggestions included creating more gender-sensitive and child-friendly spaces, providing public restrooms—especially for women and the elderly—and offering more recreational areas. Additional recommendations were made for better public transport options to reach the green spaces, the establishment of smaller PUGS nearby, and even the integration of open-air gyms.

These responses suggest that while the primary focus is on upgrading basic amenities and maintenance, there is also a call for more specialized improvements that cater to the diverse needs of the community. Urban planning strategies should, therefore, consider both the general and specific suggestions to create a more inclusive and accessible network of green spaces.

Contribution to environmental quality

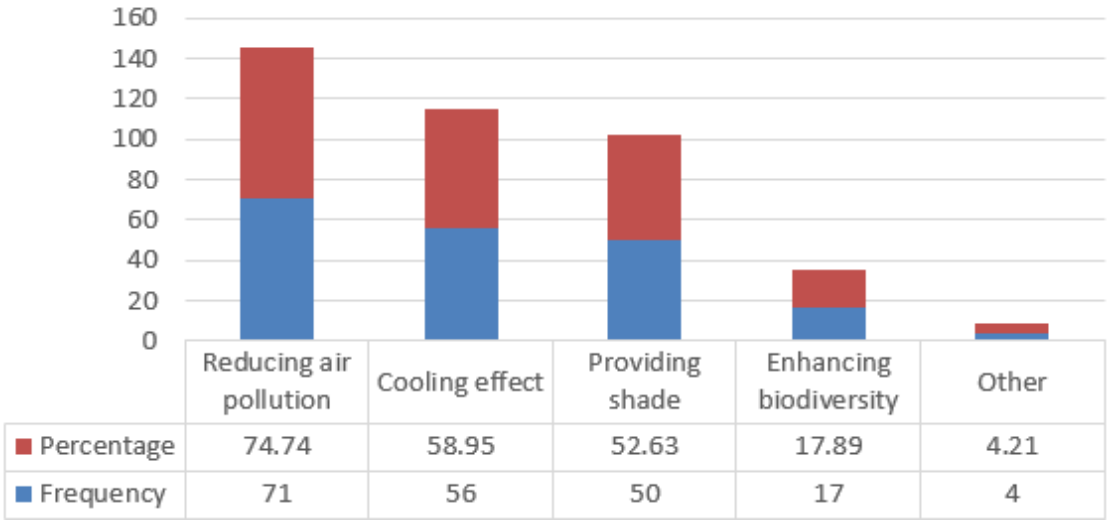


Figure 5.17: Bar chart showing perception on contribution of PUGS to Environment in different ways

A majority of respondents (92.63%) believe that PUGS in their area contribute positively to environmental quality, with only 7.37% disagreeing.

Key benefits highlighted by respondents include:

- **Reducing Air Pollution**: 74.74% noted PUGS help improve air quality.

- **Cooling Effect**: 58.95% observed a cooling effect in their areas.
- **Providing Shade**: 52.63% pointed out that PUGS offer shade, contributing to lower temperatures.
- **Enhancing Biodiversity**: 17.89% mentioned these spaces enhance biodiversity.

Other benefits (4.21%) included reducing heat, preventing soil erosion, improving water retention, providing a green buffer against heat, and serving as a habitat for local birds. One respondent indicated no observed environmental benefits.

Overall, residents strongly associate PUGS with improved environmental conditions, primarily through reducing air pollution and moderating urban heat. These perceptions underline the importance of preserving and enhancing green spaces as part of urban environmental management strategies.

User Ratings of Key Attributes of Public Urban Green Spaces

Respondents were asked to rate several aspects of public urban green spaces on a scale from 1 (very poor) to 5 (excellent). The results indicate overall low satisfaction with many attributes, highlighting areas that need improvement.

a. Cleanliness and Maintenance: The average rating was 2.01 with both the median and mode at 2. This suggests that most users consider the cleanliness and upkeep of these spaces to be poor. The relatively low standard deviation (0.57) indicates that responses were consistently low.

b. Availability of Amenities: With a mean rating of 1.39 (median and mode at 1), this attribute received the lowest score among all parameters. This result reflects a serious lack of facilities such as seating, play areas, and other recreational amenities in the green spaces.

c. Safety and Security: The safety of these spaces was rated slightly higher, with an average of 3.06 and a median and mode of 3. However, the standard deviation of 0.74 suggests that while some users may feel moderately secure, many still have concerns about safety.

d. Accessibility for All Age Groups: This aspect received a mean rating of 2.11 (with the median and mode at 2), indicating that many users do not find the green spaces easily accessible, particularly for children and the elderly.

e. Overall Quality of Green Space: The overall quality was rated at 2.78 on average, with the median and mode at 3. Although this is somewhat higher than some individual attributes, it still reflects a general dissatisfaction and points to the need for significant improvements.

In summary, the ratings clearly show that while safety is perceived as moderately acceptable, the cleanliness, amenities, and accessibility of public urban green spaces are areas where residents feel the most improvement is needed. These insights provide a strong basis for recommending targeted enhancements in maintenance, facility provision, and design to better serve the community.

Additional Features and Improvement Suggestions for PUGS

Respondents provided a wide range of suggestions to enhance the facilities and accessibility of public urban green spaces (PUGS) near their homes. Although many responses were mentioned by only one participant (approximately 1.05% each), several key themes emerged from the data. Participants recommended a variety of amenities to improve the usability of PUGS. Common suggestions included:

a. Exercise and Fitness Facilities:

- Several respondents mentioned the desire for an open or outdoor gym
- Other suggestions included dedicated jogging zones or fitness areas for both adults and children.

b. Seating and Shaded Areas:

- Multiple responses emphasized the need for more seating spaces, shaded areas, and resting spots, particularly for the elderly and children.
- Suggestions such as "benches and shaded areas" and "more shaded walking paths" indicate that providing comfortable resting areas is important.

c. Basic Amenities:

- Participants called for improvements in basic facilities such as public restrooms, water facilities (including drinking water and water fountains), and trash bins.
- Some responses combined these with technology enhancements, such as free wifi.

d. Play and Recreational Areas:

- Several respondents suggested installing play equipment for children or creating designated play zones, indicating a need for child-friendly features.

e. Lighting and Safety:

- A few suggestions included better lighting and the installation of CCTV cameras to improve security during evening hours.
- Other individual suggestions included elements like sheds, landscaped green walls, interactive or sensory lighting, and even the introduction of community activity spaces. These varied responses indicate that residents are looking for improvements that cover both recreational and functional aspects of PUGS.

About 30% of respondents suggested more seating, based on survey responses, while others called for play areas (15%) and restrooms (10%). These percentages highlight the priority residents place on basic amenities to make PUGS more usable across all wards.

5.5.3 Suggestions to Improve Accessibility and Utilization

In addition to new features, respondents provided ideas to enhance accessibility and overall usage of green spaces in their buffer zones. Key suggestions included:

a. Improving Pathways:

- Many responses focused on the need for improved pedestrian pathways. Suggestions ranged from paving existing paths to constructing alternative, less steep or wheelchair-friendly pathways.

- Several participants recommended installing handrails, ramps, or non-slip surfaces along steep or uneven paths to benefit elderly and disabled residents.

b. Enhanced Connectivity and Transport:

- Some respondents proposed better public transport connectivity or even subsidized rickshaw services to facilitate easier access to PUGS for those living at a distance.

- There were calls to develop or locate new green spaces closer to residential areas to reduce travel time.

c. Community Engagement and Maintenance:

- Suggestions also highlighted the importance of regular maintenance, better management of the space, and increased community participation in upkeep.

- A few responses stressed the need for awareness programs to educate residents on the benefits of green spaces and to encourage active community involvement.

d. Safety and Infrastructure:

- Improved lighting, proper signage, and additional security measures such as CCTV were recommended to ensure that PUGS are safe and welcoming, particularly during evening hours.

- Some respondents mentioned creating designated quiet zones or family-friendly areas to make the spaces more inclusive.

Overall, the suggestions provided by the respondents reflect a strong desire for PUGS that are not only well-equipped with physical amenities but are also easily accessible, safe, and maintained through active community and municipal involvement. These insights offer valuable guidance for urban planners aiming to enhance the functionality and inclusivity of green spaces in Nagarjun Municipality.

5.5.4 Challenges in Maintaining and Improving PUGS

Survey respondents identified several challenges affecting the maintenance and improvement of public urban green spaces (PUGS) in the municipality. Although many of these challenges were mentioned by only one or two respondents (approximately 1–2.11% each), the cumulative responses reveal a broad range of issues that need to be addressed.

A primary challenge is the lack of awareness about the benefits of green spaces, as indicated by 6.32% of respondents. This low awareness appears to contribute to minimal community involvement and coordination in the upkeep of these spaces. Budget constraints and funding issues were also frequently cited, with several responses pointing to insufficient financial resources and bureaucratic delays that hamper both development and maintenance efforts.

Additionally, geographical barriers and terrain issues—such as steep pathways, uneven surfaces, and limited public land—pose significant obstacles, particularly for the elderly and disabled residents. Dust and noise pollution from nearby roads and construction activities further diminish the usability of these spaces, while concerns over poor public transport connectivity and inadequate basic amenities (like seating, trash bins, and restrooms) were also noted.

Other responses highlighted the need for greater community engagement and more inclusive planning processes. Issues such as the unequal distribution of PUGS, safety concerns (including unlit pathways and stray dogs), and the overall lack of maintenance were also mentioned. Collectively, these responses suggest that improving PUGS requires integrated strategies that address financial, infrastructural, and social aspects, ensuring that green spaces are accessible, safe, and well-maintained for all residents.

5.5.5 Ward-Wise Qualitative Analysis and Planning Implications

This section analyzes resident views on Public Urban Green Spaces (PUGS) to guide urban planning strategies. The survey responses from residents regarding desired features, accessibility improvements, and maintenance challenges are used. Answers are grouped by ward 46 from Ward 4, 39 from Ward 6, and 9 from Ward 8—and categorized into themes such as “seating” or “funding.” These themes are linked to findings, including green space per person and distance data, to provide planning insights.

a. Ward 4: High Population Density, Urban Area with Limited Green Space

Ward 4 has only 0.51 m² of green space per person, and 53.33% of residents live more than 600 meters from PUGS. The respondents identified:

- **Desired Features**: Seating and shade (e.g., R50, R71), play areas (e.g., R61, R95), restrooms (e.g., R79, R90), open gyms (e.g., R53, R60), and water fountains (e.g., R51, R73).
- **Accessibility Ideas**: Smoother paths (e.g., R54, R67), improved lighting (e.g., R64, R80), reduced traffic noise (e.g., R50, R74), and ramps (e.g., R51, R72).
- **Challenges**: Poor maintenance (e.g., R54, R58), road noise and dust (e.g., R57, R69), limited funding (e.g., R60, R78), and scarce land (e.g., R72, R88).

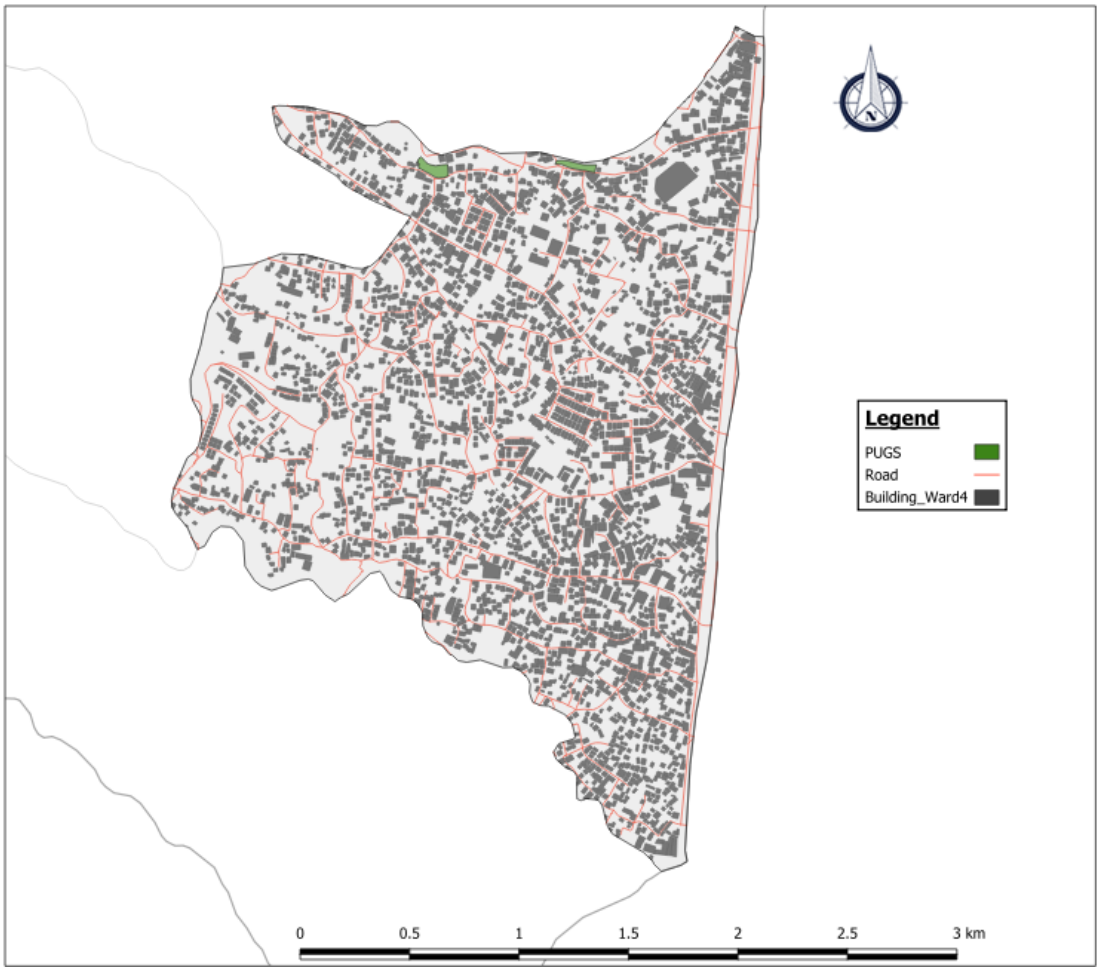


Figure 5.18: Ward 4: Showing the Saturated spaces with Buildings and less PUGS

Urban Planning Implications: Planners should create micro-parks on vacant lots or public spaces to increase green space coverage. These areas could integrate seating, play zones, and compact toilets to support various users, particularly the 53.33% far from PUGS. Green walls or tree lines along roads could mitigate noise and dust, aligning with the 92.63% who value environmental benefits. Pathways should utilize permeable paving for drainage, with solar lighting and ramps to enhance accessibility for elderly and disabled residents. Zoning regulations should prioritize small plots for PUGS to address land shortages.

b. Ward 6: Medium Population Density, Moderate Green Space, Mixed Setting

Ward 6 has 26.3 m^2 of green space per person, with 37.5% of residents within 300 meters of PUGS. The 39 respondents noted:

- **Desired Features**: Seating and shade (e.g., R13, R29), play areas (e.g., R15, R47), jogging tracks or gyms (e.g., R14, R17), toilets (e.g., R24, R44), and water facilities (e.g., R16, R19).

- **Accessibility Ideas**: Smoother paths (e.g., R13, R26), improved lighting (e.g., R12, R25), closer PUGS (e.g., R18, R28), public transport options (e.g., R35), and awareness programs (e.g., R19, R33).

- **Challenges**: Limited funding (e.g., R13, R26), poor maintenance (e.g., R30, R41), low awareness (e.g., R15, R38), dust (e.g., R35), and uneven terrain (e.g., R12).

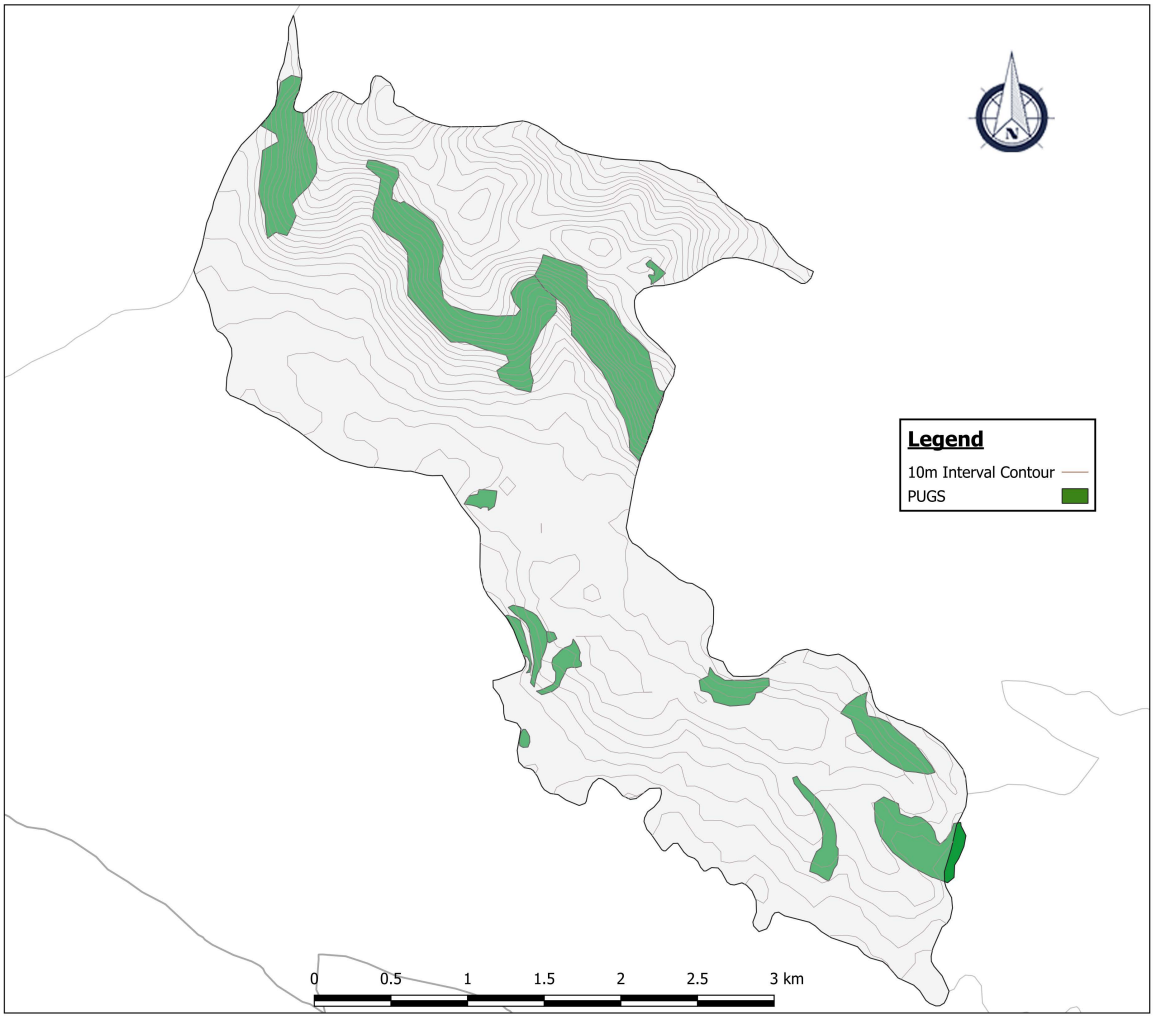


Figure 5.19: Ward 6: Showing Large PUGS area located on High terrain area

Urban Planning Implications: Given adequate green space, planners should focus on enhancing existing PUGS rather than creating new ones. Linear features such as jogging tracks and bike lanes can extend through parks, supporting the 57.89% who engage in social activities. Retrofitting paths with lighting and leveling rough terrain will improve access for the 37.5% nearby. PUGS should be integrated into public transport routes or pedestrian grids to minimize travel times. Temporary events, such as fitness days in green spaces, can gauge demand and boost awareness, while native plant buffers can mitigate d ust. Land-use policies should protect current green areas from redevelopment.

c. Ward 8: Low Population Density, High Green Space, Hilly Area

Ward 8 has 213 m^2 of green space per person, yet 41.18% of residents require over 20 minutes to reach PUGS due to hilly terrain (Section 5.3.1).

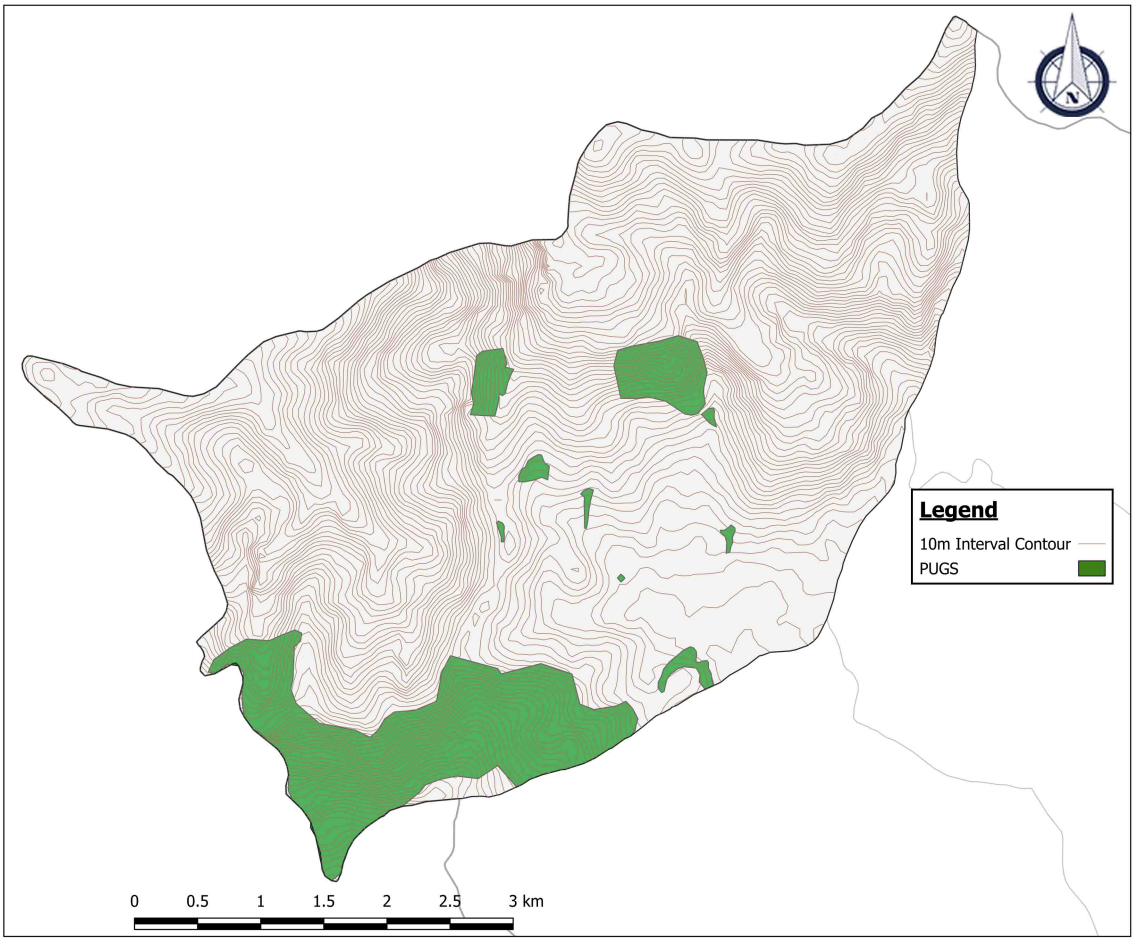


Figure 5.20: Ward 8: Showing Contour Interval of 10m and Existing PUGS

Responses noted:

- **Desired Features**: Seating and shade (e.g., R1, R4), play equipment (e.g., R1, R7), toilets (e.g., R2, R3), lighting (e.g., R5, R9), and open gyms (e.g., R8).

- **Accessibility Ideas**: Smoother, flatter paths (e.g., R5, R8), handrails (e.g., R4), rickshaw services (e.g., R6), improved lighting (e.g., R5, R8), and signage (e.g., R1, R9).

- **Challenges**: Funding shortages (e.g., R1, R9), steep terrain (e.g., R4, R7), poor maintenance (e.g., R5, R7), and low community engagement (e.g., R6).

Urban Planning Implications: In this green yet hilly ward, planners should prioritize accessibility improvements over additional expansion. Terracing slopes with steps, ramps, and handrails can help connect remote PUGS, aiding the 41.18% with long travel times. Simple features such as benches and shade trees should line pathways, accompanied by clear signage for route mapping. A low-cost rickshaw service, integrated into municipal transport systems, can provide mobility solutions for elderly and distant residents. Green spaces should be formally zoned as protected areas, with upkeep financed through local fees or partnerships to address funding constraints. Community workdays could enhance maintenance efforts and raise engagement, leveraging the extensive green coverage for long-term resilience.

Comparison Across Wards

A comparative analysis reveals distinct priorities:

- **Ward 4**: Requires new PUGS and noise reduction solutions due to high urban density.
- **Ward 6**: Needs upgrades and better connectivity given its mixed residential and green space distribution.
- **Ward 8**: Focuses on terrain-adaptive accessibility despite.

All wards face challenges related to funding, maintenance, and path accessibility. Additionally, lower-income residents express concerns about proximity and affordability, aligning with the 82.11% who cite dissatisfaction with poor amenities.

5.6 Summary of Data Analysis Findings

This study combined numbers and resident feedback to uncover key patterns about public urban green spaces (PUGS) in Wards 4, 6, and 8 of Nagarjun Municipality. The analysis shows uneven distribution, usage challenges, and ward-specific needs, offering insights for better planning before deeper discussion in Chapter 6.

Spatial analysis revealed stark differences in green space access. Ward 4 has just 0.51 m^2 per person, far below the WHO's 9 m^2 recommendation, while Ward 6 offers 26.3 m^2 and Ward 8 provides 213 m^2 (Table 5.1). This gap is clearest in Ward 4, where 53.33% live over 600 meters from PUGS, compared to 37.5% within 300 meters in Ward 6 and 41.18% taking over 20 minutes in Ward 8 due to hilly terrain (Section

Table 5.18: Comparative Table for Three PUGS in Wards 4, 6, and 8

Metric	**PUGS in Ward 4**	**PUGS in Ward 6**	**PUGS in Ward 8**
Green Space per Capita	0.51 m^2/person	26.3 m^2/person	213 m^2/person
Accessibility (Distance)	53.33% live >600 m from PUGS	37.5% live within 300 m of PUGS	Terrain affects access; no specific distance data
Usage Patterns	42.11% rarely/never visit; socializing (57.89%), kids' play (44.21%)	Socializing (57.89%), kids' play (44.21%); 38.95% stay <30 min	Socializing (57.89%), kids' play (44.21%); limited by terrain
Desired Features	Seating, shade, play areas, restrooms, open gyms, water fountains	Seating, shade, play areas, jogging tracks, toilets, water facilities	Seating, shade, play equipment, toilets, lighting, open gyms
Accessibility Challenges	Noise, dust, poor maintenance, limited land, uneven paths	Uneven terrain, dust, poor maintenance, lack of transport	Steep terrain, lack of handrails, long travel time, poor signage
Maintenance Challenges	Poor maintenance, limited funding, land scarcity	Limited funding, low awareness, poor maintenance	Funding shortages, poor maintenance, low community engagement
Resident Suggestions	Smoother paths, better lighting, ramps, noise reduction	Smoother paths, public transport, lighting, awareness programs	Smoother paths, handrails, rickshaw services, signage, lighting

Table 5.19: Ward-Wise Planning Needs

Ward	Top Desired Features	Key Accessibility Ideas	Main Challenges	Planning Focus
Ward 4	Seating, play areas, restrooms	Smoother paths, lighting, ramps	Noise, dust, funding, land	Micro-parks, green buffers, zoning
Ward 6	Seating, jogging tracks, toilets	Smoother paths, transport, lighting	Funding, upkeep, awareness	Upgrades, transport links, events
Ward 8	Seating, play equipment, lighting	Ramps, handrails, rickshaws	Terrain, funding, engagement	Terracing, transport, conservation

5.3.1). The urban density of ward 4 and the topography of ward 8 highlight the need for targeted solutions to make green spaces equitable and closer to all.

Survey data showed how residents use PUGS and what stops them. About 40% live more than 600 meters away, and 29.47% take over 20 minutes to reach a park (Section 5.3.2). This distance, plus limited recreational land (Table 1.1), means 42.11% rarely or never visit. Buffers of 300m and 600m measure how close residents are to PUGS, a standard GIS approach. This method helps identify areas where green spaces are too far, such as Ward 4, where 53.33% live beyond 600m, and Ward 8, where hilly terrain increases travel time despite high green space per capita. Socializing (57.89%) and kids' play (44.21%) are top activities, but visits are short—38.95% stay under 30 minutes—due to poor facilities, with 82.11% noting a lack of benches, restrooms, or play areas (Section 5.5). Ward-wise, Ward 4 wants seating and noise fixes, Ward 6 seeks jogging tracks and transport, and Ward 8 needs flatter paths and handrails (Section 5.5). Residents gave low ratings—2.01/5 for cleanliness and 1.39/5 for amenities—yet 92.63% value PUGS for cleaner air and shade, showing their potential if improved.

Statistical tests confirmed barriers to use. These findings support SDG 11.7's goal of universal green space access by showing how distance and poor facilities limit use, especially for lower-income and remote residents. A chi-square test linked distance to fewer visits ($p=0.001267$, Section 5.3.3), with Ward 4's 53.33% far from parks most affected. Income also matters—higher earners visit more (coefficient 0.414, $p=0.002$)—while distance slightly reduces visits across wards. This hits lower-income families and remote residents hardest, especially in Ward 4's crowded areas

and Ward 8's hills, where travel time is long despite much of green space (Section 5.5).

Qualitative data from ATLAS.ti deepened these findings. S eating (64 mentions) and maintenance (49 mentions) topped concerns, matching survey ratings (Section 5.4.1). Accessibility issues—distance, steep paths, poor walkways (156 mentions)—varied by ward: Ward 4 battles noise and land scarcity, Ward 6 lacks awareness and upkeep, and Ward 8 struggles with terrain and engagement (Section 5.5). Families want play areas, and the elderly need better paths, with a word cloud showing "spaces," "seating," and "maintenance" as key terms (Section 5.4.6). Funding and low awareness were common hurdles, slowing improvements across all wards.

Residents' ideas for better PUGS were clear and ward-specific. O verall, 94.74% want more amenities like seating and play zones, and 45.26% stress maintenance (Section 5.5.2). Ward 4 suggests micro-parks and green buffers, W ard 6 c alls for upgrades and bus links, and Ward 8 seeks ramps and rickshaws (Section 5.5). All wards agree on smoother paths and lighting, but challenges like limited budgets, tough terrain, and weak community involvement hold back progress. These ideas point to practical fixes: small parks in Ward 4's tight spaces, jogging tracks in Ward 6's mixed zones, and terraced paths in Ward 8's hills, tailored to each area's needs.

In short, PUGS in Nagarjun face uneven spread and access issues, worsened by distance, poor upkeep, and income gaps. Ward 4's scarcity, Ward 6's moderate access, and Ward 8's topographic barriers show different struggles, yet all value green spaces for social and environmental gains. Planners can use these findings—micro-parks for density, upgrades for mixed areas, and access fixes for hills—to make PUGS work better for everyone, especially underserved groups like the poor and elderly.

CHAPTER SIX: RESULTS AND DISCUSSION

6.1 Results and Discussion

Public Urban Green Spaces (PUGS) contribute significantly to the quality of life in cities by offering recreational, social, and environmental benefits. However, their accessibility, distribution, and use are often affected by socio-economic conditions, spatial factors, and policy decisions. This study explores the distribution and accessibility of PUGS in Nagarjun Municipality, Kathmandu, using both quantitative and qualitative research methods.

The findings indicate major challenges related to fair distribution, access barriers, economic differences, and maintenance issues. The following discussion examines these challenges in detail, drawing on resilience frameworks and urban planning strategies to provide further insights.

6.2 Social Capital and Community Participation in Green Space Usage

Social capital resilience refers to the ability of communities to maintain strong social connections, foster cohesion, and engage in collective participation in urban planning. The study highlights that community participation in PUGS usage remains low, despite their potential for fostering social interactions and cohesion.

A key finding from the survey indicates that social interaction (57.89%) is the most common activity in PUGS, followed by children's recreation (44.21%), relaxation (32.63%), and physical exercise (23.16%). These findings align with broader research on urban resilience, which suggests that well-maintained and accessible green spaces enhance social ties, mental well-being, and physical activity.

However, 42.11% of respondents rarely or never visit PUGS, indicating significant barriers to participation. A lack of awareness (6.32%) about the benefits of PUGS further discourages active engagement, while accessibility constraints and inadequate amenities also play a role.

Residents' frequent calls for better seating (64 mentions) and maintenance (49 mentions) in ATLAS.ti analysis (Section 5.4) suggest that poor infrastructure further discourages community engagement, supporting the need for community-driven models.

The following table summarizes the relationship between community participation and PUGS usability:

Table 6.1: Community Participation and PUGS Usability

Community Participation Factor	**Observed Trends in Nagarjun Municipality**	**Resilience Implications**
Awareness of PUGS Benefits	6.32% report low awareness	Low awareness limits engagement, leading to underutilization.
Social Interaction as Primary Use	57.89% use PUGS for meeting friends & community events	High potential for strengthening social capital.
Child-Friendly Spaces	44.21% of users bring children for recreation	Need for improved child-friendly infrastructure.
Low Engagement Levels	42.11% rarely or never visit PUGS	Indicates barriers in accessibility and inclusivity.

These findings suggest that urban planning interventions should focus on community-driven green space development models, where local residents actively participate in PUGS management, similar to post-disaster resettlement initiatives that require community labor participation.

6.3 Accessibility and Spatial Distribution of PUGS

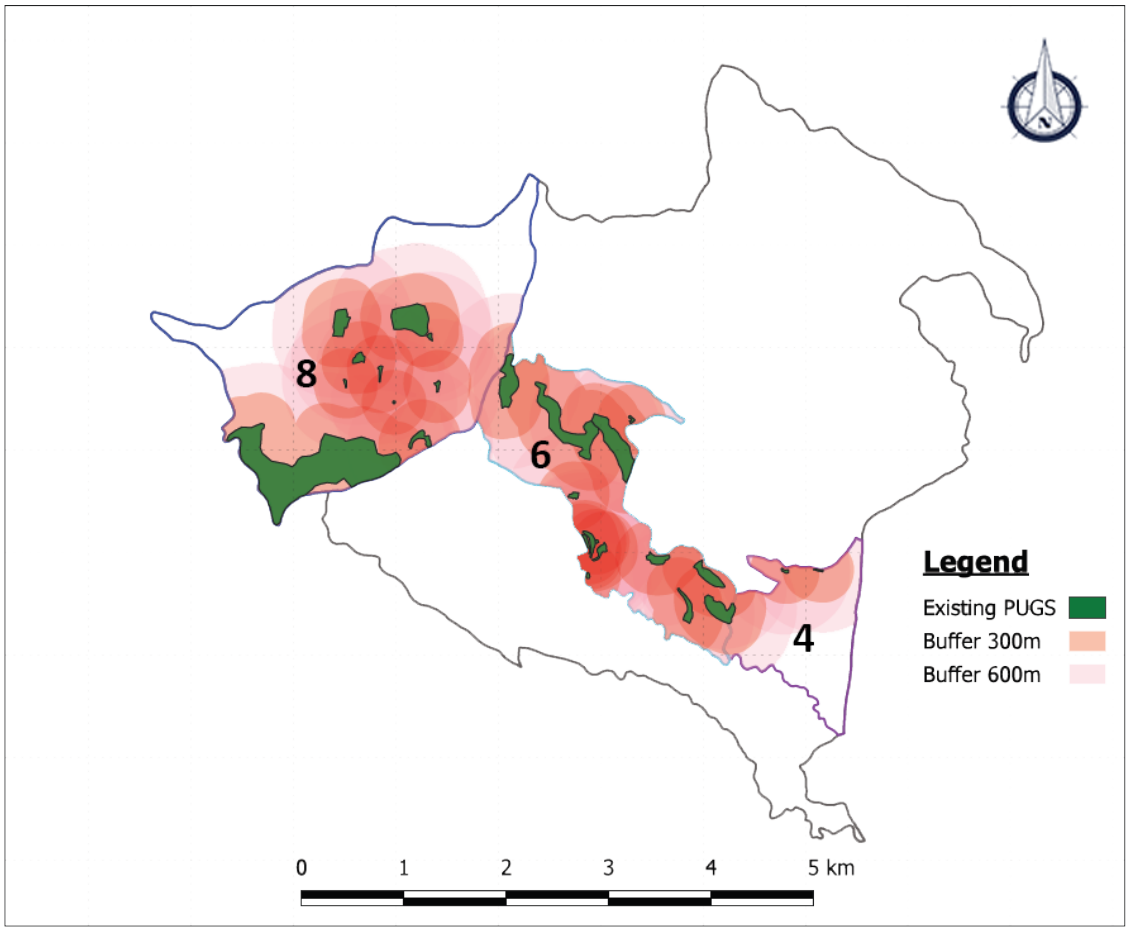


Figure 6.1: Coverage of 300m/600m buffer from PUGS

Spatial accessibility is a critical determinant of PUGS usage. The survey findings reveal that a significant proportion (40%) of respondents live beyond 600 meters from the nearest PUGS, making accessibility a major barrier. Further analysis using chi-square tests confirms a statistically significant relationship between distance and PUGS visit frequency ($\chi^2 = 21.89$, $p = 0.001267$ (Table 5.4)), reinforcing the argument that proximity is a key determinant of park utilization. Figure 6.1 illustrates that on average only 9.7% of residents fall within a 300 m buffer of PUGS, highlighting significant gaps in proximity-based access. The stark contrast in PUGS per capita—0.51 m^2/person in Ward 4 versus 213 m^2/person in Ward 8 (Section 5.6)—underscores spatial inequities that exacerbate accessibility barriers, particularly in densely populated areas.

6.3.1 Correlation Between Distance and PUGS Satisfaction

The correlation analysis further explores how distance impacts satisfaction with PUGS amenities:

The weak negative correlation between distance and amenities (r = -0.1151) aligns with 74.74% of residents perceiving unequal distribution (Section 5.5), suggesting that distant PUGS lack sufficient facilities to attract users.

Table 6.2: Correlation Between Distance and PUGS Satisfaction

Aspect of PUGS Satisfaction	**Correlation with Distance (r-value)**	**Interpretation**
Travel Time	0.8209	Strong positive correlation: Distance significantly increases travel time.
Cleanliness	0.3424	Moderate positive correlation: Residents farther away perceive better cleanliness.
Amenities	-0.1151	Weak negative correlation: Amenities slightly decrease as distance increases.
Safety	-0.2314	Weak negative correlation: Distant users feel less safe in PUGS.
Accessibility for All Ages	-0.1750	Weak negative correlation: Accessibility reduces with distance.
Overall Quality	-0.0142	Weak negative correlation relationship between distance and overall satisfaction.

These findings indicate that while proximity is the most significant factor affecting PUGS usage, satisfaction with amenities, safety, and accessibility also play important roles.

The moderate positive correlation for cleanliness (r = 0.3424, Table 6.2) suggests that distant PUGS may be cleaner due to lower usage, as fewer visitors reduce litter and wear. This contrasts with the weak negative correlation for amenities (r = -0.1151), showing that far-off green spaces often lack facilities, reducing their appeal.

6.3.2 Policy Recommendations for Equitable Green Space Distribution

- **Strategic urban greening:** Small-scale green spaces should be integrated within high-density residential areas to reduce travel distances.
- **PUGS accessibility mapping:** Municipal planners should adopt GIS-based analysis to identify accessibility gaps and plan new green spaces accordingly.
- **Pedestrian and cycling infrastructure improvements:** Dedicated pathways and better lighting can enhance connectivity to existing PUGS.

6.4 Economic Barriers and Inequality in PUGS Utilization

Household income is the strongest predictor of PUGS visit frequency (= 0.414, p = 0.002, Section 5.5.3), with higher-income households visiting more often, possibly due to greater resources and awareness, though further research is needed to confirm these mechanisms. Additionally, 82.11% cite poor amenities as a barrier (Section 5.6), disproportionately affecting lower-income groups who rely on local facilities.

The table below highlights how economic disparities affect PUGS accessibility:

Table 6.3: Economic Disparities and PUGS Accessibility

Economic Factor	**Effect on PUGS Usage**	**Urban Planning Implications**
Household Income	Higher income correlates with higher PUGS visitation.	Need for equitable green space development in low-income neighborhoods.
Accessibility Constraints	Lower-income groups may face barriers in reaching distant PUGS, as suggested by calls for better transport options.	Improve local accessibility to reduce transportation costs.
Lack of Amenities	82.11% cite poor amenities as a barrier.	Allocate funds to improve seating, restrooms, and play areas.

6.4.1 Policy Solutions

- Incentivize PUGS development in low-income areas through government grants and public-private partnerships.

- Enhance affordability of recreational programs by subsidizing entrance fees for low-income groups.

- Introduce community-managed maintenance programs to improve facilities without financial burden on local governments.

- Residents' suggestions for subsidized transport and local PUGS development (Section 5.5.3) highlight practical ways to reduce economic barriers for lower-income groups.

6.5 Institutional and Policy Gaps in Green Space Management

Despite growing recognition of PUGS as essential urban infrastructure, institutional frameworks for their planning, maintenance, and monitoring remain weak. Funding constraints and lack of community participation are key challenges (Section 5.5.4). Weak policy enforcement, such as inconsistent application of NUDS 2017's 2.5% green space mandate (Section 2.6.1), contributes to uneven PUGS distribution and maintenance issues. For example, Ward 4's 0.51 m^2 per person falls far below the 2.5% land allocation target set by NUDS 2017, showing how weak enforcement leads to green space shortages in dense urban areas. The study highlights that funding constraints, lack of community participation, and weak policy enforcement contribute to the underutilization of PUGS.

Table 6.4: Policy Gaps and Recommendations

Policy Gap	**Impact on PUGS Management**	**Recommended Interventions**
Lack of Green Space Regulations	Uneven distribution of PUGS.	Mandate minimum green space per residential area.
Funding Shortages	Inadequate maintenance and facilities.	Introduce public-private partnerships, but further study is needed to determine if this approach is practical in Nagarjun due to limited local examples.
Weak Community Engagement	Residents do not participate in park upkeep.	Establish user committees for PUGS management.

To bridge these gaps, municipal authorities should develop urban greening policies that integrate community participation, resilience-based planning, and long-term sustainability frameworks. Public-private partnerships could address funding shortages (Section 5.5.4), though their feasibility in Nagarjun requires further exploration given limited local precedent.

The study highlights critical spatial, economic, and institutional barriers to PUGS utilization in Nagarjun Municipality. Findings suggest that proximity, economic status, and infrastructure quality significantly influence how often residents use green spaces. Notably, the severe PUGS deficit in Ward 4 (0.51 m^2/person) compared to Ward 8 (213 m^2/person) highlights the urgency of addressing spatial inequities alongside economic and infrastructural barriers. Addressing these challenges requires a combination of strategic urban planning, financial investment, and policy reforms to ensure equitable access and sustainable management of urban green spaces.

By incorporating community-led maintenance initiatives, improved accessibility frameworks, and financial inclusion measures, Nagarjun Municipality can develop resilient and inclusive PUGS that serve as essential public resources for all residents.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Public urban green spaces (PUGS) are vital for making cities better places to live by providing benefits for nature, social life, and recreation. This study looked at how these spaces are spread out and reached in Nagarjun Municipality, to find differences among people with varying incomes and suggest useful ideas for planners. By using maps, surveys, and comments from residents, the research found important problems and chances to do better.

The findings show that green spaces are not the same everywhere in the municipality. Ward 4, a high population density area, has just 0.51 square meters of green space per person, much less than the World Health Organization's recommendation of 9 square meters. Ward 6 has 26.3 square meters per person, and Ward 8, with more natural land, has 213 square meters (Section 5.6). Getting to these spaces is hard too, with 40% of people living more than 600 meters away, which means 42.11% rarely or never go (Section 6.2). Tests proved that being far away lowers how often people visit (chi-square = 21.89, p = 0.001267, Section 5.3.1). This hits Ward 4 hard, where 53.33% are far from parks, and Ward 8, where 41.18% take over 20 minutes because of hills.

Income also changes who uses green spaces. The study found that richer families visit more often (coefficient = 0.414, p = 0.002, Section 5.3.1), while those with less money stay away because of bad conditions—82.11% did not like the lack of seats or care (Section 5.6). People's comments showed they want more seating and better upkeep (Section 5.4). Each ward has its own wishes: Ward 4 needs less noise, Ward 6 wants paths to walk on, and Ward 8 needs ways to cross rough land easier (Section 5.5).

Even with these troubles, residents think green spaces matter. Most, 92.63%, said they help with clean air and shade, and 57.89% use them to meet others (Section 6.2). But not many know their full value (6.32%, Section 5.5.4), and weak rules, like the spotty use of the National Urban Development Strategy's 2.5% green space target (Section 6.5), make it tough to manage them. This work shows that green spaces in Nagarjun are not even or simple to use, especially for poorer people or

those far off. Fixing this takes good planning, nicer parks, and more help from locals, as explained next.

Overall, this research highlights the uneven spread and access issues with PUGS in Nagarjun Municipality. It offers ways to make them fairer and more helpful, supporting balanced growth that meets people's needs.

7.2 Recommendations

This part gives ideas to improve public urban green spaces in Nagarjun Municipality, based on what the study learned. The suggestions cover making spaces easier to get to, fixing them up, involving residents, helping those with less money, and making rules stronger. Each idea fits the needs of Wards 4, 6, and 8, using details from earlier parts.

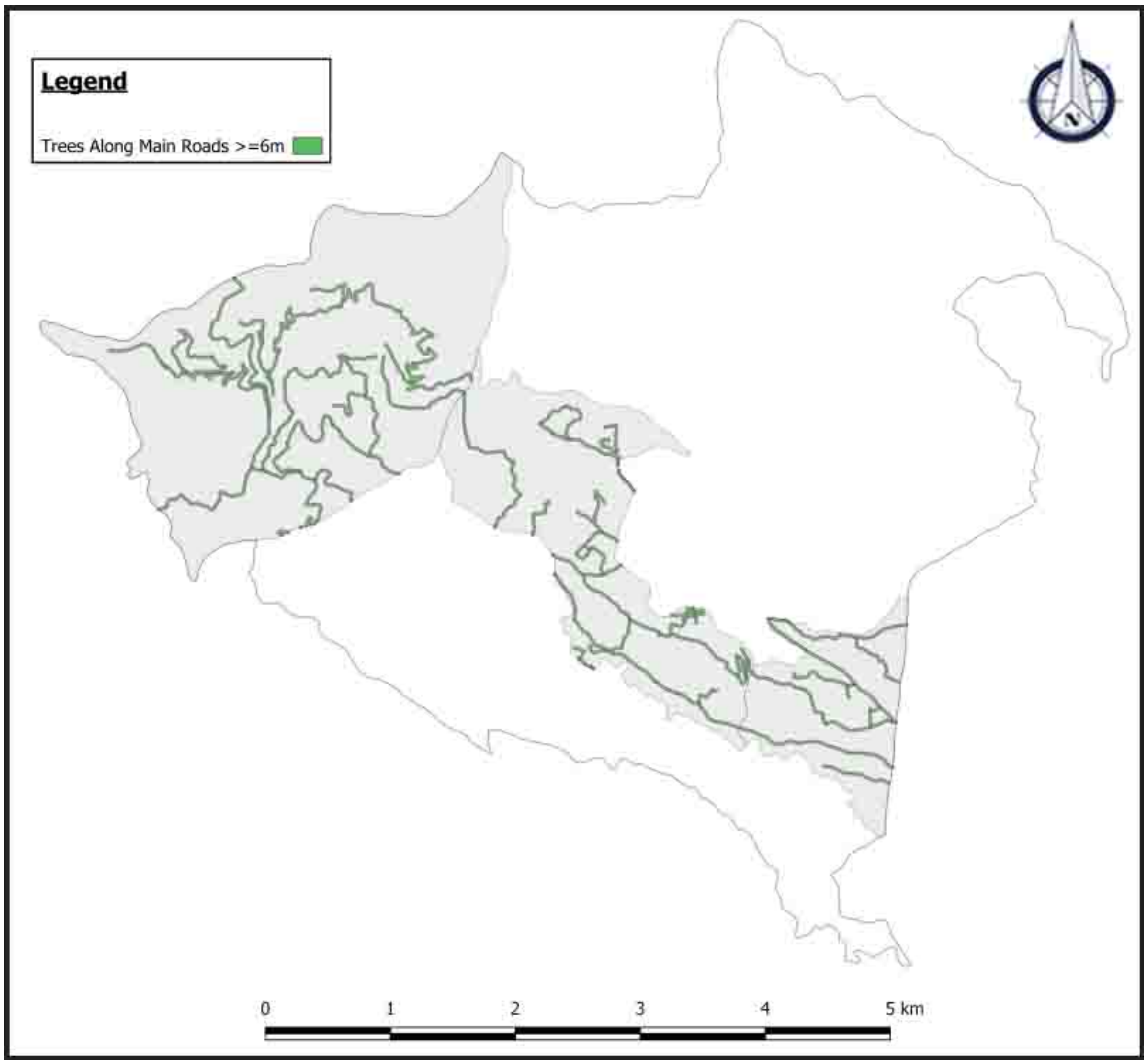


Figure 7.1: Recommendation: Plantation of Trees along Main Roads >=6m (Prioritizing high population density areas)

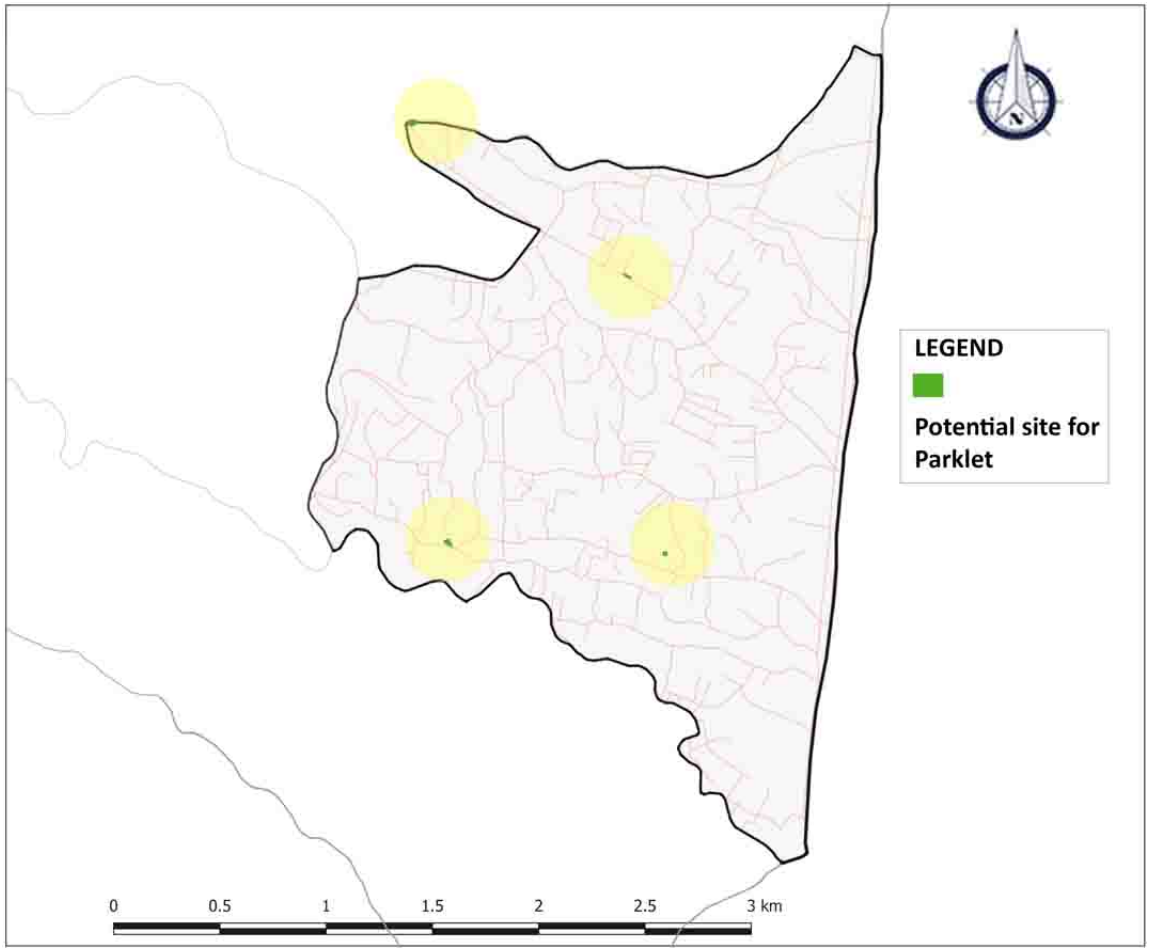


Figure 7.2: Recommendation: Potential Sites to be developed for Small Parks to Enhance PUGS Equity (Ward 4)

Getting green spaces closer and fairer is a big need, since they differ so much between wards. In Ward 4, full of buildings and with only 0.51 square meters per person, small parks could be put on empty public land. New stores or offices could add green edges or rooftop gardens to help with the shortage. Trees along loud roads could connect people to parks and quiet things down, matching the 92.63% who see green spaces as good for nature (Section 5.5). In Ward 6, with 26.3 square meters per person and growth happening (Section 1.2.3), keeping parks safe from being built on is key. Walking paths with trees could link homes to these spaces, aiding the 37.5% who live close by (Section 5.6). Small parks in new areas could also help as more people move in. In Ward 8, with 213 square meters per person near a national park, nature parks could keep the land healthy while giving people a spot to rest. Trails could join far-apart green areas, shortening the 20-minute trips for 41.18% (Section 5.6), and fixing r iverbanks c ould a dd u seful g reen s pots t hat h andle rain too (Section 1.1).

Improving green spaces with better things like seats and clean areas is another step, since people gave low marks—1.39 out of 5 for facilities and 2.01 out of 5 for upkeep

(Section 5.5). In Wards where residential and commercial buildings fill the space, parks could get more benches, lights, and play areas for kids. They could also be made to work as safe spots during earthquakes, common in Kathmandu Valley (Section 1.1). A changing area, adding paths for walking or biking and gardens for food could give people more to do. Wards with natural look, trails and trash bins could keep it nice, while plant gardens could help animals and make parks better to visit (Section 5.5.2).

Having residents help care for green spaces could fix some issues, since only 6.32% said they don't know the benefits, yet 57.89% use them to meet friends (Section 6.2). In all wards, groups of locals, ward leaders, and officials could team up to look after parks. Telling people—through talks or signs—how green spaces clean the air (Section 5.5) could get more to join in and visit.

Helping poorer families use green spaces matters, as income affects visits a lot (Section 5.3.1). In high population density areas more built-up, free things like exercise classes could bring in those with less money. Cheap transport, like low-cost rickshaws, could make getting there easier (Section 5.5.3).

Strengthening rules is needed to fix money troubles and weak planning, like the uneven use of the 2.5% green space rule (Section 6.5). For all wards, a town policy could demand green spaces in new building projects. Setting aside cash each year could pay for making and keeping parks. Using maps to check spaces often could catch problems early (Section 5.3.1). Planning parks to help in emergencies, like floods or earthquakes, could make them more useful (Section 1.1).

7.3 Future Research Directions

This study checked how green spaces are spread and used in Nagarjun, but more can be explored. Future work could watch changes over time to see if new parks or fixes raise visits, based on the population who live far off. Looking at other Nepal towns could show what works, like adding small parks or handling funds better (Section 1.4). Seeing if parks near homes improve health or nature, as 74.74% noted cleaner air (Section 5.5), could prove their worth. Using new tools like phone maps could make planning quicker.

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APPENDIX A: LIST OF KEY INFORMANTS

1. Er. Kanchan Khanal,
2. Suraj Kumar Pokhrel, Chairman (Ward 8)
3. Er. Anuj Shrestha (Ward 4)
4. Er. Narendra Shrestha (Ward 6)
5. Er. Devendra Raj Giri (Ward 8)
6. Er. Bimochan Bhandari

APPENDIX B: QUESTIONNAIRE SURVEY

Figure A.3: Conducting survey with Senior citizen

Figure A.4: Conducting survey at ward 8

Figure A.5: Conducting Questionnaire

Figure A.6: With KII (Suraj Kumar Pokhrel,Chairman, Ward 8)

APPENDIX C: QUESTIONNAIRE SURVEY FOR RESPONDENTS

Questionnaires were conducted in-person across wards.

Section 1: Demographics

1. Buffer Zone

- 0 - 300m
- 301 – 600m
- Greater than 600m

2. What is your gender?

- Male
- Female
- Other

3. What is your age group?

- 18 – 30 years
- 31–40 years
- 41–60 years
- Above 60 years

4. What is your highest level of education?

- No formal education
- Primary school
- Secondary school
- Bachelor's degree

- Master's degree or higher

5. What is your monthly household income range?

- Less than NPR 15,000
- NPR 15,001–30,000
- NPR 30,001–50,000
- More than NPR 50,000

6. How long have you lived in Nagarjun Municipality?

- Less than 1 year
- 1-5 years
- 6-10 years
- More than 10 years

7. How many people live in your household?

- 1 - 3
- 4 - 6
- 7 - 9
- More than 9 (Please specify _____)

8. Do any members of your household have mobility issues or disabilities that affect their ability to access public spaces?

- Yes
- No
- If yes, please specify: _____ (e.g., elderly, wheelchair user, other mobility issues)

Section 2: Accessibility to PUGS

1. How often do you visit the nearest PUGS?

- Daily
- A few times a week
- Monthly
- Rarely or never

2. How long does it take you to reach the nearest PUGS?

- Less than 5 minutes
- 5–10 minutes
- 11–20 minutes
- More than 20 minutes

3. Do you feel the path to the PUGS is safe and accessible?

- Yes
- No
- If no, what are the challenges?
  - Traffic
  - Poor lighting
  - Uneven paths
  - Other (Please specify _____)

Section 3: Usage Patterns of PUGS

1. What activities do you usually engage in at the PUGS? (Check all that apply)

- Exercise (e.g., walking, jogging)
- Relaxation (e.g., sitting, meditating)
- Social interaction (e.g., meeting friends, community events)
- Children's play/recreation
- Other (Please specify _____)

2. What time of day do you prefer to visit PUGS?

- Morning
- Afternoon
- Evening
- Night

3. On average, how much time do you spend at the PUGS per visit?

- Less than 30 minutes
- 30 minutes to 1 hour
- 1–2 hours
- More than 2 hours

4. What factors prevent you from visiting PUGS more frequently? (Check all that apply)

- Lack of time
- Safety concerns (e.g., crime, stray animals)
- Poor maintenance (e.g., unclean areas, broken amenities)

- Lack of amenities (e.g., seating, restrooms, play areas)
- Distance from home
- Other (Please specify _____)

5. Do you prefer visiting PUGS alone or with others?

- Alone
- With family
- With friends

Section 4: Perceptions of PUGS

1. Do you feel the PUGS are equitably distributed in your municipality?

- Yes
- No
- Unsure

2. Do you feel the PUGS meet the needs of your household?

- Yes
- No
- If no, what improvements would you suggest?
  - More amenities (e.g., seating, play areas)
  - Better maintenance
  - Improved accessibility
  - Other (Please specify _____)

3. Do you feel that the PUGS in your area contribute to environmental quality?

- Yes
- No
- If yes, in what ways? (Check all that apply)
  - Reducing air pollution
  - Providing shade
  - Cooling effect
  - Enhancing biodiversity
  - Other (Please specify _____)

4. How satisfied are you with the following aspects of PUGS? (Rate on a scale of 1–5, where 1 = Very Unsatisfied and 5 = Very Satisfied)

- Cleanliness and maintenance
- Availability of amenities
- Safety and security
- Accessibility for all age groups
- Overall quality of the green space

Section 5: Open-Ended Questions

1. What additional features or facilities would you like to see in the PUGS near your home?

2. Do you have any suggestions to improve accessibility and utilization of PUGS for residents in your buffer zone?

3. What do you think are the key challenges in maintaining and improving PUGS in your municipality?

APPENDIX D: SAMPLE SIZE CALCULATION

Sample Size Calculation

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{E^2}$$

Parameters

- **Z:** Z-score corresponding to the confidence level (e.g., 1.96 for 95% confidence level).
- **p:** Assumed proportion of the population (if unknown, use 0.5 for maximum variability).
- **E:** Margin of error (e.g., 5% or 0.05).

Adjusted Formula for Finite Population

$$n_{\text{adj}} = \frac{n}{1 + \frac{n-1}{N}}$$

- **N:** Total population size.
- **n:** Initial sample size from the first formula.

Given Values

- Confidence Level: 95% $\Rightarrow$ Z = 1.96
- Margin of Error: 10% $\Rightarrow$ E = 0.1
- Population Proportions: p = 0.5
- Population Size (N):
  - Ward 4: 17619
  - Ward 6: 15115

  - Ward 8: 3548

Initial Sample Size Calculation

- Initial Sample Size $(n) = 96.04$
- Rounded Initial Sample Size $(n) = 96$

Adjusted Sample Size for Each Ward

- For Ward 4: $n_{adj} = 95$
- For Ward 6: $n_{adj} = 95$
- For Ward 8: $n_{adj} = 93$

Proportional Sampling

- Proportional Sample for each ward $= \frac{\text{Ward Population}}{\text{Total Population}} \times \text{Total Sample Size}$
- Total Population $(N) = 36282$
- Assumed Total Adjusted Sample Size = 95

Sample Distribution Across Wards

- Ward 4: 46
- Ward 6: 40
- Ward 8: 9

APPENDIX E: JURY COMMENTS AND RESOLUTION

Table A.1: Jury Comments and Resolutions

N.	**Jury**	**Comment**	**Resolution**
1	Chakravarti Kanth	Literature on Spatial Distribution and Accessibility	Addressed in 2.2 (Page No. 32) and 2.3 (Page No. 36)
3		No need of Final Remark	Addressed
3		Limitations too long	Addressed
3		Ensure that recommendations are included alongside the conclusion	Included in the conclusion and recommendations chapter
4		Recommendation is too long	Addressed
5	Saroj Basnet	Comparative Chart of PUGS of Wards	Reflected in Table 5.1.8 (Page No. 111)
6		Write a note on Groundedness (Terminology for Qualitative Analysis using Atlas.Ti)	Addressed on 5.4.1 (Page No. 85)

APPENDIX F: IOEGC16 ACCEPTANCE LETTER AND PAPER

त्रिभुवन विश्वविद्यालय
Tribhuvan University
इन्जिनियरिङ्ग अध्ययन संस्थान
Institute of Engineering
थापाथली क्याम्पस
THAPATHALI CAMPUS
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GPO Box- 280, Thapathali, Kathmandu
Tel: 01-5339766
E-mail: info@tcioe.edu.np
Website: www.tcioe.edu.np
गोश्वारा पो. नं. २८०, थापाथली, काठमाडौं
फोन: ०१-५३३५७६६

Date: April 21, 2025

To Whom It May Concern:

This is to certify that the paper titled **"Spatial Distribution and Accessibility of Public Urban Green Spaces in Nagarjun Municipality, Kathmandu"** (Submission# **463**) submitted by **Sanjay Kumar Rokka** as the first author, which had been accepted for presentation after the peer-review process, has successfully been presented at the 16th IOE Graduate Conference held during April 18 - 20, 2025. Kindly note that the final revision of the papers and publication process of the conference proceedings is still underway and hence inclusion of the accepted manuscript in the conference proceedings is contingent upon timely response to further edits during the publication process.

INSTITUTE OF ENGINEERING 16th IOE Graduate Conference, 2025 THAPATHALI CAMPUS

Dr. Raj Kumar Chaulagain,
Convener,
16th IOE Graduate Conference

IOE Graduate Conference
[Placeholder for Publication Information]

Spatial Distribution and Accessibility of Public Urban Green Spaces in Nagarjun Municipality, Kathmandu

Sanjay Kumar Rokka [a], Dr. Ashim Bajracharya [b],

[a] *Department of Architecture, Institute of Engineering, Pulchowk Campus, Kathmandu, Nepal*
[b] *Associate Professor, Department of Architecture, Institute of Engineering, Pulchowk Campus*
[a] 079msurp017.sanjay@pcampus.edu.np, [b] ashim.bajracharya@pcampus.edu.np,

Abstract

The Kathmandu Valley is undergoing rapid urbanization, creating more pressure on its urban green spaces (UGS). This study examines the distribution and accessibility of public urban green spaces (PUGS) in Nagarjun Municipality, Kathmandu, with a focus on equity across different socio-economic groups. Using GIS (Geographic Information System)-based spatial analysis, household surveys, and key informant interviews, the research assesses the availability of PUGS, identifies accessibility gaps, and explores factors influencing their use. Findings show an uneven distribution of PUGS, with significant differences in accessibility based on residential location and income. The study highlights the need for strategic urban planning to ensure fair access, supporting both social well-being and environmental sustainability in the face of rapid urban growth.

Keywords
Public Urban Green Space, Spatial Equity, Accessibility, Urban Planning

1. Introduction

Urban green spaces (UGS) are now broadly recognized as essential elements that contribute significantly to the quality of life in urban environments. They provide a wide array of benefits that span environmental, social, and economic realms. These include helping to cool cities, improving the quality of our air and water, encouraging people to be more active and feel better mentally, and fostering connections and a sense of community. As cities continue to grow, it becomes increasingly important to protect and share UGS fairly so that everyone can enjoy these benefits and live in a sustainable, pleasant environment.

Kathmandu Valley, Nepal, is experiencing rapid, often unplanned urbanization, characterized by increasing population densities, haphazard development, and inadequate infrastructure. This swift pace of urbanization presents considerable challenges for urban planners, especially when it comes to maintaining and expanding PUGS to meet the needs of an expanding and diversifying population. Nagarjun Municipality, located in the northwestern part of Kathmandu Valley, is a prime example of these challenges. While the area is known for its natural beauty and historical importance, it faces increasing pressure from urbanization. This can lead to unequal access to PUGS. The Local Government Institutional Capacity Self-Assessment (LISA) of Nagarjun Municipality (2079/080) has also noted deficiencies in green space management.

Despite understanding the importance of PUGS, many urban areas struggle to ensure that everyone has fair access. Nagarjun Municipality faces this problem, too. The central question this research explores is whether public UGS are distributed and accessible equally, and if not, whether this negatively affects vulnerable groups by limiting their access to these beneficial spaces. Therefore, this research aims to evaluate how public UGS are spread throughout Nagarjun Municipality and how easily people can get to them. It will also focus on finding out if access differs depending on factors like income and location. The study will delve into what influences people's use of UGS and consider the potential consequences of unequal access on residents' well-being. Using a combination of GIS-based analysis, household surveying, and key interviews, this research hopes to offer evidence based recommendations. These recommendations are intended to promote fairness in access to green spaces in Kathmandu, as it becomes more urbanized, and to contribute to a more inclusive and sustainable way of developing the city.

2. Objectives

The main objective of this research is to analyze the spatial distribution and accessibility of Public Urban Green Spaces (PUGS) in Nagarjun Municipality from an equity perspective.

1. To map and analyze the spatial distribution of PUGS in order to understand their spatial characteristics and patterns.
2. To assess the accessibility of PUGS for different socio-economic groups in Nagarjun Municipality, identifying potential disparities in access.
3. To investigate the factors influencing PUGS utilization patterns among various socio-economic groups within the municipality.

3. Literature Review

Green spaces are integral to urban ecosystems, offering physical and mental health benefits, enhancing biodiversity,

mitigating urban heat, and improving air quality[1]. They are broadly categorized into public and private green spaces, PUGS are public goods that can be accessed freely by all citizens and mainly encompass vegetated natural spaces (e.g., parks, gardens, forests, and woods) and human-modified places (e.g., riverside greenbelts, institutional green spaces, greening squares, and plazas) [2]. The inclusion of institutional or military green spaces often varies, as these are typically inaccessible to the general public [3].

3.1 Theoretical Framework

Urban green space development has long been influenced by a variety of planning theories and management models. Early models, such as the Garden City Movement proposed by Howard (1898), emphasized the integration of residential, commercial, and green spaces through the creation of encircling greenbelts. This early vision laid the groundwork for later theories by highlighting the importance of balanced urban environments. Later, concepts such as Ecological Urbanism [4] have foregrounded the integration of ecological principles within urban design to promote sustainability and mitigate issues such as urban heat islands and pollution.

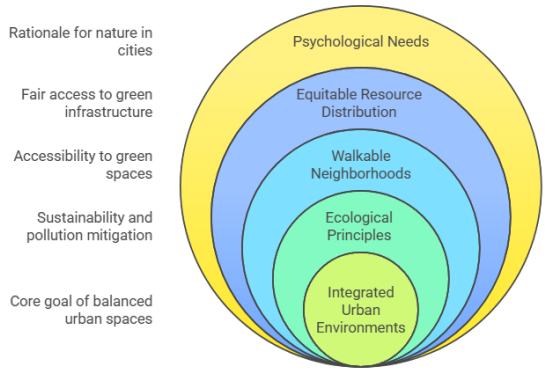

Figure 1: Framework for PUGS Development

In parallel, New Urbanism advocates for walkable, mixed-use neighborhoods, underscoring the need for accessible green spaces within short distances from residents' homes. Fainstein's (2010) Just City Theory further refines these ideas by insisting that urban resources, including green infrastructure, should be distributed equitably to support marginalized communities. Complementary to these urban planning perspectives are green space theories—most notably the Biophilia Hypothesis (Wilson, 1984) and Attention Restoration Theory [5]—which provide a psychological rationale for the need for nature in urban settings. Together, these frameworks inform both the physical layout and the social functions of urban green spaces, guiding contemporary urban planning practices in rapidly urbanizing areas such as Kathmandu.

3.2 Spatial Distribution of Green Spaces

The spatial distribution of green spaces is shaped by a combination of historical planning decisions, socio-economic dynamics, and rapid urban expansion. Globally, cities in developed regions tend to exhibit more systematic and equitable green space arrangements than those in rapidly urbanizing regions of Asia, Africa, and Latin America [6]. In many European and North American cities, large central parks and interconnected green corridors serve as evidence of long-term planning strategies that prioritize public access to nature.

At the regional level, studies have highlighted that rapid urban growth in cities such as Kathmandu has led to a patchwork of green spaces, with well-planned parks typically concentrated in central business districts and affluent neighborhoods, while peripheral and informal settlements experience significant deficits [7]. Local investigations using Geographic Information Systems (GIS) have further revealed that even within a single city, green space availability can vary drastically between adjacent neighborhoods. This spatial heterogeneity not only reflects historical planning legacies but also underscores the challenges posed by unplanned development and land-use conversion in the urban periphery.

3.3 Accessibility of Green Spaces

Accessibility is a multi-dimensional construct that goes beyond mere physical proximity. It encompasses the physical, functional, and perceived ease with which residents can reach and use green spaces. Traditional measures of accessibility—such as Euclidean distance—offer a rudimentary view of proximity, but more advanced GIS-based network analyses reveal that real-world travel routes, barriers, and connectivity issues often lead to significant disparities in access [8, 9].

Studies from cities like Brussels illustrate that while straight-line measurements might suggest an equitable distribution of parks, analyses incorporating actual road networks highlight pronounced accessibility challenges in older, densely populated districts [10]. In Kathmandu, similar methods have exposed that low-income and informal settlements face prolonged travel times to reach sizable green areas, a trend consistent with broader valley-wide studies [11]. Moreover, the perceived safety and quality of these spaces—elements often captured through community surveys and participatory mapping [12]—play a critical role in determining their usage. Thus, an integrative approach combining GIS, remote sensing, and qualitative methods is essential for a comprehensive assessment of green space accessibility.

3.4 Socio-Economic Disparities

Socio-economic factors are central to understanding both the distribution and utilization of public urban green spaces. Historical planning practices, including discriminatory policies such as redlining in several countries, have left enduring legacies that continue to affect contemporary urban landscapes [10]. In many cases, wealthier neighborhoods benefit from larger, well-maintained parks and denser green

networks, while economically disadvantaged areas are burdened with fragmented, poorly maintained spaces.

In Kathmandu Valley, for instance, rapid and unplanned urbanization has disproportionately impacted informal settlements, where the dual challenges of inadequate green space provision and poor maintenance are prevalent [7]. The physical characteristics of green spaces—such as the presence of amenities, lighting, and safe pathways—are often inferior in low-income areas, leading to reduced utilization. Cultural and social factors further complicate the scenario; parks designed without input from local communities may fail to resonate with or meet the needs of diverse user groups. As a result, not only is access to green spaces inequitable, but their actual usage also varies significantly along socio-economic lines, exacerbating broader urban health and environmental justice issues [13].

Unequal access to green spaces based on socio-economic factors is a significant issue in many cities. These inequalities can arise from differences in income, residential location, ethnicity, and disability. Addressing these disparities requires targeted policies to ensure fair access to green spaces for all.

3.5 National Plans, Policies, and Strategies

At the national level, urban green space management in Nepal is guided by a suite of strategic plans and regulatory frameworks designed to integrate environmental sustainability into urban development. The National Urban Development Strategy (NUDS, 2017) stands as a key policy document, setting quantitative targets for green space provision in existing and new urban areas. However, there is a significant gap between policy goals and actual implementation. The proportion of open spaces in major municipalities remains very low, with only 0.48% in Kathmandu and 0.06% in Lalitpur, highlighting the challenges in preserving and managing urban green spaces[14].

Complementing the NUDS is the Land Use Policy (2015), which seeks to curb urban sprawl and preserve agricultural and public lands through the development of green belts and corridors. However, the enforcement of these policies is often weak, as competing land-use priorities hinder effective implementation. The Environment-Friendly Local Governance Framework (2021) further underscores the need for inclusive design in public parks, emphasizing amenities that cater to all age groups and abilities. Technical guidelines provided by the Planning Norms and Standards (DUDBC, 2013) suggest that metropolitan areas should allocate approximately 5% of their land to neighborhood parks and green belts, yet local case studies, such as those from Sinamangal Land Pooling, indicate that the actual allocation frequently falls short of these recommendations.

Additionally, the Kathmandu Valley Development Authority's (KVDA, 2015) Atlas of Open Spaces offers a comprehensive inventory of potential green areas, although many identified sites are privately owned, limiting their utility for public recreation. These national and local policy instruments collectively underscore the challenges and opportunities for enhancing urban green space provision in rapidly growing cities like Kathmandu, highlighting the need for stronger regulatory frameworks and community-driven planning processes.

4. Methodology

This study uses a case study approach to investigate the spatial distribution and accessibility of public urban green spaces in Nagarjun Municipality. The research follows a pragmatic framework, combining both quantitative and qualitative methods to produce practical insights.

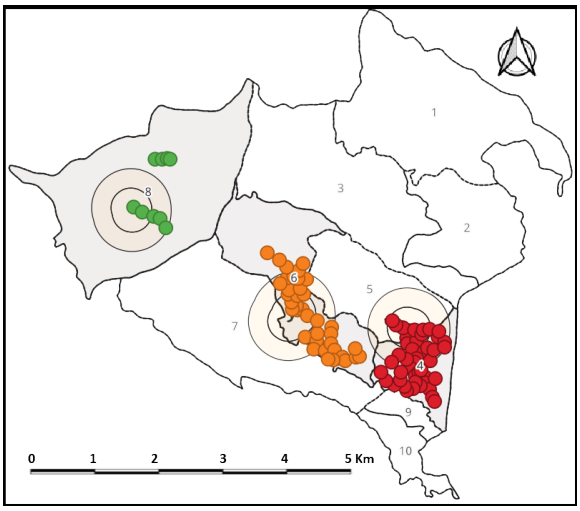

Figure 2: Locating respondents in different buffer of each specified PUGS

For the quantitative analysis, data were collected through structured surveys and GIS-based spatial analysis. QGIS software was used to conduct buffer zone mapping to assess the proximity of residential areas to green spaces. Three buffer zones were defined: 0-300m, 301-600m, and beyond 600m , which guided the household selection for the survey.

The sample size was determined using Cochran's formula:

$$n = \frac{Z^2 p(1-p)}{e^2}$$

where Z represents the Z-score for a 95% confidence level, p is the estimated proportion (assumed to be 0.5 for maximum variability), and e denotes the margin of error. Based on this calculation, a total of 95 respondents were selected: 46 from Ward 4, 40 from Ward 6, and 9 from Ward 8.

The survey results provided quantitative insights into accessibility and highlighted disparities in green space distribution among different socio-economic groups.

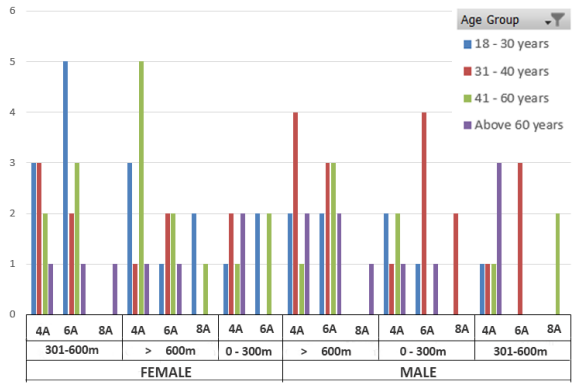

Figure 3: Demographic Data

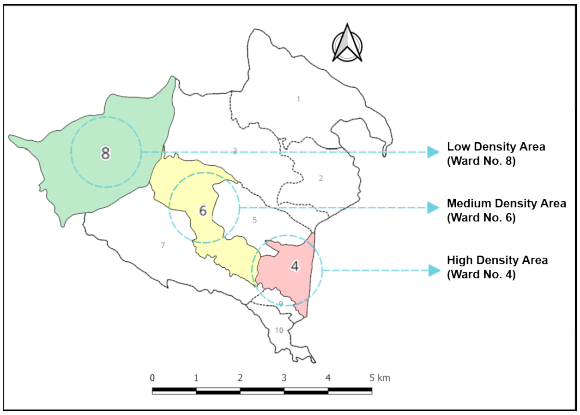

Figure 4: Case Study Area

For the qualitative part, semi-structured interviews were conducted with key personnel. In addition, information was gathered through a review of journals, official documents, and previous studies related to the topic. These interviews and document reviews offered detailed insights into residents' experiences, their perceptions of safety and quality, and other factors affecting access to green spaces.

The study focuses on identifying both the challenges and opportunities within the current framework of public urban green spaces. It aims to uncover local issues, while also suggesting strategies to improve equitable access to these spaces. By integrating quantitative measurements with qualitative insights, the research captures both the physical and subjective aspects of green space accessibility.

This dual approach ensures that the findings reflect not only the measurable spatial dimensions of urban green spaces but also the lived experiences of the community. The combination of surveys, GIS mapping, interviews, and document reviews provides a comprehensive understanding of the factors that influence green space distribution and usage in Nagarjun Municipality, supporting the development of targeted urban planning recommendations.

5. Case Area

This study focuses on three wards within Nagarjun Municipality—Ward 4, Ward 6, and Ward 8—selected based on their diverse urban settings and the distinct challenges they face regarding public urban green spaces (PUGS). These wards provide a comprehensive representation of urban development, green space availability, and accessibility issues within the municipality. Ward 4 is a highly developed area characterized by dense residential and commercial buildings. In contrast, Ward 6 features a combination of urban development and open green spaces, whereas Ward 8 is predominantly characterized by institutional green spaces and natural areas with varied terrain. This variety allows for an exploration of how different land-use patterns influence the distribution and quality of green spaces.

The availability of green spaces differs significantly among the wards. In Ward 4, the high building density results in limited green areas. Ward 6 offers a moderate amount of accessible green space, whereas Ward 8 contains a larger share of green areas; however, many of these are linked to institutional or protected lands, reducing their public accessibility. Such variations are crucial for identifying where gaps exist and where improvements are most needed.

Accessibility remains a key issue throughout all three wards. Although Ward 4 benefits from relatively better infrastructure in certain areas, its overall green space provision is low due to unplanned urban growth. In Ward 6 and Ward 8, residents face challenges such as longer travel distances with uneven pathways and high terrain which further limit access to available green spaces. These barriers underscore the need for better urban planning and enhanced infrastructure throughout the municipality.

The selected wards also vary in socio-economic characteristics, incorporating residents from diverse income levels and educational backgrounds. This diversity is important for understanding whether green spaces are equitably accessible and beneficial.

6. Analysis and Findings

This section presents findings from household surveys and key stakeholder interviews. Structured questionnaires and semi-structured interviews captured diverse experiences, revealing the ground realities of public urban green spaces. The following analysis explains patterns, barriers, and trends in the spatial distribution and accessibility of public green spaces in Nagarjun Municipality.

6.1 Spatial Distribution Analysis

GIS-based mapping techniques were employed to assess the distribution of green spaces across the study area.

The per capita analysis revealed striking disparities among the wards. For instance, Ward 8 provides approximately 213 m² per person, far exceeding the World Health Organization's minimum recommendation of 9 m² per person. In contrast,

Ward 6 offers around 26.3 m² per person, while Ward 4 is severely limited, with only about 0.51 m² per person. These differences largely reflect variations in land use and urban development patterns. Ward 4 is characterized by dense residential and commercial structures that leave little room for public green spaces, whereas Ward 8, with its mix of institutional and natural areas, exhibits a much higher green space provision.

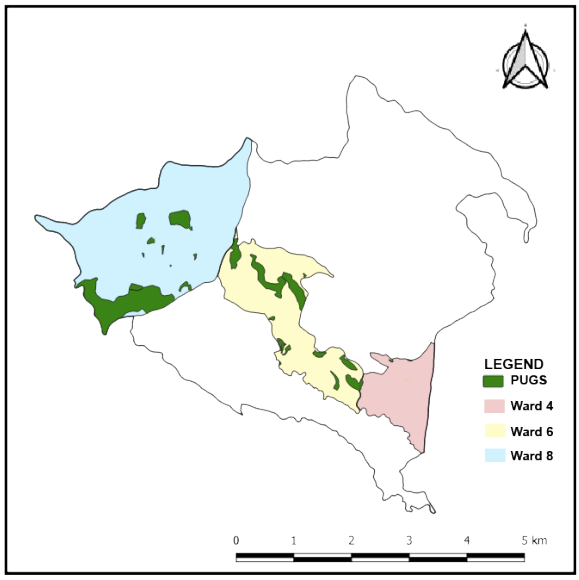

Figure 5: Presently available PUGS in case area

Table 1: PUGS Per Capita Analysis

Ward	PUGS Area (km²)	PUGS Area (m²)	Population	PUGS per Capita (m²/person)
Ward 8	0.756	756,000	3,548	213
Ward 6	0.397	397,000	15,115	26.3
Ward 4	0.009	9,000	17,619	0.51

6.2 Survey Findings and Demographic Analysis

Analysis of the survey data indicates significant variability in residents' proximity to green spaces. Demographically, respondents are predominantly working-age, with a strong representation of individuals holding tertiary qualifications and a balanced gender distribution, reflecting diverse perspectives on public green space issues. Furthermore, factors such as age, income, and educational background influence experiences with accessibility; for instance, older adults and lower-income households are more common in Ward 4 and tend to face greater mobility challenges.

6.3 Accessibility and Usage Patterns

The analysis of accessibility and usage patterns shows that travel distance and time are critical factors affecting PUGS utilization. Nearly one-third of respondents reported travel times exceeding 20 minutes to reach a green space, which corresponds with a lower frequency of visits.

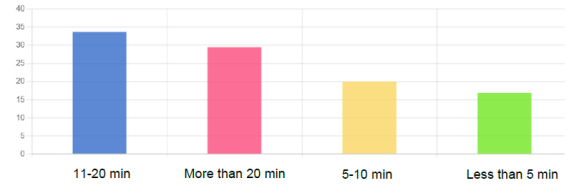

Figure 6: Travel Time Frequency Distribution Chart

In fact, 42% of respondents stated they rarely or never visited these spaces. The data demonstrate that increased distance and longer travel times are associated with reduced usage. Additionally, the physical condition of the pathways, the presence of amenities, and perceptions of safety emerged as important factors that influence the frequency of visits.

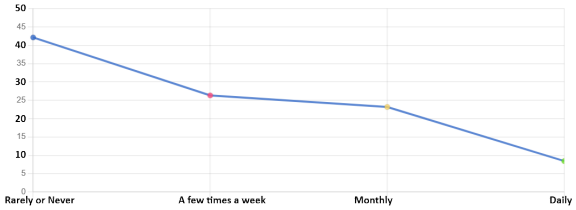

Figure 7: Visit Frequency

The data from PUGS Areas from ward no. 4, 6, and 8 show a clear relationship between household income and the distance to green spaces. In Area 4, households earning more than NPR 50,000 are found only within 600 meters of a green space, while most households in the NPR 30,001–50,000 group live beyond 600 meters. Similarly, for households earning NPR 15,001–30,000 and less than NPR 15,000, a larger share lives farther away, with around 40% residing over 600 meters from a green space.

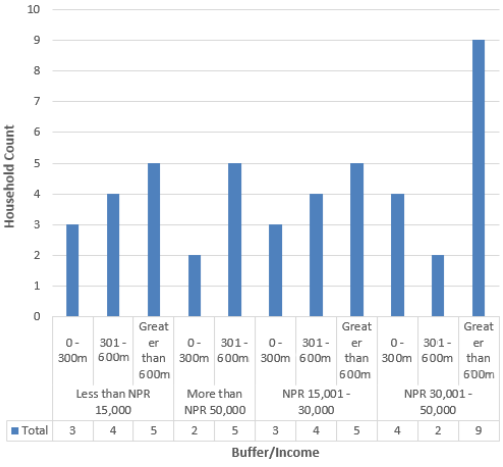

Figure 8: Household Income Distribution and Proximity to PUGS in Ward 4

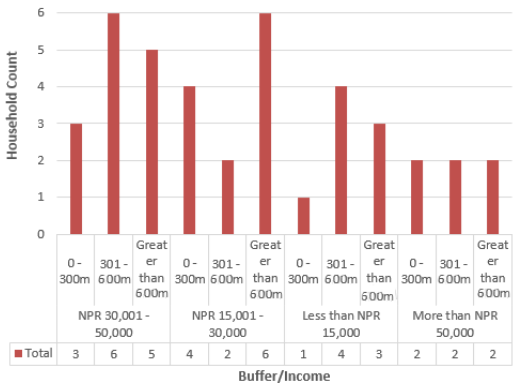

Figure 9: Household Income Distribution and Proximity to PUGS in Ward 6

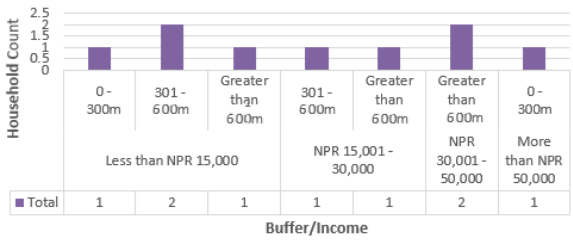

Figure 10: Household Income Distribution and Proximity to PUGS in Ward 8

In Area 6A, the wealthier group (earning more than NPR 50,000) is evenly spread across all distance zones, yet the middle- and lower-income groups tend to be concentrated in the zones beyond 600 meters. In Area 8A, where the sample is smaller, most households belong to lower income groups and are mostly found in the 301–600 meter zone, while the only household in the highest income bracket is located within 300 meters.

Overall, these findings suggest that higher-income households generally have better access to green spaces, whereas lower-income households are more likely to live further away. This income-related disparity in proximity could influence the usage of green spaces and ultimately impact residents' well-being.

6.4 Statistical Analysis

A series of statistical tests were applied to quantify relationships between key variables. Descriptive statistics provided an overview of demographic characteristics and usage patterns. The chi-square test was conducted to examine the relationship between the frequency of visits to public urban green spaces and four variables: education level, income range, travel time, and buffer zone. The results indicated that education level did not have a significant influence on visit frequency (p-value = 0.111), suggesting that individuals from different educational backgrounds visited at similar rates. However, a significant association was found between income range and visit frequency (p-value = 0.004),where people with lower incomes (e.g., less than NPR 15,000) may visit less frequently, while higher-income individuals might visit more frequently. Travel time also showed a strong relationship with visit frequency, with shorter travel times leading to more frequent visits, while longer travel times reduced visit frequency. Similarly, the buffer zone was found to have a significant impact (p-value = 0.001), as individuals living closer to green spaces visited more often than those residing farther away. These findings highlight the role of socioeconomic factors and spatial accessibility in influencing the usage patterns of public urban green spaces in Nagarjun Municipality, Kathmandu.

Table 2: Frequency Visit by Buffer Zone

Frequency Visit	0-300m	301-600m	Greater than 600m	Total
Daily	5	3	0	8
A few times a week	10	11	4	25
Monthly	4	7	11	22
Rarely or never	5	11	24	40
Total	24	32	39	95

(**Chi-Square statistic:** 21.89; **Degree of freedom:** 6; **p-value:** 0.001)

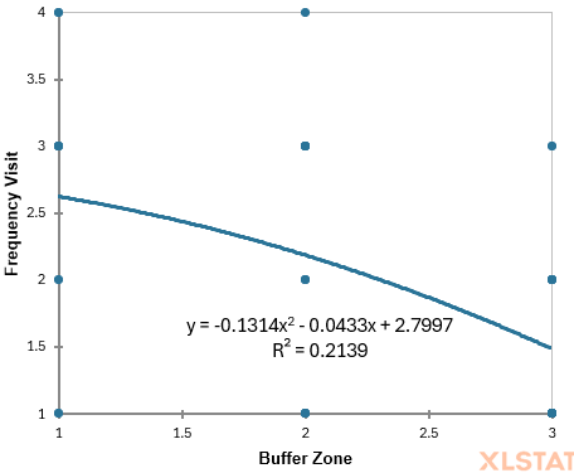

Figure 11: Frequency of visit vs Buffer Zone distance

A chi-square test revealed a significant association between travel time and visit frequency (p = 0.008). Frequent visitors tend to have shorter travel times, while less frequent visitors face longer travel times, suggesting that improved accessibility could boost usage of urban green spaces.

Buffer zone having the most substantial impact. Other variables, including Gender, Education Level, and Mobility Issues do not show significant effects within this analysis.

Table 3: Frequency Visit by Income Range

Frequency Visit	Less than NPR 15,000	NPR 15,001 - 30,000	NPR 30,001 - 50,000	More than NPR 50,000	Total
Daily	2	0	5	1	8
A few times a week	1	8	8	8	25
Monthly	4	8	9	1	22
Rarely or never	17	10	9	4	40
Total	24	26	31	14	95

(**Chi-Square statistic:** 23.89; **Degree of freedom:** 9; **p-value:** 0.004)

Table 4: Frequency Visit by Travel Time

Frequency Visit	Less than 5 minutes	5 - 10 minutes	11 - 20 minutes	More than 20 minutes	Total
Daily	4	2	2	0	8
A few times a week	7	8	7	3	25
Monthly	2	3	10	7	22
Rarely or never	3	6	13	18	40
Total	16	19	32	28	95

(**Chi-Square statistic:** 22.37; **Degree of freedom:** 9; **p-value:** 0.008)

6.5 Qualitative Insights and Perceptions

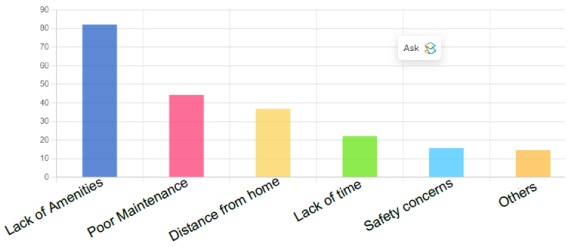

Figure 12: Frequency of Key Issues

Semi-structured interviews with municipal officials, households, and community leaders provided deeper insight into residents' experiences with PUGS. Respondents consistently reported that poor maintenance, insufficient basic amenities, and safety concerns are significant barriers that detract from the usability of available green spaces. Many expressed that while the existence of a park or garden is beneficial, its poor upkeep and lack of facilities—such as seating, proper lighting, and restrooms—diminish its value for the community. Furthermore, qualitative data reveal that even when green spaces are physically present, they do not always meet the expectations or needs of all user groups, particularly vulnerable populations like children and the elderly.

7. Discussion

Public Urban Green Spaces (PUGS) significantly enhance urban life by providing recreational, social, and environmental benefits. However, our study in Nagarjun Municipality shows that these benefits are not fully realized due to several challenges.

7.1 Social Capital and Community Participation in Green Space Usage

The findings indicate that while green spaces have the potential to foster community interaction, their use remains limited. About 57.89% of respondents use these areas mainly to socialize, 44.21% bring their children for recreation, and 32.63% use them for relaxation. Yet, 42.11% of the participants rarely or never visit PUGS. Additionally, a small percentage (6.32%) reported low awareness of the benefits of these spaces. Limited amenities and accessibility issues further discourage participation, suggesting that despite their potential, green spaces are underutilized in building community bonds.

7.2 Accessibility and Spatial Distribution of PUGS

Accessibility is a major factor affecting the use of green spaces. Nearly 40% of respondents live more than 600 meters from the nearest PUGS, which contributes to lower visitation rates. Statistical analysis confirms that greater distances significantly reduce the frequency of visits ($\chi^2 = 21.89$, $p = 0.001$). The study also found that longer travel times are closely linked to increased distance, and while factors such as cleanliness, available amenities, and safety show some correlation with distance, they do not impact usage as strongly as proximity does.

7.3 Economic Barriers and Inequality in PUGS Utilization

Economic factors emerge as a key determinant in the use of PUGS. The Chi-Square analysis confirms a significant relationship between income and the frequency of PUGS visits ($\chi^2 = 23.89$, $p = 0.004$). Lower-income individuals (less than NPR 15,000) are more likely to visit rarely or never (17.9%), while higher-income groups visit more frequently.The analysis indicates that household income is the strongest predictor of the frequency of visits. Higher-income households tend to visit green spaces more often, whereas lower-income groups face financial and mobility barriers that limit their access. This economic divide results in unequal use and benefits derived from PUGS.

7.4 Institutional and Policy Gaps in Green Space Management

This study also reveals significant institutional and policy challenges. Weak regulatory frameworks, limited funding, and inadequate community participation hinder effective management and maintenance of green spaces. These policy gaps contribute to uneven distribution and deteriorating conditions of PUGS, reducing their overall impact on urban quality of life.

Overall, these findings highlight the complex interplay of social, spatial, and economic factors that affect the use of urban green spaces, pointing to the need for comprehensive strategies to improve their accessibility and effectiveness.

8. Conclusions and Limitations

This study reveals an unequal distribution and accessibility of Public Urban Green Spaces (PUGS) in Nagarjun Municipality, Kathmandu. Densely populated areas, such as Ward 4, suffer from a critical shortage of green spaces due to limited land availability, whereas medium-density areas like Ward 6 and peri-urban Ward 8 have relatively better access. The findings show that distance and travel time significantly affect the frequency of visits; residents living farther from green spaces benefit less from them. Moreover, economic disparities are evident, with higher-income groups visiting more frequently than lower-income households. Qualitative insights further indicate that poor maintenance, inadequate amenities, and safety concerns reduce the attractiveness and usability of existing green spaces. In addition, institutional issues such as weak policy enforcement, limited funding, and low community participation further exacerbate the problem.

However, the study has some limitations. First, the analysis is based on data collected from a few selected wards and few sample, especially in Ward 8, which may not fully represent the entire municipality. Second, reliance on household surveys and interviews introduces the possibility of subjective bias in the findings. Third, while the study focuses on spatial and economic factors, it does not address seasonal variations or the broader social and cultural influences that may also affect the use of green spaces. Future research should consider these aspects to provide a more comprehensive understanding of PUGS in rapidly urbanizing areas.

9. Recommendations

Given the findings on unequal distribution and accessibility of public urban green spaces in Nagarjun Municipality, it is critical to implement targeted measures tailored to the needs of each area. In densely built-up regions like Ward 4, where limited land availability restricts the creation of new parks, alternative solutions such as vertical greenery, rooftop gardens, and small size public green spaces like parklet should be adopted. In addition, shared-use agreements with schools, government institutions, and private properties can expand available green spaces through multi-purpose use. In medium-density areas like Ward 6, efforts should focus on revitalizing existing green spaces by upgrading infrastructure, enhancing walkability, and improving safety measures. Meanwhile, in peri-urban zones such as Ward 8, future planning must prioritize the integration of larger, multifunctional green spaces that serve both recreational and ecological purposes, while preserving natural landscapes and ensuring connectivity with surrounding communities. Municipal authorities need to strengthen policy enforcement, increase public investment in urban greening initiatives, and foster active community participation in planning and maintenance. Such comprehensive and area-specific strategies will help reduce spatial inequities, promote the sustainable use of green spaces, and ultimately contribute to a more inclusive and healthier urban environment for all residents of Nagarjun Municipality.

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APPENDIX G: PLAGIARISM CHECK REPORT

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