

**SUSTAINABILITY OF DIFFERENT RESIDENTIAL DENSITY
NEIGHBORHOODS IN NAIROBI CITY COUNTY, KENYA**

BY

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DECLARATION

This project is my original work and has not been presented for a degree in any other University.

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DEDICATION

I dedicate this research to my siblings Metrine Mugah, David Mugah and Martin Mugah as an encouragement for them to pursue higher education.

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ACRONYMS AND ABBREVIATIONS

AHP	Analytic Hierarchy Process
ATM	Automatic Teller Machine
BAL	Budget Allocation
CIDP	County Integrated Development Plan
GARRA	Garden Ridgeways Residential Association
GIS	Geographic Information Systems
GPS	Global Positioning System
KARA	Kenya Alliance of Residential Associations
KNBS	Kenya National Bureau of Statistics
LUM	Land use Mix
NAMSIP	Nairobi Metropolitan Services Improvement Project
NCC	Nairobi City Council
NIUDMP	Nairobi Integrated Urban Development Master Plan
NMSP	Nairobi Metropolitan Spatial Plan
NMT	Non-Motorised Transport
NUA	New Urban Agenda
ROK	Republic of Kenya
ROR	Republic of Rwanda
SACCO	Savings and Credit Cooperative
SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Science
UK	United Kingdom
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs,
UNDP	United Nation Development Programme

ABSTRACT

Sustainability is an important element in the planning of cities and urban areas, but it has received less attention in the neighborhood. The rapid growth of Nairobi city has led to poor infrastructure, environmental challenges, and overcrowding, which has affected the sustainability of neighborhoods. This study, therefore, seeks to assess the level of sustainability of three different residential neighborhoods in Nairobi - Buruburu, Zimmerman, and Garden estate that is, medium, high, and low-density, respectively. The objectives of the study were to (a) examine the adequacy of facilities, (b) assess environmental, social, and economic sustainability, and (c) assess factors that influence residential sustainability preference of Buruburu, Zimmerman, and Garden residential neighborhoods. Data for this study was obtained from questionnaires, checklists, interview schedules, Registry Index Maps, and multispectral images. Purposive sampling was used in key informant interviews, and simple and systematic random sampling was used in the administration of 267 questionnaires to households. The checklist was used in mapping out the location of facilities and types of business. Data was analyzed using frequencies, percentages, and regression using Statistical Package for Social Science Software Version 22. The results for adequacy of facilities show that most of the facilities in Garden estate were adequate, while in Buruburu and Zimmerman estates, the facilities were inadequate due to increased population, land grabbing, and informality. Facilities in Buruburu and Zimmerman were accessible, while not all facilities were accessible in Garden Estate. Accessibility to facilities varies across the neighbourhoods, with Zimmerman's facilities distances ranging from 81m to 872m, Garden Estate from 225m to 1,438m, and Buruburu from 57m to 774m. Mobility patterns also differ across the estates, with most Buruburu residents 86% and Zimmerman residents 79% walking to access facilities, while the use of private cars is dominant in Garden Estate at 74%. The research also assessed the three estates' social, environmental, and economic sustainability. Findings indicate that Buruburu exhibited the highest level of social sustainability (5), followed by Zimmerman (4) and Garden Estate (3). Economically, Zimmerman ranked highest (5), while Buruburu (3) and Garden Estate (1) lagged. Both Buruburu and Zimmerman demonstrated medium environmental sustainability (3), whereas Garden Estate had the lowest level (2). The overall sustainability levels of the three estates were 4, 2, and 3 for Buruburu, Garden, and Zimmerman estates, which indicate their sustainability as medium-high, medium-low, and medium, respectively. Residents in Garden estate prefer living near work to forego transport costs, while residents in Zimmerman estate are likely to commute to the workplace. Safety and security, as well as open spaces and facilities, are some factors residents most prefer in a neighborhood. Factors that affect residential preference are density, income, house ownership, age, education level, and household size. Kenya lacks adequate accessibility standards for the provision of facilities within a neighborhood. Therefore, there is a need to establish planning standards to ensure the provision of facilities is accessible to improve the quality of life in the neighborhood. Assessing the sustainability of neighborhoods shows that each neighborhood density has its strengths and weaknesses across sustainability criteria and indicators, which calls for striking a delicate balance between them to maximize the strengths of the area while addressing the weaknesses to enhance the overall sustainability.

1 CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The future of the world's population is urban (UNDESA, 2018, 2019), but uncontrolled urbanization can impair sustainability due to urban sprawl, congestion, pollution, and environmental degradation (UN-Habitat, 2016a; UNDESA, 2018). It is estimated that the world will urbanize from 56.2% to 60.4% by 2030, with 96% of the growth occurring in Africa and South and East Asia (UN-Habitat, 2020a).. As the world continues to urbanize, sustainable development will depend on effective management of the growth in urban areas, specifically in developing countries, where the rate of urbanization is projected to be the fastest (UNDESA, 2019).

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Ahmad, 2020; Harris, 2003; WCED, 1987). Sustainable development aims at balancing environmental, economic and social dimensions (Zhang et al., 2018). Implementation of sustainable development in the past was at the national level. However, the challenges of achieving sustainable development are predominantly at the local level, particularly in urban areas and towns (Zhang et al., 2018). In response to these issues, many countries have embraced the Sustainable Development Goals (SDGs) to foster sustainability within their cities and communities. In response to this, various countries have adopted the Sustainable Development Goals (SDGs) to promote sustainability in their cities and towns (Zhang et al., 2018). In particular, Goals 3 and 11 of the SDGs help to promote sustainable neighbourhoods (UNDP, 2016).

Sustainability is considered an essential element in the planning of cities and urban areas (Choguill, 2008). Although it is vital in the cities, it has received less attention in developing neighbourhoods (Choguill, 2008; Hilley & Sim, 2020; Sharifi & Murayama, 2012). The design and planning of urban neighbourhoods are crucial in creating sustainable cities and urban settlements (Anjali et al., 2014; Hilley & Sim, 2020). A neighbourhood is where most human activities take place. Thus, for a city to be considered sustainable, its components, such as the built environment and neighbourhoods, should meet the criteria for sustainability (Choguill, 2008; Zhang *et al.*,

2018). All developments, activities, and processes within a neighbourhood form a city. Therefore, the overall sustainability of a city depends on the sustainability of the neighbourhoods (Bahale & Schuetze, 2023) which signifies the importance of neighbourhoods in the fabric of a city (Dehghanmongabadi et al., 2014) prosperity of a city depends on the vitality of its neighbourhoods since they promote the quality of life of its citizens through its physical and social conditions (Perola *et al.*, 2017).

Neighbourhood planning has been practiced since the 20th century as a remedy for problems caused by unregulated urbanization (Sharifi, 2016). Clarence Perry initially introduced the neighbourhood unit concept to insulate the community from the ill effects of the expanding vehicle traffic (Meenakshi, 2011; Perry, 1929). Neighbourhood planning is essential when promoting sustainability at the local level (Yigitcanlar *et al.*, 2015), which influences the planning of residential developments since it is a major land use in urban areas (Suharto, 2012). Planning of neighbourhoods based on sustainability principles can be used to guide the sustainable development of neighbourhoods (Sharifi, 2016). Neighbourhood sustainability is the process of developing neighbourhood land use, infrastructure, and street networks to satisfy the needs of residents while preventing social and environmental impacts (Yigitcanlar *et al.*, 2015). A sustainable neighbourhood is somewhere people want to live and stay for a long term and provides an environment with a high quality of life (Anjali *et al.*, 2014). It should have a wide choice of houses and enough facilities; be well connected to jobs and services that are accessible by bike, foot, and public transport; designed to conserve resources; have places of different character; and benefit from active management and lasting stewardship by local organizations, both during development and after residents have moved in (Falk & Carley, 2012).

Kenya has been faced with challenges in planning, development, and management of its urban residential neighbourhoods due high urbanization rate (Rukwaro & Olima, 2003). The unmanaged urban growth in Nairobi has led to poor infrastructure, environmental challenges, and overcrowding, which has affected the sustainability of neighbourhoods (Maiyo, 2020), which affected the attractiveness of most neighbourhoods in Nairobi, reducing the value of these residential areas (Olima, 2013). It has also led to increased density, construction of housing extensions that are illegal, incompatible land uses, inadequate public spaces and infrastructure, and loss of open spaces, resulting in inadequate

living conditions (UN-Habitat, 2016b). Given this state of affairs in Nairobi, which impacts neighbourhoods' sustainability, this study, therefore, assesses the sustainability of different residential neighbourhoods with different densities, namely Buruburu, Zimmerman, and Garden estates, which are medium, high, and low-density, respectively.

1.2 Problem Statement

Residential neighbourhoods planned in Nairobi during the post-colonial period were meant for a smaller population. Still, with the increasing population, it has surpassed the planned population contained in the original plans. It has led to development that is not in sync with the spatial development plans, overcrowding, loss of original pattern, and distribution of land uses, which has contributed to environmental, social, and economic problems (Murage, 2019), with implications on neighbourhood sustainability and facilities whereby the current growth does not match up with the available local amenities (Ng'etich *et al.*, 2022; Thuo, 2013) in both planned and unplanned neighbourhoods. Hence the study seeks to assess the sustainability of residential neighbourhoods in Nairobi city.

Unplanned residential neighbourhoods lack amenities such as playing fields, community centres and markets that residents can use (Thuo, 2013). Planned residential neighbourhoods have local amenities such as schools, shops, community buildings and open space, but with increased population, they have become inadequate (Murage *et al.*, 2016). This underscores the need for planners to address challenges of neighbourhood amenity provision to match population growth (Ng'etich *et al.*, 2022).

Residential sustainability studies done in Kenya are assessing the sustainability of Ngara estate in Nairobi but did not determine the sustainability level (Maiyo, 2020), as well as assessing environmental sustainability in upgraded informal settlements across Kenyan cities (Njeri *et al.*, 2023). This study, therefore, assesses the sustainability of three different neighbourhoods' densities: Buruburu (medium), Zimmerman (high), and Garden estate (low). Buruburu is a planned neighbourhood but it has changed due to a densification process caused by poor management that has led to informality. Zimmerman is an unplanned high-density neighbourhood, while Garden estate is a low-density neighbourhood that has not changed over time. Informality is the main contributor to environmental degradation (Oguche *et al.*, 2019), which threatens city sustainability. High-

density area is an element of sustainable urban form; hence are generally more sustainable than low-density, single-use (Dempsey *et al.*, 2012). Low-density areas are the preferred living environments for residents since they provide more open and green spaces compared to high-density areas, hence considered high-quality neighbourhoods (Dempsey *et al.*, 2012). Unplanned settlement has negative implications for the environment (Oguche *et al.*, 2019). Due to these variations in density and planning, it is unknown which type of neighbourhood is more sustainable without assessing them using indicators; thus, the study of the three neighbourhoods.

1.3 Research Objectives

The objectives of the study are:

- 1 To examine the adequacy of facilities in Buruburu, Zimmerman, and Garden residential neighbourhoods.
- 2 To assess environmental, social, and economic sustainability in Buruburu, Zimmerman, and Garden residential neighbourhoods.
- 3 To assess factors that influence residential sustainability preference in Buruburu, Zimmerman, and Garden residential neighbourhoods.

1.4 Research Questions

- 1 Are facilities in Buruburu, Zimmerman, and Garden residential neighborhoods adequate?
- 2 How sustainable are Buruburu, Zimmerman, and Garden residential neighbourhoods in environmental, social, and economic criteria?
- 3 What factors do residents prefer, and what determinants influence their decision when moving into a residential neighbourhood?

1.5 Justification and Significance of the Study

The study decided to focus on high, medium, and low-density neighbourhoods since the Physical Planning Handbook categorizes residential areas into these three (RoK, 2024). The handbook provides a comprehensive view of different urban forms and their sustainability opportunities and challenges. The study focused on neighbourhoods in Nairobi since it is the largest city in Kenya. It is among the African cities with a high

urbanization rate of 4.1% with a population of 4.3 million (JCWG & SJPTWG, 2022; KNBS, 2019). This provides solutions for managing the growth sustainably. The study focuses on sustainability as it aims at providing a better lifestyle and a high quality of life (Satterthwaite, 2015). Designing sustainable neighbourhoods is the initial step toward achieving sustainable urban settlements (Al-Hagla, 2008). Planning of neighbourhoods has a central role in creating sustainable cities (Lucky, 2021). Designing sustainable neighbourhoods is advantageous to the community and the individual as well as the environment (Zhang *et al.*, 2018).

Buruburu neighbourhood was chosen since it was planned using the neighbourhood concept in 1971 and is of medium density (Agwa, 2014); due to poor management, rapid densification, and socio-economic changes, the estate has experienced an extension of settlements and physical structures constructed on the open spaces that were meant for recreational uses and road reserves within the residential areas (Songoro, 2015). This resulted in increased plot density, crowding, and congestion, which disrupted the initial design of the neighbourhood (Agwa, 2014). Zimmerman is high high-density estate. The neighbourhood was chosen since it developed through unplanned schemes and illegal subdivisions. The estate has unguided growth and no regular pattern of development. This has resulted in the construction of unplanned residential and commercial houses that are unapproved and informal, which caused the neighbourhood to have inadequate facilities and services, such as recreational spaces, incompatible land use, and environmental degradation (Muchiri, 2014). Garden estate is a low-density neighbourhood. Garden estate was chosen as an example of a neighbourhood that is assumed not to have changed over time. The estate has a serene environment, well-laid-out paved streets, high security, and strict zoning regulations, and is primarily a low-density residential area. However, without any form of assessment, it remains unknown whether it is more sustainable compared to other residential estates.

The research is significant in the following ways: the current urbanization rate in the city will create additional demand for housing for urban residents. Examining the adequacy of facilities in neighbourhoods helps planners to provide adequate facilities that will enhance the liveability and sustainability of neighbourhoods. Assessing sustainability factors residents prefer in different neighbourhoods is important for planners and policymakers in

developing residential areas, especially in Nairobi city, since population growth coupled with the housing deficit is likely to influence the kind of residential areas needed in the future which will ensure long-term environmental health, social equity, and economic vitality. This also calls for appropriate use of land to accommodate the rising population. Several estates will be renewed under the Nairobi Metropolitan Services Improvement Project (NAMSIP). The renewal plan aims to create self-sustaining neighbourhoods (Dierkx, 2019). Hence, the finding of this study provides information that influences physical planning handbook standards and guidelines.

1.6 Theoretical Underpinning of the Study

Neighbourhood Unit

This concept and planning framework was proposed by Clarence Arthur Perry in the 1920s (Byun *et al.*, 2014; Perry, 1929). It evolved in response to the deteriorating social and environmental conditions during the Industrial Revolution in the early 1900s (Meenakshi, 2011). The neighborhood unit was needed to sustain an elementary school with between 1,000 and 1,200 students, which would equate to 5,000–6,000 people. The neighborhood unit was to be a low-density residential area with 10 households per acre, occupying around 160 acres and is to be shaped so that no child would have to walk more than a quarter of a mile to get to school (Meenakshi, 2011; Perry, 1929; Shekhar, 2015). Recreation would occupy about 10% of the space, and interior roadways would only be used by residents to access services. Traffic arteries would be restricted to the surrounding streets (Meenakshi, 2011; Perry, 1929; Shekhar, 2015). The unit would be served by facilities such as churches, a library, and a shopping and community center, being located in conjunction with the school. (Meenakshi, 2011; Perry, 1929; Shekhar, 2015). It suggests 6 basic principles of spatial planning of a neighborhood: size, boundary, open space, institution, local shop, and internal street system (Byun *et al.*, 2014; Meenakshi, 2011; Perry, 1929). This concept promotes sustainable neighborhoods by promoting mixed-use development, which reduces the need for automobiles, thereby reducing air pollution and congestion, hence promoting sustainable transport.

New Urbanism

The Congress for New Urbanism was established in 1993 to create buildings, neighborhoods, and regions that provide a high quality of life for all residents while protecting the natural environment (CNU, 2001; Rahnama *et al.*, 2012). This concept and planning framework was formulated due to the rise of vehicles in the 1920s, which led to urban sprawl and leapfrog development, which caused traffic congestion and environmental issues (Wey & Hsu, 2014). The framework advocates for strategies that help to curb suburban sprawl and inner-city decline by building and re-building neighborhoods, towns and cities (Wey & Hsu, 2014). The principles of new urbanism are walkability, connectivity, mixed housing, mixed-use and diversity, quality architecture and design, increased density, traditional neighborhood structure, green transportation, sustainability, and quality of life (CNU, 2001; Rahnama *et al.*, 2012; Wey & Hsu, 2014) these principles were developed to curb sprawling, low density and single land use. The social, economic, and environmental benefits of the new urbanism are it helps to create a better and more sustainable place to live, play, and walk by the provision of open spaces and facilities (Rahnama *et al.*, 2012).

Smart Growth

This concept and planning framework evolved rapidly in the mid-1990s as a strategy for dealing with the problems of urban sprawl (Beatley & Collins, 2000; Tregoning *et al.*, 2002). Smart Growth advocates the creation of a pedestrian-friendly environment and offers mixed housing and commercial uses while preserving the natural environment (Blair & Wellman, 2011; Kolbadi *et al.*, 2015). The principles of a smart growth planning framework are to create a range of housing choices, walkability, encourage community and stakeholder collaborations, land use mix, preserve open spaces and critical environmental areas, provide a variety of transport choices, foster attractive communities and make development fair and cost-effective (Blair & Wellman, 2011; Kolbadi *et al.*, 2015). This concept promotes sustainable neighbourhoods by making neighbourhoods have accessible facilities, have housing diversity, vibrant, diverse, and liveable neighbourhoods, and minimize environmental impacts (Kolbadi *et al.*, 2015). The environmental benefits of the framework are reducing urban sprawl, minimizing paved surfaces, preserving open spaces,

and reducing the use of cars will help to protect biodiversity, enhance recreational activity in a neighbourhood, improve water quality, and lead to low pollution (Kolbadi *et al.*, 2015; Shekhar, 2015; Shrivastava & Sharma, 2011). The concept and planning framework also offers social benefits to the neighbourhoods, such as promoting walkability in neighbourhoods, which improves public health by promoting physical activity, reducing reliance on cars, and promoting safety in the neighbourhood (Kolbadi *et al.*, 2015; Shekhar, 2015). Smart growth principles promote economic benefits by supporting vibrant, mixed-use neighbourhoods, which can attract businesses, which leads to creating a more vibrant local economy, reducing service costs and development costs by creating compact communities (Kolbadi *et al.*, 2015; Shekhar, 2015).

1.7 Conceptual Framework

The conceptual framework shows the link between various variables in the study. The independent variables are facilities, density, and street design. Street design affects the sustainability of neighbourhoods since the design layout can promote or reduce the connectivity of an area by discouraging or encouraging walking or the use of private cars. The use of private cars reduces environmental sustainability due to air pollution. Walking, on the other hand, increases sustainability by encouraging social interaction among the residents, promotes the well-being of the residents, and also leads to zero emissions. Density either promotes or reduces sustainability in the following ways: low density reduces impervious surfaces. It increases open spaces, which increases sustainability but increases energy consumption and pollution due to reduced accessibility, which decreases sustainability. A higher density is regarded as an efficient land-use strategy because it concentrates people and their activities in a smaller area. This results in lower energy consumption for travel and reduced resource use, thereby promoting sustainability (Bahadure & Kotharkar, 2018), but it should be properly managed to prevent sprawl. Sustainability in urban areas cannot be achieved without adequate facilities (Moroke *et al.*, 2020). The provision of adequate facilities in residential neighbourhoods plays an important role in the social sustainability of a neighbourhood since its provision has a significant impact on enhancing the living conditions of a society. Socio-economic characteristics influence residential preferences. The intervening variables are regulations, standards, and institutions that help manage and control neighbourhood development. The

standards and regulations also affect the provision of facilities, density, and street design of a neighbourhood. Regulations, standards, and institutions have an indirect influence over residential preferences by shaping the physical attributes of neighbourhoods. Their implementation and enforcement play essential roles in developing sustainable residential areas that suit different requirements and preferences of inhabitants, and ensuring these neighbourhoods have enough facilities. This study is anchored in smart growth, new urbanism, and neighbourhood unit concepts since their principles and planning frameworks promote neighbourhood sustainability.

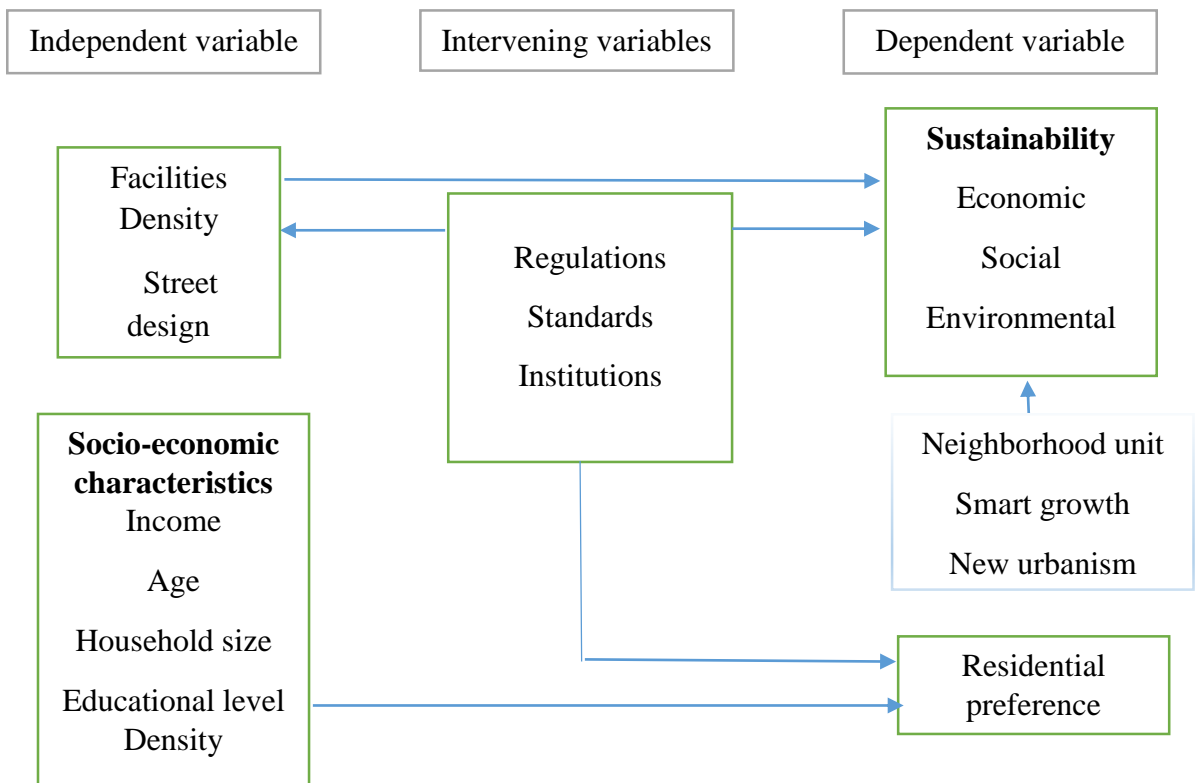


Figure 1-1: Conceptualising neighbourhood sustainability

Author: Researcher, 2024

1.8 Limitations of the Study

- This study only used one normalization technique, which limited the researcher against

- The study focused only on neighbourhoods within Nairobi due to a lack of enough funds to conduct it across the different cities in Kenya.

1.9 Definition of Terms

Planned neighbourhood: residential area with clear and demarcated plots, basic infrastructure, and a regular layout pattern, which includes well-organized roads. These neighbourhoods are moderate or low-density areas with houses built uniformly (Baffoe et al., 2020).

An unplanned neighbourhood: an area with an organic layout structure with no orderly arrangement of the roads with high density and lacks green spaces (Kuffer & Barros, 2011).

Informality: construction of illegal house extensions to serve human needs through informal processes in residential spaces and road reserves (Anyamba, 2011).

Sustainability: integration of environmental, social, and economic dimensions, recognizing that all must be considered together for the prosperity of future generations (Harris, 2003)

Neighbourhood sustainability: process of developing a neighbourhood land use, infrastructure, and street networks to satisfy the needs of existing and future residents while preventing social and environmental impacts, providing opportunity and choice, and contributing to a high quality of life (Yigitcanlar *et al.*, 2015)

Affordable Housing: Housing that is adequate and costs not more than 30% of the household income per month to rent or acquire (RoK, 2016)

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Neighbourhood Concept and Characterisation

Human settlements have been spatially divided into neighbourhoods since ancient times (Sharifi, 2016; Smith, 2010). Various researchers have defined a neighbourhood. Clarence Perry (1929) described a neighbourhood as a collection of close-together dwelling units that share a common interest in the character of the surrounding surroundings and intimate social contacts among its people and community composition.

A neighbourhood is an integrated and planned urban area that is part of a larger community and consists of a residential area, religious buildings, shopping and education facilities, open spaces, and service industry (Meenakshi, 2011; Whittick, 1975). Neighbourhoods are self-contained places with related facilities and specific boundaries (Veluru, 2020). Neighbourhoods are where people live and spend most of their time and are most concerned with what happens in their neighbourhoods affects their quality of life (Rohe, 2009). A neighbourhood is a subdivision of an urban area (Bahale & Schuetze, 2023; Choguill, 2008). A neighbourhood has exceptional character, functions, and essential amenities where residents can work, live, interact, and shop with their neighbours (Shekhar, 2015). A neighbourhood can be defined as the planning unit of a town and the most critical urban element that establishes the social and economic sustainability of the area (Mokhtar & ElDabosy, 2017). Neighbourhoods are building blocks of urban areas and are considered places representing the relationship between the city and the residents (Khatibi *et al.*, 2023). Neighbourhoods also help to bridge the gap between homes and the urban environment (Khatibi *et al.*, 2023). Neighbourhoods are the smallest, basic planning units of urban areas (Isaacs, 1948), although their surface areas and density of living vary (Umdu & Alakavuk, 2022). From these definitions, a neighbourhood can be defined as a spatial unit of a town with facilities where residents can work and live; hence, they should be sustainable for the city to be considered sustainable.

2.1.1 Characteristics of Residential Neighbourhoods

Neighbourhoods of developing countries face a significant challenge in classification. However, various attempts have been made (Ahmad, 2020). Baffoe *et al.* (2020) categorized Rwanda's neighbourhoods into planned, unplanned, and mixed neighbourhoods. Planned neighbourhoods have organized street networks with clearly demarcated plots. They are characterized mainly by low-density or single-dwelling houses built uniformly. At the same time, unplanned neighbourhoods have houses constructed with rudimentary materials and techniques that are non-durable, located on a hazardous site, bearing an area with minimum legal house area or plot size, and lack adequate infrastructure and services (Baffoe *et al.*, 2020). Banyikwa (1990) categorized Nairobi residential neighbourhoods into four distinct types. These neighbourhoods emerged through choice and opportunity by residents, not by planning from the government (Banyikwa, 1990). The master plan for 1948 proposed residential neighbourhoods that were based on racial and social segregation because of colonialists (Banyikwa, 1990). The main racial groups were African, Asian, and European. The residential neighbourhoods for each racial group were to be separated, and this planning idea aimed to preserve racial integrity (Banyikwa, 1990). After independence, the residential neighbourhoods developed in the same setting. Four categories of residential neighbourhoods were developed: low, medium, and high density, as well as squatters. These areas are distinguished by density, quality of environment, and economic level (Banyikwa, 1990) of the residents. The low-density neighbourhoods cover areas such as Muthaiga, Karen, Westland's, Karen, Lavington, Loresho, Gigiri, Kitisuru, Ridgeways, Garden Estate, and Balozzi (Banyikwa, 1990; NCC, 2004, 2018). These areas have attractive open spaces that ensure the neighbourhoods are aesthetically pleasing. The housing types in these neighbourhoods are usually single-dwelling houses. These neighbourhoods are inhabited by wealthy government officials (Banyikwa, 1990), which has created high spatial disparity and inequalities in these neighbourhoods where upper and middle-income neighbourhoods are well-planned with adequate infrastructure and services, while the people who live squatters in congested, dilapidated, high-density neighbourhoods with inadequate infrastructure and services (Jimmy *et al.*, 2020). Currently, the residential patterns are formed by income level (Jimmy *et al.*, 2020), with 60% of people residing in informal settlements (Jimmy *et al.*, 2020; Kieti *et al.*, 2020).

2.2 Adequacy of Facilities

2.2.1 Definition of Facilities

Facilities are essential in a neighbourhood and may include health, recreational, educational, post offices, banks, and other communal facilities (Rani, 2013). The facilities and services in a housing area should include public transportation, parking space, education and health facilities, communication and recreation facilities, and a police station (Pauzi *et al.*, 2017). Communal facilities refer to facilities that provide daily services to the public to support urban neighbourhoods' social and community life at the neighbourhood scale. The hierarchy of these facilities is based on service provision rather than functions for all users in the city. These facilities include bars, cafes, markets, service centres, shops, and restaurants (Lang *et al.*, 2018). Khan (2020) also defines community facilities as physical properties provided by the local government for the delivery of services, for social functions, recreational use, and civic purposes; they should be available to the public for free or at an affordable cost. Community facilities are the amenities utilized by local communities for various purposes. They may include food retail, transport, education, recreation, social and cultural, financial, and health (Xia *et al.*, 2018). facilities are essential parts of a neighbourhood, which include shopping, municipal service, education, medical, transport, fitness, open space, entertainment, and administrative service facilities (Zhang *et al.*, 2023). The public sector and private sectors can provide these facilities. Like the local authorities, the public sector can provide amenities such as parks, public squares, and recreational facilities. The private sector can provide amenities such as restaurants, cafes, retail shops, and other goods or service providers (Allen, 2015). In the United Kingdom, eight local facilities are provided in a neighbourhood, which includes a post office, supermarket, primary school, newsagent, and open space. Other facilities that residents need but are not used frequently are a chemist, bank, and community centre (Jenks & Jones, 2010). Providing these facilities or amenities in a neighbourhood substantially impacts enhancing and sustaining society's living conditions (Rani, 2013, 2014).

Communal facilities differ from one community to another, depending on the size and what is needed within a neighbourhood (Fakere & Ayeni, 2013). Shortage of facilities causes the residents to travel to the neighbourhood with surplus facilities, causing congestion and imbalance in the available facilities, which indicates the importance of equitable facility

distribution within a neighbourhood (Muiga & Rukwaro, 2017). Neighbourhood facilities help to take care of the desires of the residents locally (Smith, 2010). Facilities should be accessible to residents; other factors to be considered are adequacy, location, and affordability (UN-Habitat & RoK, 2018). These facilities should include religious facilities, community libraries, education and training facilities, public buildings like administration, health care facilities, cultural centres, social halls and markets, and recreational facilities such as green open spaces and children's playgrounds (UN-Habitat & RoK, 2018). The provision of facilities depends on the resident population's requirements; hence, these facilities differ within each neighbourhood. Therefore, the local context and population requirements are essential (Jenks & Jones, 2010; Khajouei, 2017).

Different researchers have defined these facilities as local facilities and community facilities. All these have the same meaning; their provision depends on the country and can be provided by the public or private sector. The resident population determines the supply of facilities; hence, facilities provision varies from neighbourhood to neighbourhood.

2.2.2 Provision of Facilities in a Neighbourhood

The provision of facilities started with Perry's first neighbourhood concept (1929). The elementary school played a prominent role in this concept, with each neighbourhood supposed to extend a half-mile radius around the elementary school (Rohe, 2009). About 10% of the neighbourhood was to be allocated for recreation, and the unit was to be served by shopping facilities, churches, a library, and a community centre, the latter being located in conjunction with the school (Meenakshi, 2011). An ideal neighbourhood would embrace all the public facilities and conditions the average family requires for comfort and proper development (Rohe, 2009). The essence of providing facilities within a neighbourhood is to allow residents to access the six core functions of living, working, commercial, health care, education, and entertainment with a 15-minute walk or bike ride (Khavarian-Garmsir, Sharifi, & Sadeghi, 2023).

In Kenya, the provision of neighbourhood facilities started in 1959, whereby the late colonial housing estates featured houses and community facilities, including open spaces and schools that families would use (Harris & Hay, 2007; Masiga, 1975). Neighbourhood planning was adopted in various estates such as Bondeni, Bahati, Kaloleni, Mbotela, Ofafa,

and Ziواني (Harris & Hay, 2007). Kaloleni was planned to have a shopping centre that hosted commercial shops such as grocery and barber shops, salons, bars, butchery, and carpentry shops. It also has a recreational facility, such as a social hall and an open ground (Makachia, 2013). The provision of facilities in these neighbourhoods has been overtaken by urbanization and poor management of the neighbourhoods (Murage *et al.*, 2016; Olima, 2013). Developing a well-planned urban settlement requires providing facilities (Forkuor *et al.*, 2013). These facilities are different within places and depend on the size and needs of a residential neighbourhood (Fakere & Ayeni, 2013). Provision and access to local facilities and services are important in planning and designing neighbourhoods for better living quality (Barton *et al.*, 2021).

2.2.3 Accessibility of Facilities

Accessibility of facilities is a fundamental principle highlighted from earlier concepts. In Clarence Perry's concept, facilities were placed within a 400m walking distance (Khavarian-Garmsir, Sharifi, Abadi, *et al.*, 2023; Perry, 1929); the aim of this was to increase social contact (Khavarian-Garmsir, Sharifi, Abadi, *et al.*, 2023; Patricios, 2002). Jane Jacobs also stated that accessibility is essential (Jacobs, 1961). accessibility, according to her, has various advantages, such as less infrastructure per capita, better access to educational, economic, social, and cultural opportunities, promoting active transport, and safer streets (Salazar & Menéndez, 2007). The American Public Health Association in 1960 also came up with standards for accessibility of services. The standards were provided for residents to avoid fatigue, protect residents from traffic and accidents, and encourage the usage of facilities (APHA, 1960). The 15-minute city concept currently advocates for Chrono-urbanism, supporting planning based on the proximity of essential services within a 15-minute walk (Willberg *et al.*, 2023). This can help reduce car dependency and fuel consumption, reducing pollution (Moreno, 2022). This has been essential, especially after COVID-19, which led to movement restrictions and quarantine measures imposed by local governments to curb the transmission of the virus (Khavarian-Garmsir, Sharifi, Abadi, *et al.*, 2023). This led to severe challenges for cities (Khavarian-Garmsir, Sharifi, Abadi, *et al.*, 2023), making accessibility of facilities critical and making life convenient for city residents.

Accessibility to community facilities and adequate amenities within walking distance from houses are essential standards of a suitable living environment and are closely linked to people's liveability standards (Lang *et al.*, 2018). Neighbourhood amenities accessibility is associated with the unique character of centralized demand; this enables sustainability and high liveability due to adequate facility provision (Lang *et al.*, 2018). Lack of access to facilities could have a more significant impact on the health and wellbeing of residents in neighbourhoods of low socioeconomic compared to neighbourhoods of high socioeconomic due to cost and mobility barriers to the facilities (Witten *et al.*, 2003). Good accessibility to facilities helps to establish healthy neighbourhoods as residents without cars will be able to access these facilities on foot or bike, and those who have cars will not travel far; this reduces pollution and energy use (Barton *et al.*, 2006). The location of facilities in a neighbourhood can be adjusted. Within walking distance of 15 minutes, there should be adequate facilities for the population (Jia *et al.*, 2020). The facilities that should be provided within walking distance are playgrounds, schools, and local shops (Azmi & Karim, 2012). Facilities should be grouped to encourage their usage. These facilities should also be accessible by walking and using cars and be placed in the direction of the significant traffic flow from the neighbourhood. Even though these facilities should be placed together, they should be physically separated from each other to prevent circulation conflict (Azmi *et al.*, 2013). Facilities should be clustered together at locations well-served by public transport and bike and pedestrian routes; these are preferred in linear clusters (Azmi *et al.*, 2013; Barton *et al.*, 2006). Clustering of facilities helps to save time as it provides an opportunity for multi-purpose trips; it also increases the proportion of residents who will use public transport rather than private cars (Barton *et al.*, 2006). Reducing the need for private transport use is one of the aims of sustainability (Jenks & Dempsey, 2005). Increasing residents' accessibility to facilities by providing them locally in the neighbourhood can reduce private transport use. The need to own and use private cars is diminished if appropriate facilities are within walkable distances from the homes. The usage of facilities in the neighbourhood by the residents leads to more developers moving into the neighbourhood to support the area further; this will increase the need for quality public transport, hence reducing the need for private cars and increasing the range of facilities for the residents (Jenks & Dempsey, 2005). The Kenya Affordable Housing Programme under

the Urban Design Guidelines (2018) also states that community facility provision should be placed at the heart of the development and accessible by pedestrian, cycle, and vehicular means (RoK, 2018). Residential attraction to the neighbourhood and mobility is affected by spatial distribution, accessibility, and quantity of facilities (Jia *et al.*, 2020).

2.2.4 Importance of Provision of Facilities in a Neighbourhood

Facilities within a neighbourhood enable the community to improve employment, education, and health levels as well as local social cohesion, hence promoting local sustainability (Gibberd, 2014). Availability and accessibility of social facilities improve residents' quality of life in both urban and rural areas (UN-Habitat, 2020b). The facility provision in a neighbourhood is essential and contributes to its social sustainability (Rani, 2013, 2014). Using the services and facilities within a residential neighbourhood helps to generate physical activity if it involves walking or cycling. In addition, using local neighbourhood facilities increases the opportunities for a meeting without planning and social interaction with the residents. Using local services also increases the use of streets and public spaces, further reinforcing that benefits increase activity in these spaces (Rani, 2013). Neighbourhood facilities are necessary to enhance the daily activity of residents. Residents will likely be dissatisfied if the neighbourhood facilities don't meet their needs (Pauzi *et al.*, 2017). Lack of facilities in a neighbourhood may lead to dissatisfaction among the residents (Muiga & Rukwaro, 2016). Infrastructure availability is one factor affecting the demand and choice of residential property because human beings are socioeconomic; hence, they usually seek to dwell in places with maximum facilities at affordable prices. Hence provision of facilities that would enrich the living conditions of people in a neighbourhood is essential (Yakubu *et al.*, 2019). A study conducted by Allen (2015) also supports the above statement. One of the main reasons people moved to new estates in urban areas was the proximity to a range of amenities and convenience made by the availability of these amenities and the ability to walk or use public transport (Allen, 2015). The neighbourhood's vibrancy can be determined by the number of facilities (Armin *et al.*, 2021). The availability of local facilities helps promote healthy lifestyles for children, especially when they walk and cycle. Retail and commercial facilities provide jobs locally in the neighbourhood (Barton *et al.*, 2006, 2021). Hence, community facilities are

significant components for planning a city; thus, they are important for city sustainability (Khan, 2020).

2.3.4 Neighbourhood Planning Standards in Kenya

The Physical Planning Handbook has a set of rules and guidelines to guide physical planning practices and processes in Kenya (PPD, 2007; RoK, 2024). The handbook recognizes an estate as a spatial unit; for example, residential quarters for workers should have amenities such as schools, green spaces, recreation, health, sanitation, and water facilities. Residential estates should have adequate basic community facilities; which streets should border. The service centre, which is the focal point of the estate, should be within walking distance from the perimeter. The average number of houses should be 100, and the estate's population should be able to support the services. The estate should have a standard housing design, entry and exit points, services, uniform design, and plot sizes. The neighbourhood, conversely, is defined as a common spatial unit with several estates, a socioeconomic identity, common facilities, and self-contained (PPD, 2007; RoK, 2024).

The handbooks also give the standards for various facilities regarding population catchment and plot sizes, as indicated in Table 2-1. Even though the standards are available, some are conflicting, such as plot sizes for primary schools and police stations. Also, the standards are inadequate since they did not provide all the standards for facilities; hence, it is hard to analyse the adequacy and accessibility of these facilities (PPD, 2007; RoK, 2024).

Table 2-1: Standards for facilities provision and accessibility in Kenya

Facility	Population catchment	Size (Ha)	Accessibility Distance (m)
Pre-primary	2,500	0.15-0.25	500
Primary school	5,000	3.9	500-2,000
Secondary school	8,000	3.4-4.5	500-3,000
Library	-	0.4	-
Community centre	20,000	1	-
Health centre	5,000	0.2	-
Police station	5,000	2-3	-
Market	5,000	0.2	-
Post office	2,000-10,000	0.1	-

Religious facility	-	0.1	-
Shopping centre	15,000	3	-
Local shops	100	0.045	-
Playground	1000	0.5	-
Police station		2	-
Social hall	20,000	0.25	-

Source : (PPD, 2007; RoK, 2024).

The handbook also specifies standards for subdivision and streets within the estate; for example, a street of 9 meters should be the access road, while a street width of 12 meters should be the secondary road. A footpath of about 2-4 m should be provided after every 8 plots. The cul de sac street should not exceed the length of 60 meters, should not serve more than 8 to 10 plots, and should have a radius of at least 15 meters. Fire extinguishers should be provided within a radius of 90m (RoK, 2024).

The 1948 Master Plan for Nairobi introduced neighborhood planning as a tool for functional urban organization. However, it was heavily shaped by colonial priorities of segregation and inequality. Its legacy continues to influence Nairobi's urban landscape today (Banyikwa, 1990).

National Urban Development Policy (NUDP) emphasizes promoting compact residential neighbourhoods for optimal use of land and infrastructure. The policy also emphasizes providing adequate public spaces and maintaining infrastructure in the neighbourhood. NUDP also advocates forming neighbourhood associations to foster public participation by the residents in issues affecting them. Promote compact residential neighbourhoods for optimal use of land and infrastructure (UDD, 2016).

2.3 Sustainable Neighbourhood

A sustainable neighbourhood is a place where there is a balance between work, housing, and social services for different socioeconomic groups (Armin *et al.*, 2021). A sustainable neighbourhood is an environment where residents want to live and work now and in the future (Anjali *et al.*, 2014). Sustainable neighbourhoods tend to exhibit high levels of walkability, a sense of place, social cohesion and stability, and neighbourhood resiliency amidst changing economic and socio-political conditions (Bahale & Schuetze, 2023). A

sustainable neighbourhood aims to meet the needs of present and future generations, create safety and balance between the neighbourhood's environmental, economic, and social components, and respect and accept the needs of other neighbourhoods on a larger scale (Armin *et al.*, 2021). The sustainable urban neighbourhood is achieved by combining principles of urban planning with the quality of life of neighbourhoods, resulting in a variety of housing and facilities well linked to services and jobs that are within walking distance, cycling lanes, and public transport, integrating economic prosperity; highlight good practice in design and local governance (Moroke *et al.*, 2020). Key features of sustainable neighbourhoods are integrated, compact, and connected (UN-Habitat, 2013). The principles of sustainable neighbourhood are high density, mixed land-use, adequate and efficient street network, social mix, and limited land-use specialization (Awad, 2019; Dehghanmongabadi *et al.*, 2014; Falk & Carley, 2012; UN-Habitat, 2015). Sustainability at the neighborhood level is required to operationalize sustainable development since the neighborhood is a primary unit of a city that works as a critical area for interaction among society, economy, and business (Ahmad, 2020). The character of sustainable neighbourhoods, including streets, buildings, workplaces, shops, and public spaces, should encourage physical activities since they benefit the community, the individual, and the environment (Mokhtar & ElDabosy, 2017).

2.3.1 Neighbourhood Sustainability Indicators

Indicators represent the characteristics of a given system, either as quantitative or qualitative variables, and are used in certification and accreditation schemes as standardized references to assess and monitor performance and progress for decision-making (Onyango & Adewumi, 2021). Sustainability indicators represent significant changes in the environment, social systems, economics, human wellbeing, and quality of life, hence measuring what is important to people (Alanbari *et al.*, 2014).

Good neighbourhood indicators show the community's goals and provide reliable data for policymakers and professionals to create policies and initiatives that directly address community priorities (Jozsa & Brown, 2005). Aspects considered in selecting sustainability indicators should be easily understood by the public, accurate and reliable, data available and consistent, relevant to policymakers, provide long-term changes, promote equitable

distribution of resources, reflect on community values, and be easier to implement (Alanbari *et al.*, 2014; Jozsa & Brown, 2005).

Various studies have applied sustainability indicators to identify sustainability levels in different neighbourhoods. A study done in Bragança, Portugal, identified indicators that could be applied at a neighbourhood scale through a literature review (Dos Santos *et al.*, 2017). After identification, the authors selected the indicators through a feasibility study, and the final selection process was through the identification of indicators that integrate principles of New Urbanism, New Urban Agenda, the Sustainable Development Goal 11, and the New Charter of Athens (Dos Santos *et al.*, 2017). This limitation is that some indicators are complex for residents to understand. Another study in Lagos, Nigeria, identified the indicators through qualitative information on perceptions and relative preferences for the suitability of various indicators from relevant stakeholders and residents (Onyango & Adewumi, 2021). The limitation of this study was that some indicators identified were difficult to measure, and the residents and stakeholders had conflicting ideas on the preference of some indicators. Another study done in Malaysia identified important indicators through the Delphi survey technique through the assessment of stakeholders (Suharto, 2012). The limitation of this study is that the researcher used a 75% cut-off point as a consensus technique to omit some relevant indicators. In contrast, if other consensus techniques, such as interquartile range, standard deviation, or group mean, had been used, some indicators would have been retained.

Establishing the target audience before selecting indicators is necessary since they influence the chosen indicators because distinct groups have different priorities and opinions of the most significant concerns (Jozsa & Brown, 2005). Good neighbourhood-level indicators show the community's goals and provide reliable data that policymakers and professionals may utilize to create policies and initiatives that directly address these priorities (Jozsa & Brown, 2005). When selecting sustainability indicators, the following aspects are essential to consider: indicators that are easily understood by the public, accurate and reliable, data availability and consistency, relevance to policymakers, provide long-term changes, promote equitable distribution of resources, reflect on community values and are easier to implement (Alanbari *et al.*, 2014; Jozsa & Brown, 2005).

Sustainability has three primary dimensions: economic, social, and environmental, which are integrated to be effective and balanced (Lin & Shih, 2018). Economic sustainability indicators enhance neighbourhood quality by using resources efficiently, ensuring economic capital is maintained, and human capital is utilized (Suharto, 2012). At the neighbourhood scale, economic sustainability includes the provision of jobs and opportunities, smart efficiency, and growing potential (Zhang *et al.*, 2020). Social sustainability ensures that development adheres to specific social relations, customs, and values while reducing social inequality, particularly in terms of social exclusion, social discontinuity, and destructive conflict, as well as providing a decent standard of living for current and future generations (Ahmed, 2013). At the neighborhood level, it involves social interaction, safety and security, the feeling of place, community stability, and membership in collective groups and networks in the neighborhood (Zhang *et al.*, 2020). The social indicators are those that are focused on the quality of life offered by each neighbourhood (Hilley & Sim, 2020). Environmental sustainability aims to increase human wellbeing by safeguarding the sources of raw materials utilized for human requirements and ensuring that human waste sinks are not overburdened to protect humans. It covers site and outdoor environment, street and transport, and energy efficiency at the neighbourhood scale (Zhang *et al.*, 2020).

Out of the 50 indicators (Table 2-2), 18 were selected to measure the sustainability of the three estates:

- Social indicators were satisfaction with the area, accessibility of educational facilities, access to emergency services, access to public transport facilities, access to open spaces, access to local services, and access to the community centre.
- Environmental indicators included open space, street intersection, population density, land use mix, external connectivity, impervious surface, and non-motorized transport (NMT) provision.
- Economic indicators were housing proximity to the workplace, affordability, diversity, and commercial establishment.

Table 2-2: Sustainability indicators compiled

	Indicators	Citation
Environmental	Open spaces, impervious surface, population density, intersection density, sidewalks and bike lanes, development footprint, proximity to water features, pedestrian space, green space, housing density, a mix of land use, road connectivity, pollution, vision, tolerable capacity, water use, energy use, waste recycling. Compact development, materials	(Armin <i>et al.</i> , 2021; Dos Santos <i>et al.</i> , 2017; Hilley & Sim, 2020; Martins <i>et al.</i> , 2021)
Social	Walkability, proximity to local facilities, public transport, access to parks, access to grocery stores, segregation, crime rate, identity and vitality, management, satisfaction, community stability, security and safety, mobility, community activity	(Ahmad, 2020; Dos Santos <i>et al.</i> , 2017; Hilley & Sim, 2020; Moroke <i>et al.</i> , 2020)
Economic	Unemployment, poverty, vacant housing, commute time, percentage of the population that is learned, affordable housing, access to jobs, local jobs, business activity, employment, a mix of housing types, economic vitality, human capital, house affordability, house diversity	(Ahmad, 2020; Hilley & Sim, 2020)

2.3.2 Importance of Indicators

Housing diversity refers to various housing that serves different residents or people (Aurbach, 2005; Chakraborty & Mcmillan, 2018; Suharto, 2012). The main reason for housing diversity is to make the neighbourhood vibrant by enabling the residents to have a wide variety of people in terms of household size, age groups, and different economic levels, as well as provide aesthetic preference for a variety of housing types in a neighbourhood (Aurbach, 2005; Chakraborty & Mcmillan, 2018).

The availability of local jobs provides sources of income for neighbourhoods and can contribute to the overall economic growth of a country (Bahale & Schuetze, 2023). A neighbourhood's economic resilience depends on the working residents' capacity and skilfulness to support the dependent population. The availability of jobs within the neighbourhood can lead to resilience (Bahale & Schuetze, 2023). Providing local jobs also helps boost the local economy, allowing residents to cycle or walk to the workplace, reducing their carbon footprint. Providing convenient employment opportunities for those who cannot drive helps improve air quality in the neighbourhood (Barton *et al.*, 2021;

Saville-smith *et al.*, 2005). Housing affordability is one of the key factors that can describe the socioeconomic stability of a country by stimulating economic development. Housing affordability aims to ensure the housing provided is affordable to every income-earner group, whether low-income, middle-income, or high-income group (Suhaida *et al.*, 2011). The provision of commercial establishments helps to boost the local economy, allows residents to cycle or walk, leading to a reduction of carbon footprint, and also provides employment opportunities for the residents and increases the vibrancy of the neighbourhood (Barton *et al.*, 2021; Saville-smith *et al.*, 2005).

Land use mix (LUM) is an essential indicator for neighbourhood walkability; it refers to the diversity of land uses within an area and is calculated by the entropy index (Jia *et al.*, 2021; Shi *et al.*, 2021). The purpose of mixed land use is to reduce the use of private cars, encourage pedestrian and cyclist traffic, and reduce landscape fragmentation (UN-Habitat, 2015). Population density measures people per unit area (UN, 2020). The benefits of population density include efficient land use, reduced car dependency and parking demand, increased support for public transport, Increased energy efficiency, and decreased pollution (UN-Habitat, 2015). Non-motorized transport (NMT) refers to providing walking and cycling facilities on the road (Mwangi *et al.*, 2021). The provision of NMT leads to improved accessibility, reduced congestion, reduced road fatalities, improved air quality, and reduced carbon emissions. It also promotes a healthy environment by minimizing the environmental impact of transportation (Mwangi *et al.*, 2021). Intersection density is an indicator that measures the ratio of the number of intersections in a neighbourhood (Molaei *et al.*, 2021). It shows how street networks within the neighbourhood are connected (Hilley & Sim, 2020). Intersections allow drivers to take shorter or more direct routes, hence using less fuel, leading to low air pollution (Hilley & Sim, 2020). External connection indicators measure how well a neighbourhood is connected to its surroundings (Aurbach, 2005; Suharto, 2012).

Open space is an essential component of urban planning and contributes significantly to urban sustainability. Open spaces have significant benefits in environmental services, enhanced biodiversity, health, creativity, mental growth in children, wellbeing, cultural growth, and social cohesion, and minimize mental stress and disorders (Mwaniki *et al.*, 2019). An impervious surface is any land surface that prevents water from infiltrating the

soil, which generates surface runoff that increases the risk and severity of floods, erosion, and decreased water quality in urban areas due to reduced soil filtering ability (Schmidt & Barron, 2020). Large impermeable surfaces cause higher runoff during storms and limit groundwater recharge (Sobieraj *et al.*, 2023). Knowing the distribution of impervious surfaces helps to analyze the impacts of urbanization on hydrologic processes and water quality (Sobieraj *et al.*, 2023). Emergency services refer to providing facilities such as fire stations, police stations, and health facilities (NCC, 2018; Suharto, 2012). The rationality for providing emergency services is the need for specialized staff and equipment to manage all contingencies or disasters that might occur within a neighbourhood (Barton *et al.*, 2021). Neighbourhoods must be comprehensive in satisfying the current needs of the residents. The neighbourhood should have an appealing environment and be safe, convenient, well-planned, and user-friendly; this directly affects the neighbourhood experience for residents. Therefore, the residents' satisfaction level is adequate proof of a neighbourhood (Wijesundara *et al.*, 2021). Accessibility of facilities is essential as it enables better access to educational, economic, social, and cultural opportunities and promotes active transport with reduced private transport use and safer streets (Salazar & Menéndez, 2007; Barton *et al.*, 2021; Jenks & Dempsey, 2005). Accessible public transport provides better connectivity between people and locations, which decreases the congestion on roads (Saif *et al.*, 2018) and encourages more sustainable travel patterns that are safe with less energy consumption, noise, and air pollution (Martins *et al.*, 2021) as well as improving accessibility to other services (Saif *et al.*, 2018).

2.3.3 Weighting, Normalization, and Aggregation

Weighting and aggregation are critical in developing the Sustainability Index because they transmit sustainability information from variables to sub-indicators and indices. There are different methods for aggregating and weighing; each method has its benefits and disadvantages (Gan *et al.*, 2017). The weight of an indicator provides information about its relative importance to other indicators in contributing to a specific output or a desired state. The weight of an indicator indicates its relative importance to other indicators in contributing to a particular output or desired condition (Adewumi *et al.*, 2023). Assigning weight to indicators is critical because weighting reflects the relative importance given to

each indicator (Bahadure & Kotharkar, 2015). There are various weighting methods, ranging from equal weighting, arbitrary weighting, analytic hierarchy process (AHP), principal components analysis (PCA), factor analysis (FA), benefit of doubt (BOD), budget allocation (BAL), and public opinion (EU, 2008; Gan *et al.*, 2017; Zhou & Zhang, 2018). Equal weighting is a method where all the indicators are considered equally important due to a lack of statistical or empirical evidence. It is simple and straightforward (Gan *et al.*, 2017; Zhou & Zhang, 2018). Using the linear transformation technique, PCA minimizes data dimensionality while preserving substantial information. This method is appropriate when you have many indicators, and the weights may not correlate to the relative importance of dimensions in the real world. Hence, this method can be invalid for sustainability evaluation (Gan *et al.*, 2017). BOD is a data envelopment analysis (DEA) application in which indicator weights are revealed by the relative performance of a set of indicators, with more beneficial indicators assigned higher weights and less beneficial indicators assigned lower weights. The incomparability of different outcomes and insufficient transparency may inconvenience this strategy (EU, 2008; Gan *et al.*, 2017). BAL, also known as expert opinion, is a participatory method where experts are given a budget as points to allocate over the indicators. The essential indicators get more pay from the experts (EU, 2008; Gan *et al.*, 2017). However, weights based on this method may be obscure or misleading, as weight may measure the urgency or need for political intervention instead of importance. The weights may not be transferable from one region to another because they may reflect specific local conditions (Gan *et al.*, 2017). AHP is a structured technique for multiple criteria decision-making based on pairwise comparisons of alternative elements (Gan *et al.*, 2017). AHP is simple and flexible; hence, it can be combined with other techniques. However, it requires many pairwise comparisons, and the results depend on the chosen evaluators (Gan *et al.*, 2017).

Normalization is converting different indicator units into a standard and comparable scale (Bahadure & Kotharkar, 2015) to increase the comparability of sustainability data and results. Normalization is usually followed by weighting when the relative importance of indicators or impact categories is needed (Ahmad *et al.*, 2019). If one indicator is more "important" than another, the former is assigned a higher weight than the other. Normalization and weighting processes are challenging and complex but crucial for more

precise and standardized sustainability assessment (Ahmad *et al.*, 2019). Normalization and weighting substantially make sustainability assessment more accurate and standardized (Ahmad *et al.*, 2019). Various normalization techniques can be employed in sustainability assessment: ranking, distance to target, Z-score, and min-max (Pollesch & Dale, 2016; Talukder *et al.*, 2017; Zhou & Zhang, 2018). Each technique has its advantages and disadvantages (Table 2-3), and they impact sustainability measurements. Hence, the researcher should consider the suitable one.

Table 2-3: Advantages and disadvantages of normalization techniques

Technique	Advantage	Disadvantage
Ranking	It is simple	Cannot lead to any conclusion
Distance to target normalization	Results are easy to handle and understand	The imbalance between scores and ranks remains Outliers may influence results
Z score	Individual scores can be directly compared It provides no distortion from the mean	Minimum and maximum values are not influential
Min-Max	All indicators can have the same range (0- 1) (1-5)	Difference Variance is not eliminated The maximum and minimum values can influence the final output

Source: (Talukder *et al.*, 2017).

Various normalization and weighting techniques have been used to determine sustainability levels. It is important to note that weighting of the indicators is not done when the indicators used are from the same category, for example, social indicators (Bahadure & Kotharkar, 2012; Njeri *et al.*, 2023). Normalization techniques are not applied when various indicators measured are of the same units. A study done in Malaysia used the categorical normalization technique (Suharto, 2012; Yigitcanlar *et al.*, 2015). In this research, the indicator score was transformed into a scale of one to five. Indicator values of less than 30% were normalized to a value of 1, those between 30% to 50% were normalized value of 2, between 50% to 70% were normalized as 3, between 70% to 90% were normalized as 4, and values of over 90% were 5. The weighting technique used was based on the budget allocation technique. The weighted sum aggregation method was used to calculate the overall sustainability level of each case study (Suharto, 2012; Yigitcanlar *et al.*, 2015).

Another study in India used normalization based on a five-point scale, with an equal weighting technique adopted since diversified indicators were present. Still, it wasn't easy to judge which indicator was better than the other (Bahadure & Kotharkar, 2015). Kamble & Bahadur (2022) also used a categorical scale of 1-5 to represent the sustainability of the study areas, with indicator weights obtained through an expert opinion survey and analysed by the AHP tool.

Aggregation methods vary; the commonly applied aggregation options include additive aggregation (arithmetic mean), geometric aggregation GME (multiplication), and multi-criteria analysis (Talukder *et al.*, 2017). Aggregation implies the search for an appropriate function that can incorporate multiple indicators into a single composite indicator (Zhou & Zhang, 2018). The additive aggregation method is used when all indicators have the same measurement unit. Geometric aggregation is better suited if the modeller wants non-compensability between different indicators (Gan *et al.*, 2017). Additive aggregation is widely used since it is simple, transparent, and easy to understand. An undesirable feature of this method is its compensability; specifically, the low performances of some indicators can be compensated by the sufficiently high values of other indicators. Thus, in this way, the composite sustainability index will not entirely reflect any information about its indicators (Gan *et al.*, 2017). The limitations of the additive method can be partially overcome by using GME; additive aggregation is calculated as: $CSI = \sum_j I_{s_{j,t}} \times w_j$ Where w_j is the weight of the group of sustainability indicator (sub-indices) j and $I_{s_{j,t}}$ is sustainable sub-indices for a group of indicator j in a neighbourhood t . The additive aggregation method employs functions that add up the normalized values of sub-indicators to form a sustainability index. The most common additive method is the weighted arithmetic mean (Gan *et al.*, 2017). Geometric aggregation is recommended when non-comparable and strictly positive sub-indicators are presented in different ratio scales (Zhou *et al.*, 2012). Geometric aggregation is calculated as a product of the normalized individual indicators as a power of their weights: $CSI = \prod_j (I_{s_{j,t}})^{w_j}$ where w_j is the weight of the group of sustainability indicator (sub-indices) j and $I_{s_{j,t}}$ is sustainable sub-indices for a group of indicator j in a neighbourhood t (Gan *et al.*, 2017; Talukder *et al.*, 2017; Zhou *et al.*, 2012) low performance in any indicator is directly reflected in the composite indicator's

value. This technique is partly compensable since it rewards composite indicators with higher indicator scores. Multi-criteria analysis (MCA) is used to aggregate non-compensatory data. MCA generally provides an overall ranking based on the weight and values of given indicators. One of the limitations of MCA is that when the number of indicators to develop composite indicators is high, it is challenging to compute MCA (Talukder *et al.*, 2017). Data can be aggregated without being scaled if all the variables are measured with the same units (Talukder *et al.*, 2017).

2.4 Residential Preference

Residential preference refers to residents' choices regarding housing type, price and quality, neighbourhood characteristics, and accessibility to services and facilities (Fattah *et al.*, 2018). Residential preferences can be categorized into stated or revealed preferences. Stated preferences are the qualities of a residential environment that residents prefer to live in. Revealed preferences are the choices residents make, causing them to live in that residential environment (Akinbamide & Adegoke, 2022; Li *et al.*, 2019; Vasanen, 2012). These can represent priorities recent residents who have moved consider when looking for a place to live. It can be why long-term residents continue to live in their residential neighbourhood (Li *et al.*, 2019).

When choosing a residential place, residents can make two choices based on the type of house and the type of environment, which is guided by preference and restricted by income (Jabareen, 2005). Residential preferences, such as location closer to the workplace, availability of facilities such as education, health, or commercial (Alago *et al.*, 2019), and affordability (Owoicho & Ogwuche, 2018) can contribute to a decision residents can make when choosing a residential location. Being familiar with the residential environment can also be a factor, as the person has grown up in the area, has adopted the lifestyle, or is emotionally attached to the place (Owoicho & Ogwuche, 2018). Conditions such as an increase in rental houses and insecurity, on the other hand, can reduce the value and cost of the houses (Alago *et al.*, 2019), leading to residents moving out of the area.

Many studies have identified Socioeconomic and demographic variables as primary determinants of residential preferences. Demographic variables influence residential preferences in that when the size and composition of a household change, residential

preferences may change as well (Hasanzadeh *et al.*, 2019); for example, single and childless households can reside in the city, whereas households with children can change from city to a suburban location (Jansen, 2020). When the income and education of a household increase, the household tends to choose a more integrated residential environment (Hasanzadeh *et al.*, 2019), whereby preference for a low-density area is associated with high housing status and is considered attractive (Vasanen, 2012). Socioeconomic factors such as household income, age, and education level influenced housing preference, according to a study done in Shauri Moyo, Kenya (Kipngeno, 2014). Another study in South Western Nigeria found that the households' socioeconomic status was the most significant factor in residential preference (Olayiwola & Adeyemi, 2019). Older residents are likely to prefer smaller homes with easy access to services, which results in a preference for denser houses in walkable neighbourhoods (Jansen, 2020). Attitude, socioeconomic characteristics, and awareness of environmental matters can determine household preference for a residential location. A household's choice to settle in an area can be based on neighbourhood characteristics, socio-demographic factors, access, and proximity to jobs and facilities (Cockx & Canters, 2020).

Neighbourhood planning aims to improve the quality of life in residential areas. Planners have focused on income, demographics, job opportunities, and social objectives such as participation, diversity, and affordable housing. These factors are significant since they promote the welfare of the residents. Nonetheless, neighborhood plans are frequently put forth without a thorough grasp of the social dynamics at play in the neighborhood (Duggan, 2007).

2.5 Research Gap

Prior studies in Nairobi focused on assessing urban neighbourhood sustainability by examining indicators of the sustainable neighbourhood in Ngara estate (Maiyo, 2020). Another study focused on giving insight into household and neighbourhood preferences in low-income areas, which was Shauri Moyo (Kipngeno, 2014). The gaps identified include the lack of studies showing the use of indicators in assessing neighbourhood sustainability levels in Kenya (Maiyo, 2020). No comparative study has been made in Kenya to show residential preferences in low, medium, and high-income neighbourhoods (Kipngeno, 2014). Various studies are done to assess facility adequacy

for urban planning studios or at urban levels (Geodev, 2015; Miri *et al.*, 2020; RPC & NCC, 2019). Various studies have assessed facility accessibility through distribution in Hong Kong and Japan (Kataoka, 2020; Lang *et al.*, 2018; Lotfi & Javad, 2009); others studies are on the walking behaviour of residents to community facilities, perceptions of residents towards accessibility of community facilities in Putrajaya (Azmi *et al.*, 2013; Azmi & Karim, 2012). Assessments of accessibility of amenities in Africa have been on health facilities (Amer, 2007; Campbell *et al.*, 2019; Falchetta, Hammad and Shayegh, 2020; Kanyangarara *et al.*, 2021; Bihin, Longueville and Linard, 2022; Nadella *et al.*, 2022), public and non-motorised transport (Olvera, Plat and Pochet, 2013; Campbell *et al.*, 2019; Mboup, 2019; Oviedo *et al.*, 2022; Cobbinah and Finn, 2024), and job accessibility (Venter, Vokolkova and Michalek, 2007; Peralta-Quiros, Kerzhner and Avner, 2019). No study has been done in Kenya to assess the accessibility of facilities in high, medium and low density neighbourhoods. This research, therefore, examines the adequacy of facilities and assesses the sustainability level and residential preference of high, medium, and low-density neighbourhoods.

3 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter will focus on the study area, research design, sampling techniques, data collection method, and data analysis.

3.2 Study Area

Nairobi is the capital and commercial city of Kenya. The major land use of Nairobi is residential area, which covers about 25% of the total land use (NCC, 2018). Nairobi has four categories of residential neighbourhoods: low, medium, and high (RoK, 2024), which are distinguished by density, quality of environment, and economic level (Banyikwa, 1990). This research was based on three neighbourhoods (Figure 3-1) with different densities: Buruburu (medium), Garden (low), and Zimmerman (high). Buruburu estate occupies about 221Ha of land, developed in five phases and located between latitude 1.27°S to 1.29°S and longitude 36.87°E to 36.88°E. The estate was planned in 1971 as a medium density based on the neighbourhood concept. Due to the increase in population, the original design of the estate has been compromised due to informality whereby the homeowners constructed extensions after mortgage payments to get more income. This extension has led to challenges such as inadequate facilities and services. The current population is about 19,999 (KNBS, 2019), with most residents being middle-income earners. The estate has 4924 residential plots with an average size of 185m². The estate was planned for about 5,000 households.

Zimmerman is a residential estate along Thika Super Highway located between latitude 1.20°S to 1.22°S and longitude 36.91°E to 36.88°E. The estate was developed informally and currently is a high-density, low-income with a population of 49,533 (KNBS, 2019). The estate has 1402 residential plots with an average size of 373m².

Garden Estate is a low-density, high-income neighbourhood located between latitude 1.23°S to 1.21°S and longitude 36.84°E to 36.86°E. It is approximately 9km from the Nairobi Central Business Centre (CBD) and is assumed not to have changed significantly over time since its development. The estate has 794 plots with an average size of 2455m² and a population of 19,201 (KNBS, 2019).

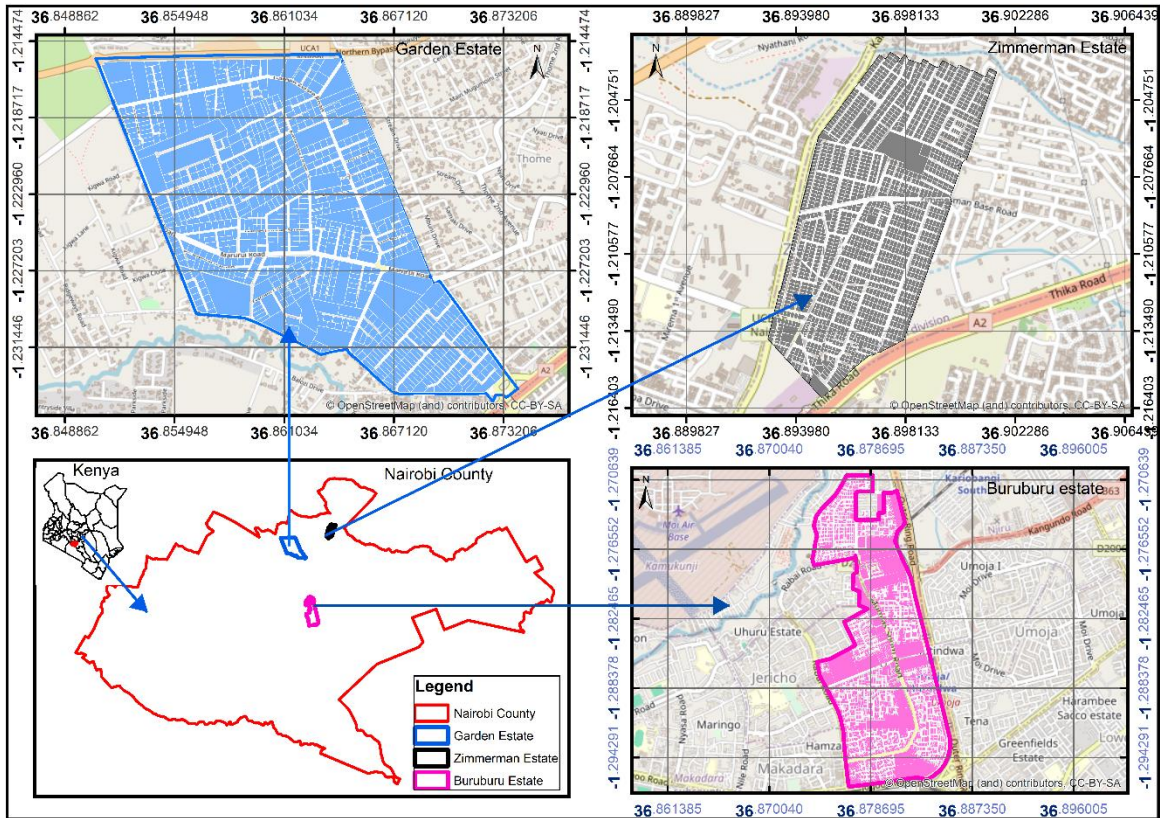


Figure 3-1: Location of the three neighbourhoods in Nairobi, Kenya

3.3 Research Design

The research is based on case study analysis utilising an embedded research design. An embedded research design involves inserting one dataset within the other so that the datasets can support each other. This design is suitable for assessing the sustainability of case studies since it provides a richer context and offers more validity and reliability to the findings (Alasmari, 2020). The case study design was used since it allows for the collection of a variety of data ranging from quantitative data techniques such as questionnaires and qualitative data techniques such as interviews and observations (Creswell, 2014). Case study design lacks scientific rigor, hence providing biased views for generalization, and it is difficult and lengthy to conduct (Zainal, 2007). Still, despite its weakness, it is suitable since three case studies were used, providing an in-depth understanding of the research problem (Crowe et al., 2011) on how density affects sustainability.

3.4 Sample Size and Sampling Procedure

Cochran's formula was used to calculate the sample size (Cochran, 1977). The target population for this study was the households. They were used as the representatives of the whole population of the study area (Phrasisombath, 2009). The sampling units are the households; hence, the sample size was calculated using the households. This formula was used since we know the population size and population proportion. The formula was applied as shown:

$$n = \frac{p(1-p)}{\frac{e^2}{z^2} + \frac{p(1-p)}{N}} \dots\dots\dots \text{Equation 1}$$

n is the sample size, e is the acceptable sampling error (0.05), p is the population proportion 10% (0.1), and z is the reliability level or significance level value. z=1.96 if the significance level is 0.05 at a 95% reliability level and N is Population. Buruburu estate had 6,174 households, Zimmerman had 18,934, and Garden estate had 5,481 (KNBS, 2019). Applying equation 1 gave a sample size of 135 for Buruburu, 137 for Zimmerman, and 134 for Garden estate, giving 406 households, but only 268 responded (Table 3-1).

Primary data was based on the households (Table 3-1). The number of households used was obtained from the 2019 Census (KNBS, 2019). Household questionnaire distribution was done using systematic sampling in Buruburu, simple random sampling in Zimmerman, and an online survey in Garden Estate. Garden estate association does not allow entry into resident's houses. For Garden estate, the method used was an online survey. Due to the nature of the estate, one is not allowed to enter residents' houses. This was the best method that could be used in the area, even though the response rate is usually low. The researcher used a sample of techniques, as stated by Nulty (2008), such as extending the survey's duration, making the questions brief, and providing frequent reminders to get more responses from the online survey.

Sampling methods used include purposive, systematic, and simple random sampling. Purposive sampling is a method whereby the researcher samples with a purpose in mind to reach the targeted sample (Teddlie & Yu, 2007). Purposive sampling was used to administer interview schedules for Nairobi City County planners, residential neighbourhood association leaders, and community leaders. Systematic random sampling

was used to distribute the questionnaires in Buruburu since it was planned. The first household was selected randomly, and a fixed number selected the remaining units of the sample; for the Zimmerman estate, simple random sampling was used since the area is of high density. Every household had the same probability of being selected (Taherdoost, 2016). Collecting data through this method is easier as minimal knowledge of the population is required (Acharya et al., 2013).

Table 3-1: Distribution of household questionnaires in the three estates

Estate	Number of households	Sample size	Administered	Response rate
Buruburu	6,174	135	125	93%
Zimmerman	18,934	137	83	61%
Garden	5,481	134	60	44%

3.5 Data Collection

3.5.1 Nature and Sources of Data

The sources of data for this study were secondary and primary data. Secondary data was obtained from the Registry Index maps (RIM) multispectral imagery and the census report. The sources of data for this study were secondary and primary data. Secondary data was obtained from the Registry Index maps (RIM), multispectral imagery, and census reports. The RIMs were instrumental in obtaining subdivision plans for the three estates, which were subsequently used for sustainability assessment and to extract data for spatial analysis. Multispectral imagery was used for impervious surface analysis due to its resolution. Primary data was obtained from questionnaires, interview schedules, and checklists. The questionnaire contained closed and open-ended questions to obtain qualitative and quantitative data (Appendix I). An interview schedule from the key informants was conducted to gather information on the estates' planning, design, management, facility provision, and land use. Interview schedules were conducted with Roysambu Physical

Planner, GARRA, Roysambu Housing Cooperative Society, and community leaders (Appendix II). The checklist was used to identify the type and number of facilities and business types (Appendix III).

Primary data on the adequacy of facilities was collected through a household questionnaire (Appendix I) and a checklist (Appendix III), while secondary data was obtained from the Survey of Kenya in the form of Registry Index Maps (RIM) and census data from the Kenya National Bureau of Statistics (2019). A GPS (Geographic Positioning System) gadget was used to collect the coordinates of the facilities, and a checklist was used to identify the type and number of facilities.

Sustainability assessment data was acquired from RIM, multispectral image, questionnaire, interview schedule, and checklist. RIM was used for spatial analysis of facility accessibility, while multispectral imagery was used for remote sensing of impervious surface maps. Multispectral imagery was used because it was clear.

Residential preference data was also acquired through a questionnaire. The questionnaire entailed factors residents consider important in a residential area. The factors that were assessed in this study were related to sustainability indicators to know the residents' views. The factors were safety and security, availability of open spaces, proximity to workplace, provision of facilities, housing of various prices, accessibility, land use diversity, availability of local employment, and easy accessibility to services. Only nine factors were employed since they provided a comprehensive view of the people and ensured a more efficient and straightforward evaluation because they were easier to understand. The respondents were asked to rate the importance they attached to the above factors when they chose a residential area. The rating of the factors was based on a Likert scale of five, with five representing very important and one not important.

3.6 Data Analysis

Data from the RIM, multispectral images, and GPS were analysed using Geographic Information System (GIS) ArcMap 10.8 software, while Statistical Package for Social

Science (SPSS) software version 22 was used for statistical analysis of the questionnaire data.

3.6.1 Adequacy of Facilities

The adequacy of facilities was examined based on population catchment and accessibility. This was done first by identifying the facilities available in the study area. The type of facilities assessed were based on the Physical Planning Handbook of Kenya, Urban Planning for City Leaders and Neighbourhood Unit Concept (Perry, 1929; RoK, 2024; UN-Habitat & RoK, 2018). The facilities were open spaces, educational and training facilities, shops, places of worship, a library, a shopping centre, a health facility, a social hall, a police post, bus stations and banking institutions. The adequacy of facilities was evaluated using population catchment as stipulated in the Physical Planning Handbook of Kenya (PPD, 2007; RoK, 2024), while WHO standards were used for open spaces provision (WHO, 2016). The estate population was acquired from the 2019 census, where Buruburu had 19,999, Garden Estate 19,201, and Zimmerman 49,533 (KNBS, 2019). A minimum of 9m² of green open space per resident (UN-Habitat, 2023; WHO, 2016) was used as the accessibility threshold. Adequate amenities are those with the required amenities to serve the residents. A primary school, a health centre and a police station should serve a population catchment of 5,000 people (neighbourhood). A secondary school should serve a population of 8000, while a library and social hall should serve a population of 20,000.

Accessibility was analysed in terms of planning standards in Table 3-2, mode of transport and Kernel density (Equation 2). Spatial accessibility was determined by distance and location using ArcGIS. Using a near analysis tool determined the distance of facilities from residential plots. The near tool calculates the distance from each facility to the nearest residential dwelling. The input data coordinate system WGS 1984 UTM zone 37°S was used to ensure distance accuracy. The near tool uses a straight line to generate the distance between the features. A straight line was used because it is a good measure of spatial accessibility (Rahman & Neema, 2015), and the total number of facilities per type was used to determine general accessibility. This was then measured by determining the percentage of residential plots located from the facility using the recommended distances by the World

Health Organization (WHO), Rwanda Planning Codes, and Kenyan Physical Planning Standards in Table 3-2 (Barton et al., 2021; PPD, 2007; RoK, 2024; RoR, 2015).

Table 3-2: Accessibility standards for neighbourhood facilities

Type of facility	WHO standards	Rwanda standards	Kenyan standards
	Distance from the furthest dwelling plot in meters	Distance from the furthest dwelling plot in meters	Distance from the furthest dwelling plot in meters
Day-care	-	500	-
Nurse school	400-600	500	500-2000
Primary school	500-800	1000	-
Playground & park	400	500	500
Health centre	800-1200	500	-
Library	-	2000	-
Shopping centre	600-1000	-	-
Social hall	500-800	500	-
Religious	-	5000	-
Senior secondary	700-1500	2000	500-3000
Public transit	200-400	500	-
Corner shop	300-500	500	-
Supermarket	1200-2000	-	-
Post office	600-800	2000	-
Market	-	1000	-
Source:	(Barton et al., 2003, 2021)	(RoR, 2015)	(RoK, 2024)

Different countries have different standards for accessibility for various facilities, but this research was based on computing the level of accessibility of facilities using WHO standards and Rwanda standards since the Kenyan planning standards lack some standards for local facilities that should be provided within a neighbourhood.

Kernel density was calculated using Equation 2 (Silverman, 2003) multiplied by the number of facilities in the area. It was used to show the spatial distribution and location of facilities in the neighbourhood, with facilities closer to each other given a greater value. The higher the density, the more clustered the facilities, while a lower density depicts a scattering of facilities. Kernel density has been used in other studies to show the ratio of

population to facility of health facilities (Xu et al., 2023) and distribution of facilities (Spencer & Angeles, 2007).

$$\text{Kernel density} = \frac{1}{(\text{Radius})^2} \sum_{i=1}^n \left[\frac{3}{\pi} \cdot \text{pop}_i \left(\left(1 - \frac{\text{dist}_i}{\text{radius}} \right)^2 \right)^2 \right] \dots \dots \dots \text{Equation 2}$$

where $i=1$ and n are the facilities, pop_i is the total number of facilities, and dist_i is the distance between the facilities and their coordinates.

3.6.2 Sustainability Assessment

Sustainability indicators were used to assess the sustainability level of the neighbourhood based on spatial data analysed using GIS ArcGIS 10.8 software and questionnaire data analysed using Statistical Package for Social Science (SPSS) software version 22. The indicators were computed through quantitative analysis (Table 3-6). Reference values were used to interpret the indicator values.

The impervious surface classification was done using ArcMap10.8 on the multispectral image using supervised image classification after selecting training classes. Supervised classification was used since the spectral signatures obtained from training samples were used to classify images. Supervised classification is used to quantitatively analyse remote sensing data (Rwanga & Ndambuki, 2017). The image was first classified into broad land use types such as vegetation, built-up area, bare land, tarmacked area, and swimming pool. A swimming pool was used since the area lacked some water bodies, and swimming pools are man-made features. Impervious surfaces are man-made features such as buildings, roads, parking areas, and swimming pools, while pervious surfaces are areas with vegetation cover and bare grounds. After classification, an accuracy assessment was done to assess the performance and quantify the accuracy of the classified image. Full accuracy assessment was done by determining overall user and producer accuracy to get the kappa coefficient. Stratified random sampling was used to distribute the accuracy assessment points where each class had the number of points relative to its area to avoid bias. A total of 115, 111 and 105 accuracy assessment points were located on the classified images in Garden, Buruburu, and Zimmerman estates, respectively. Accuracy assessment aims to

quantitatively assess how effectively the pixels were sampled into the correct land cover classes (Rwanga & Ndambuki, 2017). The emphasis for accuracy assessment pixel selection was on areas that could be identified on Google Maps. KAPPA analysis/confusion matrix is a distinct technique used to accurately assess land cover maps (Landis & Koch, 1977; Rwanga & Ndambuki, 2017). The analysis was computed using Equation 3:

$$K = \frac{N \cdot \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_i + Xx_{+i})}{N^2 - \sum_{i=1}^r (x_{ii} Xx_{+i})} \dots\dots\dots \text{Equation 3}$$

Where: r = number of rows and columns in error matrix , N = a total number of observations (pixels) , x_{ii} = observation in row *i* and column *I*, x_i = marginal total of row *I*, and x_{+i} = marginal total of column *I* (Rwanga & Ndambuki, 2017; Shao et al., 2016). Table 3-3 was used to interpret the kappa coefficient.

Table 3-3: Kappa coefficient rating criteria

No	Kappa statistics	Rating
1	< 0.00	Poor
2	0.00-.0.20	Slight
3	0.21-0.40	Fair
4	0.41-0.60	Moderate
5	0.61-0.80	Good
6	0.81-1.00	Very good

Source: (Landis & Koch, 1977; Rwanga & Ndambuki, 2017)

The kappa coefficient results (Table 3-4) indicate that Garden estate had 0.61 (classification was good), Buruburu had a value 0.62 (classification was good), and Zimmerman the value was 0.62 (classification was also good).

Table 3-4: Overall accuracy assessment of impervious surface classification in the Garden, Buruburu, Zimmerman estates

Land use classes		Vegetation			Tarmacked area			Swimming pool			Built up area			Bare ground			Total User			User accuracy (%)			Producer accuracy			
Estate		G	B	Z	G	B	Z	G	B	Z	G	B	Z	G	B	Z	G	B	Z	G	B	Z	G	B	Z	
Vegetation	G	59			1			0			3			0			63			94			98			
	B		15			2			0			0			0			17			88			94		
	Z			11			4			0			0			2			17			65			85	
Tarmacked area	G	0			7			0			2			1			10			70			35			
	B	-	1	-		7			0			4			2			14			50			41		
	Z			2			49			0			1			5			57			86			83	
Swimming pool	G	1			1			5			3			0			10			50			100			
	B		0			0			10			0			0			10			100			100		
	Z			0			0			0			0			0			0			0			0	
Built up area	G	0			11			0			8			3			22			36			42			
	B		0			2			0			16			2			20			80			50		
	Z			0			4			0			12			5			21			57			92	
Bare ground	G	0			0			0			3			7			10			70			64			
	B		0			6			0			12			32			50			64			89		
	Z			0				2	0			0			8			10			80			40		
Total producer	G	60			20			5			19			11			115									
	B		16			17			10			32			36			111								
	Z			13			59			0			13			20			105							
Overall accuracy	G	75% Kappa =0.6152																								
	B	72% Kappa= 0.628843																								
	Z	76% Kappa =0.623																								

Key: G= Garden estate, B= Buruburu estate, Z= Zimmerman estate

Intersection density was determined by use of the intersection tool in ArcGIS. The roads were digitized as line features. Street node points were created on locations where two or three or more roads meet. Nodes are intersections or the end of a cul-de-sac (Berrigan et al., 2010; Dill, 2004). Dead-end nodes were excluded. Only real nodes were considered. Real nodes are intersections of two/three roads, while dead-end nodes are the end of the roads or cul de sacs (Berrigan et al., 2010). In this indicator, a higher ratio indicates more intersections that lead to more area connectivity, hence high sustainability. This indicator was calculated using Equation 4 adapted from (Aurbach, 2005; Molaei et al., 2021).

$$\text{Intersection density} = \frac{\text{Intersections}}{\text{Area of the neighborhood}} \dots\dots\dots \text{Equation 4}$$

External connectivity was determined by use of ArcGIS; this indicator measures how well a neighbourhood is connected to its surroundings. The boundaries of the estates were digitized as polygons and considered as the neighbourhood’s perimeter. The entry/exit points were points on the boundary where the road network of the neighbourhood connects with the other road network of the surrounding areas (Aurbach, 2005; Suharto, 2012). This indicator was calculated using the Equation 5 adopted from (Aurbach, 2005; Henry et al., 2021)

$$\text{External connections} = \frac{\text{Perimeter of the neighbourhood}}{\text{Number of entry and exit points}} \dots\dots\dots \text{Equation 5}$$

Density was measured as population divided by the area of the neighbourhood (Table 3-6). The area of the neighbourhood was determined by ArcGIS. Population used was adopted from 2019 census.

Land use mix was determined by ArcGIS. Land uses were categorized into seven different types, residential, public purpose, commercial, educational, transport, public utility and recreation, where:

- All plots with shops, supermarket, and buildings with retail shops, petrol stations, hotels, offices, banks were considered as commercial,
- Schools and colleges were considered as educational,

- Religious institutions, health facilities, police station, library and community halls were classified as public purpose,
- Playgrounds and open spaces were considered as recreational,
- Parking spaces were considered as transport, and
- Electricity substations were considered as public utilities.

Roads and streets were excluded since they are automatic in an area. Other researchers have also excluded specific land uses from land-use mix measures (Im & Choi, 2019; Mavoa et al., 2018; UN, 2020; Zandieh et al., 2017).

Land-use mix is an important measure of land use diversity within an area. Land use mix was calculated using the Shannon-Wiener index (Equation 6), which is a commonly used indicator for land-use diversity (Im & Choi, 2019).

$$H' = - \sum_{i=1}^N P_i \times \log_2 P_i \dots\dots\dots \text{Equation 6}$$

Where: N is the number of different types of land type use; P_i is the share of each land use within the neighbourhood divided by the total area (calculated as the percentage of each land use category); and $\log_2 P_i$ is the logarithm of the percentage of each land use category (Iannillo & Fasolino, 2021). The index value should range between 0 and 1. A score of 0 corresponds to a condition of minimum diversity of land uses, for which there will be a single land use for the neighbourhood, while a score of 1 corresponds to a condition of maximum variety of land use is distributed evenly (Iannillo & Fasolino, 2021; Im & Choi, 2019).

Emergency services assessment was determined by accessibility of facilities such as fire station, police station and health facilities. Response time was the main indicator used for assessing emergency services accessibility. The average distance for police station and health facilities was determined by use of near analysis tool.

Spatial accessibility was determined by distance using ArcGIS where the distance of facilities from residential plots was determined by the use of near analysis tool. To ensure distance measurement accuracy, input data coordinate system WGS 1984 UTM zone 37°S was used. A straight line was used because it is a good measure of spatial accessibility

(Rahman & Neema, 2015), with the total number of facilities per type was used to determine general accessibility. Accessibility was measured by determining the percentage of residential plots located from the facility using sustainability distances in Table 3-5, the standards were adopted from World Health Organization (WHO), Rwanda Planning Codes and Kenya Physical Planning Standards (Barton et al., 2021; RoK, 2024; RoR, 2015). These standards were used since the planning standards for Kenya lack sustainability standards for accessibility of local facilities. The standards were adopted by considering the Kenyan local context regarding density and population thresholds needed for the facility.

Table 3-5: Sustainability standards for accessibility of various facilities

Facility	Accessibility Standards	Citation
Public transport	500m	(RoR, 2015)
Schools	3000m	(RoK, 2024)
Community centre	800m	(Barton et al., 2021)
Open spaces	400m	(UN-Habitat, 2023)
Local services	500m	(Barton et al., 2021)

17 variables were used to measure neighbourhood satisfaction assessed using Likert scale of 1-5 and the average mean of the 17 variables used to determine the satisfaction level: 1.0-2.0 (dissatisfied), 2.1-3.0 (least satisfied), 3.1-4.0 (satisfied), and 4.1-5.0 (very satisfied). Kruskal-Wallis Test was used to test if the satisfaction level between the three estates was significantly different since the data was non-parametric.

Housing affordability was measured by the use of a questionnaire. The respondents, both house owners and those who rent, were asked to rate housing affordability using the income ratio method, which defines a percentage of housing cost to income ratio in assessing the housing consumption ability of residents (Ikenna & Hoskara, 2019). This variable fails to account for the cost of living and other living expenses that range within different housing markets and actual financial constraints the households face (Herbert et al., 2018; Ikenna & Hoskara, 2019). Despite its weakness, this method was used since it is easy to apply and

globally accepted. It can be applied in many areas to study household differences and affordability trends over time (Ikenna & Hoskara, 2019). The National Housing Policy stipulates that an affordable house does not cost more than 30% of the monthly household income when renting or buying (RoK, 2016). Those respondents who were paying rent of less than 30% of their income were considered affordable, while Buruburu and Garden estate house owners who bought or acquired houses by mortgage and paid with less than 30% of their income were also regarded as affordable.

The use of the checklist determined commercial establishments. All business types were categorized into seven types: general, business, transport, finance and communication services, accommodation and catering, technical and financial business, private education, health and entertainment business, small traders, industries, factories, and workshops. This categorization of business was adopted from the Nairobi City County Trade License Act (RoK, 2019). Transport and communication services entail driving schools, ATMs (Automatic Teller Machine), mobile banking agents, and petrol stations. Accommodation and catering services entail businesses such as lodging and guest houses, bars, clubs, restaurants, and hotels. General business services entail wholesale shops, hypermarkets and mini supermarkets, retail shops, salons and barber shops, milk ATMs, drinking water shops, boutiques, chemists, butcheries, and kiosks. Technical and financial services entail businesses such as SACCOs (Savings and Credit Cooperatives Societies) and cybercafés. Private education and entertainment services entailed businesses such as private schools and colleges, private clinics, dentists, sports clubs, and gyms. Industrial services entail businesses such as car repair shops, plumbing services, and hardware. Small trade services entailed kiosks, hawkers, street vendors, and grocery stores.

Local job availability was measured as the percentage of people who work within the neighbourhood. It can be calculated as the percentage of residents working within the neighbourhood or the time used to travel to work by the residents (Alanbari et al., 2014; Jozsa & Brown, 2005). Hence, this study considered respondents who travelled from home to work in less than 30 minutes. This data was obtained by using a questionnaire.

Table 3-6: Computation of sustainability indicators

	Indicator	Formula	Units
Environmental	Impervious surface	$\frac{\text{Sealed surface (m}^2\text{)}}{\text{Total area (m}^2\text{)}} \times 100$	%
	Intersection density	$\frac{\text{Number of real nodes}}{\text{Area of the neighborhood}}$	n
	Open space	$\frac{\text{Total area of open space}}{\text{Population}}$	Open space m ² per person
	Population density	$\frac{\text{Population}}{\text{Area}}$	people per km ²
	External connectivity	$\frac{\text{Perimeter of the neighborhood}}{\text{number of entry and exit points}}$	Meter
	NMT provision	$\frac{\text{Length of NMT}}{\text{total length of the road}} \times 100$	%
	Land use mix	$LUM' = - \sum_{i=1}^N P_i \times \log_2 P_i$	Index
Social	Access local service	$\frac{\text{No of plots within 500m from local services}}{\text{Total residential plots}} \times 100$	%
	Access open space	$\frac{\text{No of plots within 400m from the open spaces}}{\text{Total residential plots}} \times 100$	%
	Access public transport	$\frac{\text{No of plots within 500m from public transport}}{\text{Total residential plots}} \times 100$	%

	Access school	$\frac{\text{No of plots within 3000m}}{\text{Total residential plots}} \times 100$	%
	Access community centre	$\frac{\text{No of plots within 800m from community centre}}{\text{Total residential plots}} \times 100$	%
	Satisfaction	Mean value of satisfaction	Index
	Emergency services	Average response distance from emergency services	Km
Economic	Local job availability	% of people working in the neighbourhood	%
	Commercial establishment	Number of various types of business activities	Number
	House affordability	% population spending 30% or less on housing	%
	Housing diversity	% population renting	%

Source (Jozsa & Brown, 2005; Moroke et al., 2020; Perola & Dos, 2017; UN-Habitat, 2015; Zheng, 2015)

The raw data of the indicators were normalized to bring different units and measurements into the comparable scale. This research used the min-max technique to have the same range within the indicators. The min-max normalization technique was used to derive the normalized data, as shown by Equation 7 (Talukder et al., 2017).

$$N = \frac{(x-A)(b-a)}{B-A} + a \dots \dots \dots \text{Equation 7}$$

Where N = is the normalized value of the indicator, x = raw indicator value, A = is the minimum raw indicator value, B = Maximum indicator value, and b = maximum value range. In this case, 5 is our maximum value, and a = minimum value range, which is 1.

The normalization technique was based on a five-point scale ranging from 1 to 5, whereby 1 represented low sustainability and five high sustainability (Table 3-7). The indicator scores for raw data that were percentages were normalized into five different categories where one represented below 30% score; two represented 30-50% score, three represented 51-70% score, 4 represented 71-90% score, and 5 represented more than 90% score. %). Normalization of indicators: all indicators with high values had high sustainability except external connectivity, impervious surfaces, and emergency services, in which normalization followed an inverse direction. Low external connectivity distance, less impervious surface, and less time is taken to access indicated higher sustainability for the neighbourhood.

Equal weighting was used since no expert opinion was conducted to rate the indicators. It was difficult for the researcher to judge which indicator was more important than the other. Each indicator weighting was multiplied with the normalized data of each indicator to get the composite index of the three dimensions of sustainability. The composite indicator score was done by aggregating the weighted normalized indicator using linear aggregation Equation 8 (Kamble & Bahadure, 2022; Talukder et al., 2017). This method was used since it is simple and easy to understand (Gan et al., 2017).

$$\text{Composite indicator score} = \sum_{i=1}^n w_i l_i \dots \dots \dots \text{Equation 8}$$

where $i =$ is the indicator category, n is the indicator, w is the weight of each indicator, and I correspond to the normalized score of the indicator (Table 3-7), which ranges from 1 to 5.

The overall sustainability of the neighbourhood was determined by dividing the overall normalized indicator by the total number of indicators per section. The indicators' performance was compared to the benchmark value (Bahadure & Kotharkar, 2015). Benchmarking helped appraise performance and comparative analysis of neighbourhoods and allowed for improvement in current performance.

Table 3-7: Sustainability scores based on normalization

Scale	Sustainability benchmark
1	Low level of sustainability
2	Medium low level of sustainability
3	Medium level of sustainability
4	Medium high level of sustainability
5	High sustainability

The arithmetic mean was used to sum up the normalized indicator values using Equation 10 to determine the estates' sustainability level (Talukder et al., 2017).

$$x = \frac{\sum_{i=1}^n x}{N} \dots\dots\dots \text{Equation 10}$$

where N is the number of indicators, i is the indicators, and n is the sum of the normalized indicators data. The arithmetic mean was used because it was easier to compute.

3.6.3 Residential Preference

The SPSS Version 22 was used in the analysis of residential preference data. Data was analysed using descriptive statistics, with factor analysis used to identify the major factors that have a greater influence among the variables, while multiple regression was used to determine the relationship between socioeconomic characteristics and the major residential preferences identified through factor analysis. Factor analysis was suitable for the study

since the sample size was adequate and variables were well correlated, which is in line with Pallant (2011), who noted that a smaller sample size of 150 cases is sufficient if solutions have several high-loading marker variables above 0.8 and correlation matrix has coefficients greater than 0.3. The nine preference variables and sample size of 268 were considered adequate for the factor analysis, while multiple regression was used since the dependent variable was continuous. The average index was used based on responses on a Likert scale of four: 1.0-2.0 (not important), 2.1-3.0 (least important), 3.1-4.0 (important), and 4.1-5.0 (very important). The mean of the factors was ranked and interpreted according to the average index scale to identify the most important and the least important factors residents consider in a neighbourhood environment. The ranking was made to identify which factors the residents in low, middle and high-density residential neighbourhoods consider first when moving into an estate. The most important factors were those with a mean of 3 and above.

3.7 Data Validity and Reliability

Cronbach's coefficient alpha was used to determine the questionnaire's internal consistency. A Cronbach's alpha of 0.76 was obtained, indicating greater reliability. SPSS was used to calculate the value. The indicators used to measure sustainability were adopted from other studies to ensure content validity. A pilot study was conducted with 20 students at Kenyatta University to ascertain the validity of the questionnaires. After the pilot study, the researcher corrected the questions that were not clear.

3.8 Ethical Requirement

A research permit was obtained from the National Council for Science and Technology (NACOSTI) to carry out research in the three estates. Consent was obtained from Buruburu and Zimmerman's area chiefs before distributing the questionnaires. Consent was obtained from the chairman of GARRA before the online questionnaire was distributed to the residents of Garden Estate. Respondents who participated in the study did it voluntarily and were assured of the confidentiality of the research by not asking for their names. The online and physical questionnaires contained information about the study's purpose to provide participants with a clear understanding of the aim of the research.

4 CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter documents the results of research done in Buruburu, Garden and Zimmerman estates. The chapter is structured in terms of results analysed based on the objectives of the study. The research objectives were:

- 1) To examine adequacy of facilities in Buruburu, Zimmerman and Garden residential neighbourhoods.
- 2) To assess environmental, social and economic sustainability in Buruburu, Zimmerman and Garden residential neighbourhoods.
- 3) To assess factors that influence residential sustainability preference in Buruburu, Zimmerman and Garden residential neighbourhoods.

4.4.1 Socioeconomic Characteristics of Respondents

Table 4-1 shows the socioeconomic characteristics of households in the study areas. In Garden Estate, 30% of the sampled respondents were male, while in Buruburu and Zimmerman, 70% and 54.2% were male, respectively. In terms of house ownership, all the respondents in Garden Estate were house owners, (31.2%) in Buruburu were owners, and (13.3 %) in Zimmerman were owners.

The level of education for all respondents in Garden estate was graduates, while in Buruburu and Zimmerman, it is mixed, showing the majority of the respondents in the study area were educated. The classification of age was based on the constitution of Kenya's age groups. The older people are those who are aged 60 years and above, while the youth is a person between 18 to 34 years, and the middle are those who are between 35 to 59 years old (RoK, 2010). Most of the residents in Zimmerman are young people, while Buruburu has a variety of residents ranging from young, middle, and older people, and the Garden estate majority are middle and older people (Table 4-1). The youth are not found in Garden estate. This can be attributed to the fact that the area is low density area, and the cost of acquiring land and building in the area is expensive; hence, most youth cannot afford to live in the area.

The income levels of people in this estate range from KES 300,000 to 1,500,000, making Garden estate a high-income estate according to the economic survey of 2023 (KNBS, 2023). Buruburu comprises lower-income (who live in the extensions and work within the estate) and middle-income earners, with the majority and owners being middle-income earners since they earn between KES 46,356-184,394 per month according to the economic survey (KNBS, 2023). who represent (52.8%) of households surveyed. Zimmerman comprises low-income earners earning below KES 30,000. The average household size in Garden Estate is 3.9, Buruburu 3.2, and Zimmerman 2.9. The majority of households have lived in Garden estate (78.3%) for at least 11-21 years, Buruburu (44.8%) for at least 10 years, and Zimmerman (65.1%) have lived for 1-5 years (Table 4-1).

Table 4-1: Socio-economic characteristics of the respondents in the three estates

Category		Estate		
		Garden	Buruburu	Zimmerman
Gender	Male	30%	63.2%	54.2%
	Female	70%	36.8%	45.8%
Age groups	Young	-	20.8	57.8
	Middle aged	66.7	52	26.5
	Elderly	33.3	27.2	15.7
Education	No formal education	0	4%	1.2%
	Primary	0	1.6%	7.25%
	Secondary	0	33.6%	41%
	College	0	31.2%	27.7%
	University	100	29.6%	22.9 %
House ownership	Owner	100 %	31.2%	13.3%
	Rental	0	68.8%	86.7 %
Years lived in the estate	1-5 years	21.7%	44.8 %	65.1%
	6-10 years	0	19.2 %	16.9%
	11-15 years	30%	4.8%	4.8%
	16-20 years	10%	11.2%	3.6%
	≥21 years	38.3%	20%	9.6%
Motivated to live in the estate	Yes	68.3%	76.4%	63.4%
	No	31.7%	23.6%	36.6%
Average Household size		3.98	3.24	2.98

4.2 Adequacy of Facilities

Buruburu had the majority of the facilities, while Garden Estate and Zimmerman had fewer facilities (Table 4-2). Buruburu has the highest number of facilities since the neighbourhood was planned, using the neighbourhood concept in 1971 to be self-contained with the provision of various facilities. The facilities provided in the initial plan were a shopping centre, one police station, religious facilities, one health facility, five primaries and two secondary schools, recreation facilities, and corner shops. The corner shops were placed within each phase of the estate. Lack of funds from the government led to some facilities not being developed, such as a public health facility, one secondary school, and one community centre. Ten plots allocated for social amenities and open spaces have been grabbed and subdivided for commercial and other uses. The estate has informally developed housing extensions as servant quarters for renting out, which has changed its character (mix of low- and middle-income) and increased the number of people in this estate. Even though informality has occurred in this estate, it has brought the redevelopment of other facilities, such as private health facilities, primary schools, general shops, and markets. The planned facilities in the initial plan were adequate since the neighbourhood was intended to serve a population of about 5000 households. Still, with an increasing number of households to 6,174, some facilities have become insufficient (Table 4-2). Inadequate facilities are the market, police station, secondary school, and recreation spaces. The facilities are provided mainly by private providers, thus viewed as expensive. The secondary and religious facilities generally have the required land size while the educational have an inadequate size, with only 20% having the size of land needed.

Zimmerman estate has the least facilities, although, in the initial subdivision plan, facilities such as open spaces, a community hall, and a market were provided. However, the city council's weak development control enforcement and lack of funding to develop these facilities led to land grabbing and selling of designated plots to developers for other uses. Thus, the estate currently lacks open spaces and a social hall, with most facilities available having deficient land size compared to the stipulated land requirement in the handbook due to weak development control enforcement. The estate has only one public school with the required land size. At the same time, the rest are private academies established in residential

plots that lack playgrounds, with pupils using vacant plots yet to be developed as temporary playgrounds.

Garden estate is a low-density estate managed by a residential association called the Garden and Ridgeways Residential Association (GARRA). According to the Physical Planning Handbook, facilities in low-density areas should range from 0.1 to 1% of the total land. However, not all facilities are provided in low-density regions since they are expensive due to the low population. Regardless, the estate has various facilities such as religious, supermarket, schools, bank, entertainment joints, and health. Since the estate is managed by one association, the facilities are shared between Garden Estate and Ridgeways Estate. The estate is close to two malls, Ridgeways and Mountain Mall, which host the banks, supermarket, and health facility. All recreation spaces and entertainment facilities, such as restaurants, are provided and managed by private entities. The only public facilities in the estate are Garden Estate Primary and Garden Estate Secondary, while private entities provide the other schools. Regarding land size, all facilities available have the required land size.

Table 4-2: Adequacy of facilities in Buruburu, Zimmerman and Garden estates

	Type of facility	Service providers (%)		Adequacy analysis				Land size		
		Public	Private	Population catchment	Current no of facilities	Required no of facilities	(-) /(+)	Remarks	Required Land size (Ha)	% with right land size
Buruburu Estate	Primary school	43%	57 %	5,000	15	4	+11	Adequate	3.9	20%
	Secondary school	100%		8,000	1	3	-2	Inadequate	4.5	100%
	College		100%	-	3	-		-	10	0%
	Library	100%		20,000	1	1	0	Adequate	0.4	
	Health centre		100%	5,000	4	4	0	Adequate	2	-
	Police station	100%		5,000	1	4	-3	Inadequate	2	100%
	Market			5,000	1	4	-3	Inadequate	0.2	100%
	Post office	100%		-	-	-	-	-	0.1	100%
	Open/recreation space	98%	2 %	9m ² /person	84,500.91 m ²	179,991 m ²	-	Inadequate	-	-
	Religious facility	-	100%	-	12	-	-	-	0.1	92%

Zimmerman Estate	Entertainment joints	-	100%	-	30	-	-	-	-	-
	Shopping centre	-	100%	15,000	2	-	-	-	3	-
	Supermarket	-	100%	-	3	-	-	-	-	-
	Bank	-	100%	-	7	-	-	-	-	-
	Local shop	-	100%	100	300	200	+100	-	0.045	100%
	Social hall	-	-	20,000	0	1	-1	N/A	-	-
	Primary school	8%	92%	5,000	12	10	+2	Adequate	3.9	8.3 %
	Secondary school	-	-	8,000	0	6	-6	N/A	4.5	-
	College	-	100	-	1	-	-	-	-	-
	Library	-	100	20,000	1	2	-1	Inadequate	0.4	0 %
	Health centre	-	100	5,000	6	10	-4	Inadequate	2	-
	Police post	100	-	5,000	1	10	-9	Inadequate	0.2	100 %
	Market	-	-	5,000	0	10	-10	N/A	0.2	-
	Post office	-	-	-	-	-	-	-	0.1	-
	Open/recreation space	-	-	9 m ²	0	445,797 m ²	-	N/A	-	-
						445,797 m ²				

Garden Estate	Religious facility	-	100	-	14	-	-	-	0.1	4%
	Entertainment joints	-	100	-	40	-	-	-	-	-
	Shopping centre	-	-	15,000	-	-	-	-	-	-
	Supermarket	-	100	-	3	-	-	-	-	-
	Bank	-	100	-	1	-	-	-	-	-
	Local shop	-	100	100	200	-	-	-	-	-
	Social hall	-	-	20,000	-	-	-	-	-	-
	Primary school	-	-	5,000	6	4	+2	Adequate	3.9	100%
	Secondary school	-	-	8,000	2	2	0	Adequate	4.5	100%
	College	-	-	-	1	-	-	-	-	-
	Library	-	-	20,000	0	1	-1	N/A	0.4	-
	Health centre	-	-	5,000	3	4	-1	Inadequate	2	100%
	Police station	-	-	5,000	1	4	-3	Inadequate	2	100%
	Market	-	-	5,000	0	4	-4	N/A	0.2	-
Post office	-	-	-	-	-	-	-	0.1	-	

Open/ recreation space		100	9m ²	259,423 m ²	172,809 m ²	86,614 m ²	Adequate	-	-
Religious	-	100	-	-	-	-	-	0.1	100%
Entertainment joints	-	100	-	-	-	-	-	-	-
Shopping centre	-	-	-	-	-	-	-	-	-
Supermarket	-	100	-	3	-	-	-	-	-
Bank	-	100	-	3	-	-	-	-	-
Local shop	-	-	-	0	-	-	-	-	-
Social hall	-	-	20,000	0	-	-	N/A	-	-

Key: - = standards not available, N/A= Not applicable

4.2.1 Accessibility of Facilities

Accessibility by planning standards shows that in Buruburu, 51-100% of dwelling plots are within the recommended distance by WHO standards (Table 4-3). The facility with the least accessibility is the post office since it is not centrally located, while those used daily (educational) have better accessibility. In Zimmerman, accessibility ranges from 73-100%, with bus stations having the least accessibility since they are few. Garden estate accessibility ranges from 9 to 100%, with facilities used daily (educational) being accessible. In contrast, those far away, such as health centers, public transit, and religious facilities, have low accessibility.

Computation of accessibility using Rwanda planning standards (Table 4-3) shows that 65%-100% of dwelling plots in Buruburu are located within the recommended distance, with facilities used daily (education) having better accessibility. Zimmerman, accessibility ranges from 87-100%, with bus stops having the least accessibility, while in Garden estate, accessibility ranges from 9-100%, with facilities that are used daily (educational) being accessible while those located far and few like health center, bus stations and religious facilities having low accessibility. Since most facilities are accessible by Rwanda standards, Kenya can adopt them, especially where they lack health, recreation, bus stations, police stations, and religious facilities. The three estates are accessible according to Kenyan Standards Table 4-3. The standards available are only for nursery and secondary schools; for the other facilities standards, Kenyan planners can adopt either WHO or Rwanda standards.

Generally, according to the different planning standards (Table 4-3), accessibility by distance depends on the type, location, and number of facilities provided. Regardless of the standards, facilities that have the least number of dwelling plots accessible are those facilities located at a far distance. Consequently, Zimmerman estate has high accessibility while Garden estate has low accessibility to facilities. Health and public bus stations had the least accessible plots in Garden Estate, while Buruburu Estate was the library. The facilities that had low accessibility were not centrally located and were few. Zimmerman had many facilities for religious, schools, and supermarkets, improving accessibility. This

supports the study that indicated that the spatial accessibility of a facility is affected if the number is limited, while accessibility improves when the number increases (Rahman & Neema, 2015). Zimmerman is a high-density area, and even though spaces for facilities were grabbed, developers were able to provide the missing facilities, thus enhancing accessibility. This is in tandem with study findings that noted that high-density areas support a great number and variety of local facilities, and higher densities increase accessibility to the facilities (Jenks & Jones, 2010).

Access by mode of transport to facilities in a neighborhood (Table 4-4) shows that in Buruburu, facilities accessed by walking are playgrounds, open spaces, police stations, religious places, library, market, bus stations, health, supermarket, and bank. The least used means of transport are public transport and cycling. All facilities are accessible by walking except the college. About (86%) of the residents in Buruburu walk to various facilities in the neighborhood, with public transport accounting for (9%) of the trips made, private cars (19%) and cycling accounting for (6%). Walking is the most preferred mode of transport due to the design and location of facilities in the estate. In Garden estate, the most used mode of transport to access facilities is a private car (74%); walking accounts for (43%) while (22%) are accessed by motorcycle. All facilities are accessed by private vehicles and by walking, and they are open spaces, education, and religious facilities. In contrast, open spaces and religious facilities can be accessed through cycling. The only facility that can be accessed through public vehicles is the college. The least used mode of transport is public vehicles and cycling, which is attributed to most residents' car ownership, the lack of non-motorized transport infrastructure, the design layout (that is, a cul-de-sac. Hence, it does not favor walking), and the location of facilities.

The highest average trip to various facilities in Zimmerman is made by walking (79%), while the least used means of transport is a private car (6%). All facilities are accessible by walking, public transport account for (16%) and cycling/motorcycle account for (11%). The estate's design is a grid layout; hence, it has influenced the mode of transport used in accessing the facilities since the streets are shorter and provide many alternative routes. This supports Dill (2004) statement that grid street networks are preferred over cul-de-sacs since they increase distance between destinations.

Access to facilities in Garden estate is mostly by private cars, and Zimmerman and Buruburu estate is by walking. This supports a study that showed that as income rises, walking generally decreases, and the use of private cars increases (Babijes, 2016). Residents in Garden Estate travel longer distances to access facilities since the area is primarily single-use, while residents in Zimmerman have a lower average distance to facilities; hence, most trips are made by walking. The average distance of facilities in Zimmerman ranges from 81-872m, while in Garden estate, the average distance ranges from 225-1438m, and in Buruburu, it varies from 57 m to 774m. This supports the study that indicates single-use zoning leads to residents traveling longer distances and using private vehicles than residents living in mixed-use areas that reduce travel distance and enable walking to various facilities (Seto & Dhakal, 2014; UN-Habitat, 2014). In Buruburu, access to various facilities is by walking, which supports the study by Laari *et al* (2019) that reported that land use planning enables the provision and distribution of public facilities, which also affects the distance of public facilities from dwelling plots. Walking promotes environmental sustainability by reducing car emissions (Hajjar, 2015) hence, facilities should be provided in each neighborhood regardless of density.

Table 4-3: Computation of accessibility of facilities according to different standards

Facility	WHO standards				Rwanda standards				Kenyan standards			
	distance (m)	% plots accessible			distance (m)	% plots accessible			distance (m)	% plots accessible		
		B	Z	G		B	Z	G		B	Z	G
Nursery	400-600	100	100	100	500	100	100	94	300-500	-	-	-
Primary school	500-800	100	100	100	1000	100	100	94	500-2000	100	100	100
Playground and park	400	100	-	90	500	100		95	-	-	-	-
Health Centre	800-1200	91	100	28	500	65	87	9	-	-	-	-
Post office	600-800	51	-	-	2000	-	-	-	-	-	-	-
Library	-		-	-	2000	100	100		-	-	-	-
Local shop	300-500	99	-	-	500	99		-	-	-	-	-
Shopping Centre	600-1000	84	-	-	-	-	-	-	-	-	-	-
Religious	-	-	-	-	5000	100	100	94	-	-	-	-
Secondary	700-1500	98	-	100	2000	100	-	100	500-3000	100	-	100
Supermarket	1200-2000	100	100	91	-	-	-	-	-	-	-	-
Bus stops	200-400	98	73	9	500	100	89	26	-	-	-	-
Police post	-	-	-	-	2000	100	100	100	-	-	-	-

Table 4-4: Mode of transport used to access various facilities

Facility Estate	Mode of transport											
	PSV/ School Bus			Private car			Walking			Cycling		
	B	Z	G	B	Z	G	B	Z	G	B	Z	G
Primary school	19.6%	15.6%	-	17.6%	4.4%	77.3%	62.7%	77.8%	22.7%	-	2.2%	-
Secondary school	7.7%	29.4%	-	11.5%	5.9^%	22.2%	80.8%	64.7%	77.8%	-	-	-
College	16.7%	21.4%	54.8%	83.3%	7.1%	45.2%	-	57.1%	-	-	-	-
Library	-	-	-	-	-	-	90.2%	88.2%	-	9.8%	11.8%	-
Health centre	5.9%	10.4%	-	13.7%	6%	100%	77.5%	73.1%	-	2.9%	10.4%	-
Police station	-	-	-	-	8.7%	100%	90.3%	85.5%	-	9.7 %	5.8%	-
Market	4.4%	-	-	-	-	-	93.3%	-	-	2.2%	-	-
Open / recreation space	-	-	-	-	-	21.3%	89.7%	-	61.7%	10.3%	-	17%
Playground	-	-	-	-	-	-	95.9%	-	-	4.1%	-	-
Entertainment	-	-	-	10.8%	-	100%	85.1%	86%	10.9%	4.1%	14%	10.9%

Religious facility	1.9%	1.4%	-	4.6%	7.2%	78.2%	90.7%	85.5%	-	2.8%	5.8%	-
Supermarket	4.2%	-	-	5%	2.7%	100%	88.2%	83.6%	-	2.5 %	13.7%	-
Bank	2%	-	-	9.1%	-	100%	83.8%	77.4%	-	5.1%	22.6%	-
Bus stations	-	-	-	-	-	-	86.3%	88.2%	-	13.7%	11.8%	-

Accessibility of facilities was further explored by density maps (Figures 4-1,4-2 and 4-3) to show their location and distribution. The maps show distribution disparities of facilities across the three estates. The facilities (schools, recreation areas, and bus stops) in Buruburu are evenly distributed across the estate (Figure 4-1), which makes their accessibility to be high. Facilities such as banks, supermarkets and colleges are not spatially distributed across the estate but are located centrally, improving their accessibility. In Garden estate, facilities such as schools and recreation areas are evenly distributed, but banks, supermarkets, and bus stops are unevenly distributed, leading to a decrease in accessibility as depicted in Figure 4-2. In Zimmerman, the facilities are evenly distributed, which has increased the accessibility of facilities in the estate, as illustrated in Figure 4-3.

Regarding location, facilities in Buruburu and Zimmerman are clustered (concentrated together), while for Garden Estate, the facilities are dispersed. Clustering facilities in Buruburu and Zimmerman estates make most residents prefer walking to the facilities, which supports the statement by Barton *et al* (2021) that clustering of facilities reduces the use of private cars. The location of facilities in the Garden estate is dispersed (Figure 4-2). Hence, the mode of transport used to access facilities is a private car, which supports the finding that dispersing of facilities increases the percentage of residents who use private cars as residents will have to make multiple trips (Barton et al., 2003, 2021).

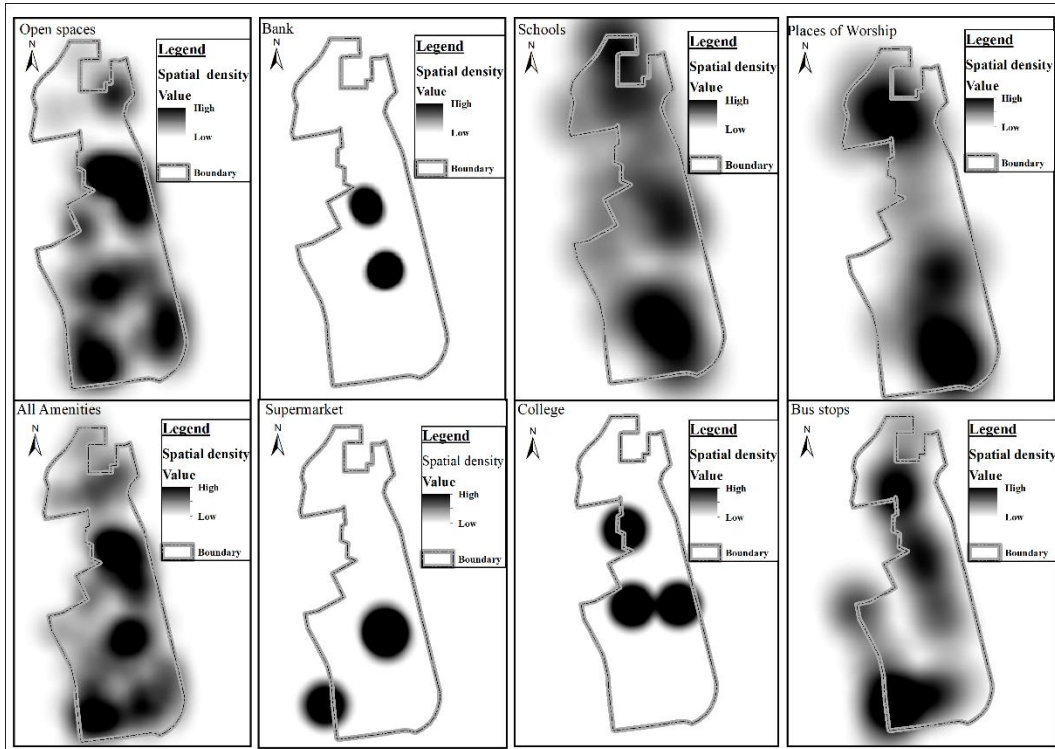


Figure 4-1: Spatial distribution of facilities in Buruburu estate

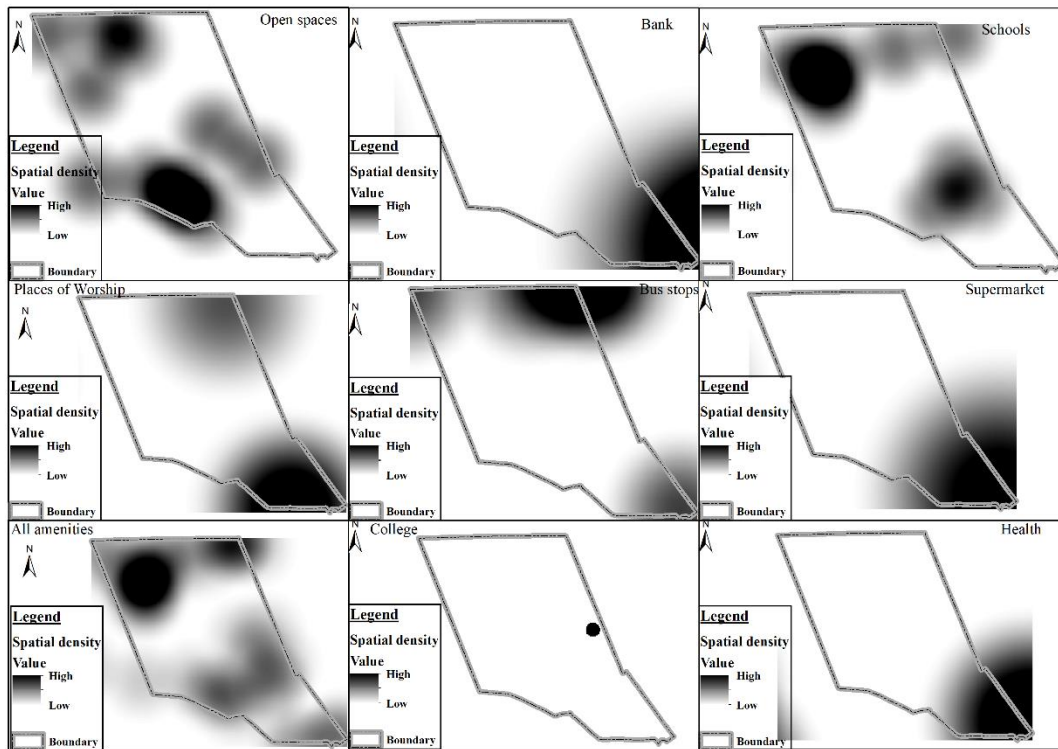


Figure 4-2: Spatial distribution of facilities in Garden estate

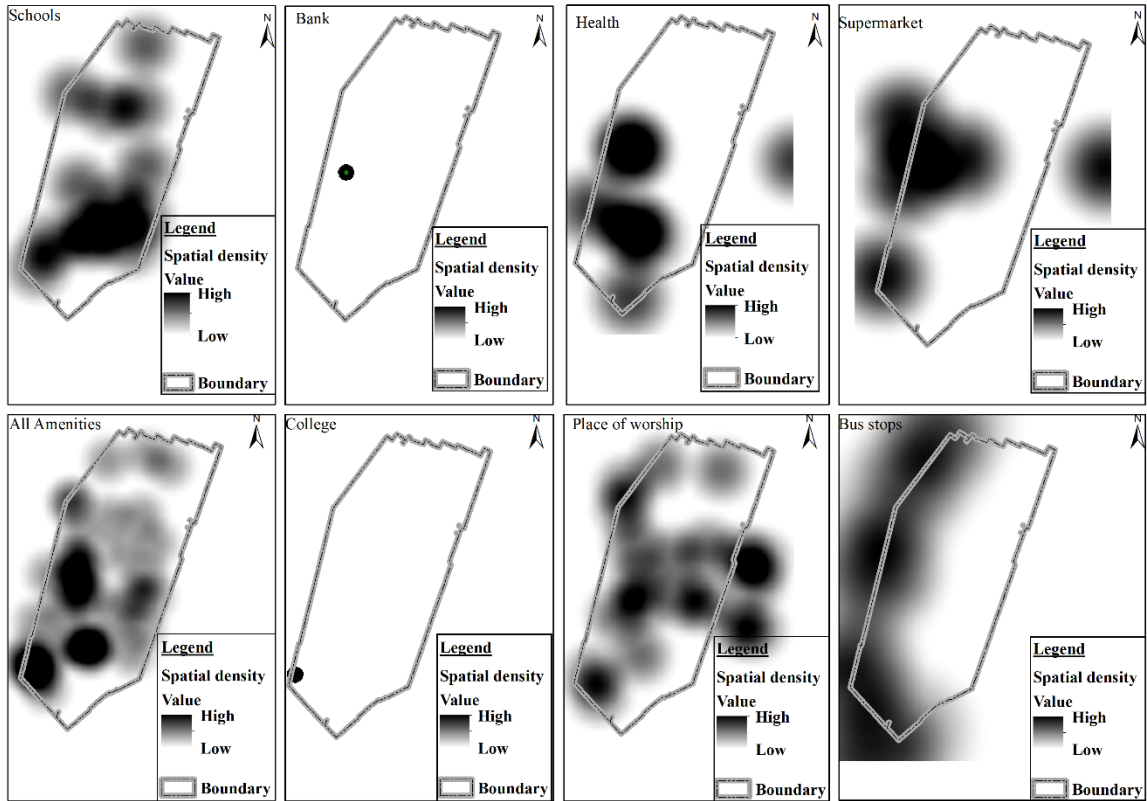


Figure 4-3: Spatial distribution of facilities in Zimmerman estate

4.3 Neighbourhood Sustainability

4.3.1 Environmental Sustainability

The environmental indicators that were measured were intersection density, external connectivity, impervious surface, land use mix, open space provision, and population density.

a) *Intersection density*

Based on Equation 4, the results in Table 4-5 indicate that Zimmerman had the highest number (212) of intersection density, followed by Buruburu (199) and Garden Estate (37). Zimmerman had an area of 0.77 km² and the number of nodes was 164, translating into 212 intersections/Km², above the recommended value of 80-100 intersections per Km² by (UN-Habitat, 2023). Buruburu has an area of 2.2 km² against 437 nodes, translating into

199 intersections/Km². Garden estate has an area of 2.9 km² against 106 nodes, translating into 37 intersections/Km². Zimmerman estate has many intersections compared to the other neighbourhoods due to its street design, grid network pattern (Figure 4-4). This supports the statement by Mwangi *et al*, (2021) and Zandieh *et al*, (2017) that grid street patterns have many intersections; hence they reduce the distance between trips. Grid patterns also provide many alternative trip routes, allowing pedestrians to have various routes for convenience and safety (Mwangi *et al.*, 2021). Neighbourhoods with grid pattern street networks have greater connectivity than those with curvilinear layouts (Azmi et al., 2013; Azmi & Ahmad, 2015; Zandieh et al., 2017). Garden estate have a low number of intersections since the street design of the neighbourhood is cul de sac or curvilinear. Zimmerman has the highest intersections; hence, it was more sustainable since the roads enable the drivers to take more direct routes, therefore using less fuel, leading to low air pollution, as stated by (Hilley & Sim, 2020). Normalization of the raw data (Table 4-24) indicates that Zimmerman has high sustainability (5), while Buruburu has a medium-high level of sustainability (4), and Garden Estate has a low sustainability level (1).

Table 4-5: Intersection density computation

	Buruburu	Garden	Zimmerman
Number of nodes	437	106	164
Area of the neighbourhood (km ²)	2.2	2.9	0.77
Intersection density = $\frac{\text{Intersections}}{\text{Area of the neighborhood}}$	199	37	212



Figure 4-4: Intersection density map for Buruburu, Zimmerman and Garden estates

b) External connectivity

Based on Equation 5, the results for external connectivity (Table 4-6) indicate that Zimmerman had high external connectivity, with an average distance of 271m, followed by Buruburu, with an average distance of 1,028m, and Garden Estate, which had an average distance of 1,299m. Buruburu estate has a perimeter of 9248 m, and the number of entry/exit points is 9, as depicted in Figure 4-5, translating into an average entry distance of 1,028m. The garden estate has a perimeter of 7793m, and entry/exit points were 6, as depicted in Figure 4-6, translating into an average distance of 1,299m. Zimmerman estate has a perimeter of 4070m, and entry/exit points were 15, as depicted in Figure 4-6, translating into a distance of 271m. A lower distance indicates higher sustainability; hence, an inverse direction was followed to normalize this indicator. This gives Zimmerman's estate a high external connectivity, making it more sustainable. Normalization of the raw data (Table 4-24) indicates that Zimmerman has high sustainability (5), while Buruburu has a medium-low level of sustainability (2), and Garden Estate has low sustainability (1).

Table 4-6: External connectivity computation

Estate	Buruburu	Garden	Zimmerman
Perimeter (m)	9248	7793	4070
Number of entry and exit points	9	6	15
Average entry/ exit distance (m)	1,028	1,299	271

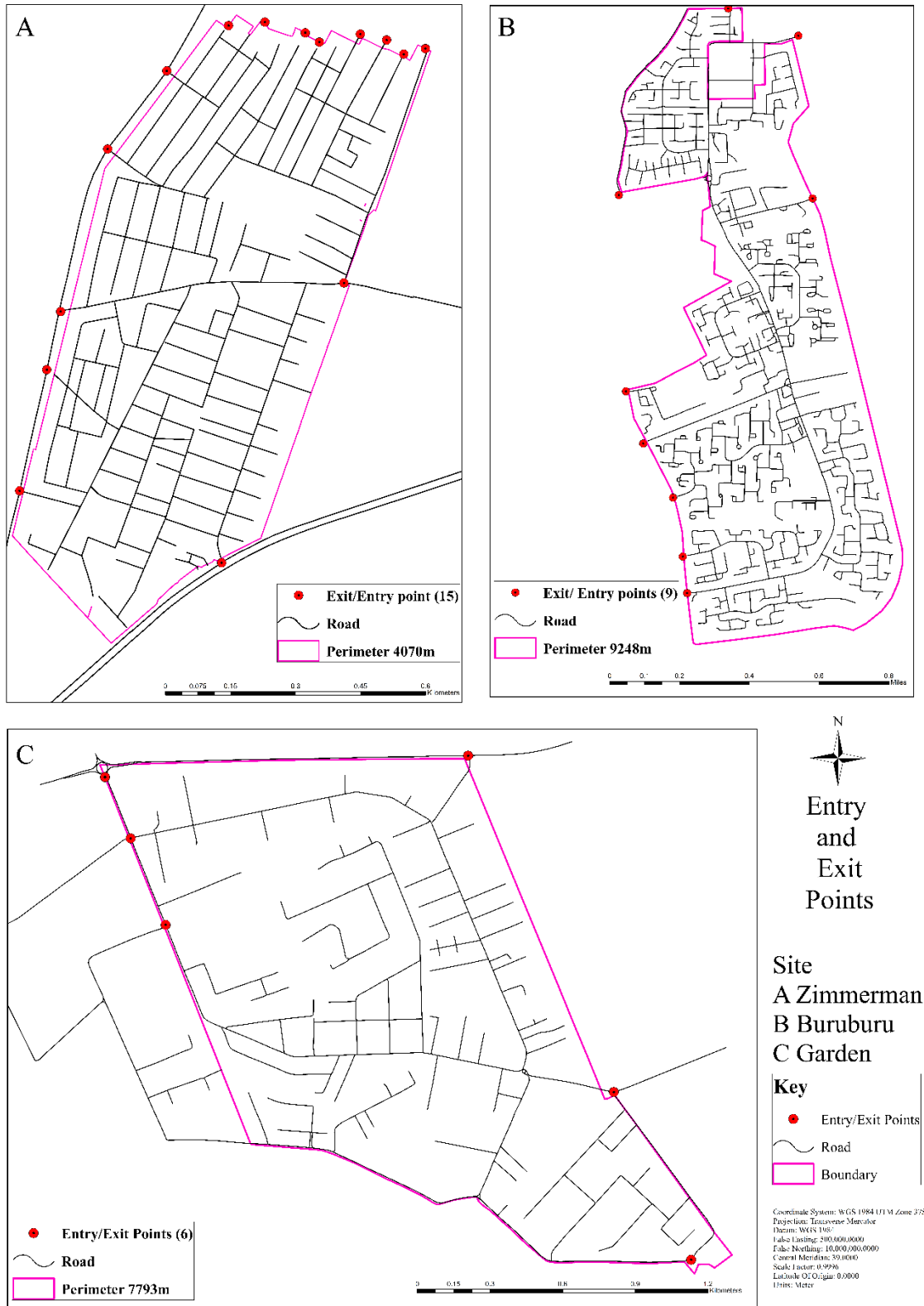


Figure 4-5: Entry and exit points in Buruburu, Zimmerman, and Garden estates

c) Provision for open spaces

Table 4-7 shows the provision of open spaces in all the three estates. The results indicate that Garden estate had the highest open spaces of 13.51m² per capita of open space, followed by Buruburu with 4.22 m² per capita of open space, and Zimmerman estate had the last with 0m² per capita of open space. Zimmerman had no open spaces with a population of 49,533 (KNBS, 2019) translating into 0 m² of open space per person. Buruburu has a total open space of 84,500.91 m² against a population of 19,999 (KNBS, 2019) translating into 4.22 m² of open space per person. This shows that Buruburu estate has inadequate open spaces as per WHO guidelines of 9m² of space per person. Garden estate has an open space of 259.423 m² against a population of 19,201 (KNBS, 2019) translating into 13.51 m² of open space per person, which is adequate as per 9m² guidelines WHO (2016). Garden estate has sufficient open space facilities for its residents since it has not changed its character and has a low population. This is supported by one research that states that lower-density areas provide more green and open spaces than high-density areas (Dempsey *et al.*, 2012). This gives the residents of Garden Estate a healthy environment since they have places to relax, exercise, meet people, and socialize; the spaces also raise the area's property value, as supported by (Mwaniki *et al.*, 2019). Zimmerman, on the other hand, has no open spaces due to haphazard development and land grabbing. This is supported by other studies that state that unplanned areas lack open spaces due to haphazard development (Abdu & Hashim, 2015; Kuffer & Barros, 2011). The open spaces in Buruburu were inadequate due to population increase and in-formalization of the estate, which led to some open spaces being grabbed and reduced open spaces required per person. Normalization of the raw data (Table 4-24) indicates Garden estate has high sustainability (5), while Buruburu has a medium-low level of sustainability (2), and Zimmerman estate has low sustainability (1).

Table 4-7: Open space provision computation

Estate	Buruburu	Garden	Zimmerman
Population	19,999	19,201	49,533
Area of the open spaces	84,500.91 m ²	259,423 m ²	0
Open spaces per person (sq.m)	4.22	13.51	0

d) Provision of non-motorised transport

Table 4-8 shows the provision of NMT in all three estates. The results indicate that Buruburu had 12% of NMT, followed by Zimmerman (0%) and Garden Estate (0%). This shows that the Buruburu estate has NMT provision compared to the other neighbourhoods. Provision of NMT in Buruburu is located along Mumias South Road, where walkways are on both sides of the road, Rabai Road walkways and cycling lanes are on both sides of the road, and Buruburu Road has also sidewalks on both sides of the road. The total length of NMT in Buruburu is 5.6 km, while the total road length in the estate is 46.5 Km, which translates to 12 % of NMT provision. This has improved the accessibility of facilities in Buruburu estate, and many residents walk there. Garden estate lacks NMT provision, which acts as a barrier to NMT, and therefore, residents drive to reach destinations. This study and other studies done in Kenya show that residential streets that are cul de sacs lack NMT, thus discouraging residents from walking or biking by increasing trip length and decreasing modal and route choice (Mitullah *et al.*, 2017; Mwangi *et al.*, 2021). Zimmerman estate also lacks NMT provision, but the road design encourages walking since it offers many alternative routes. On the edge of the estate is Kamiti Road, which provides NMT, but these facilities are encroached upon by traders, which discourages the use of NMT due to crowding. Poor maintenance of NMT facilities does not ensure the safety and comfort of pedestrians along streets in Nairobi, which continues to deteriorate, leading to increased congestion and poor safety of NMT users, as stated by Mwangi *et al.*, (2021). These are some of the factors that discourage pedestrians from using NMT facilities. The most sustainable estate was Buruburu since it has NMT facilities, which help minimize transportation's environmental impact as most people walk; hence, it promotes public health and minimizes carbon emissions. Normalization of the raw data (Table 4-24) indicates that Buruburu estate had a high sustainability (5), while Garden and Zimmerman have a low level of sustainability (1).

Table 4-8: NMT provision computation

	Buruburu	Garden	Zimmerman
Total street length	46.5 Km	29Km	18.9Km
NMT length	5.6 Km	0	0
% NMT	12	0	0

e) Impervious surface

The results for impervious surface Table 4-9 indicate that Garden estate had an impervious surface of 30%, followed by Buruburu with 33%, and Zimmerman was the last with 75%. Garden estate had a 30% sealed area due to lower density and many planted trees, as depicted in Figure 4-6. Buruburu also had a lower impervious surface due to the provision of open spaces and courts with trees and bare land. Zimmerman had the highest sealed area of 75%. This can be attributed to the lack of open spaces and high density; hence, this neighbourhood is unsustainable. This is in line with other research that states that unplanned areas have high ground coverage of 80% (Kuffer & Barros, 2011) leading to low tree coverage, and this negatively affects the surface of the area (Oguche *et al.*, 2019); hence, this area have low pervious surfaces. Garden estate is the most sustainable since it has a low percentage of impervious surface due to the planting of trees and high vegetation cover; hence, the area can have low surface runoff and is less likely to experience flooding. A lower impervious surface indicates a higher sustainability for the area. Thus, an inverse direction was followed for the normalization of this indicator. Buruburu and Garden Estate have a medium-high level of sustainability (4), while Zimmerman has a medium-low level of sustainability (2) since it has a highly impervious surface (Table 4-24).

Table 4-9: Impervious surface computation

Land use classification	Buruburu	Garden	Zimmerman
Bare ground (m ²)	1102948	224823	4494
Vegetation cover (m ²)	374530	1838098	190093
Swimming (m ²)	956	2780	0
Tarmacked area (m ²)	300345	239615	261952
Built up area (m ²)	432446	632139	309249
Total pervious (m ²)	1477478	2062921	194587
Total impervious (m ²)	733746	874534	571201
Total area (m ²)	2211224	2937455	765789
% imperviousness	33%	30 %	75 %

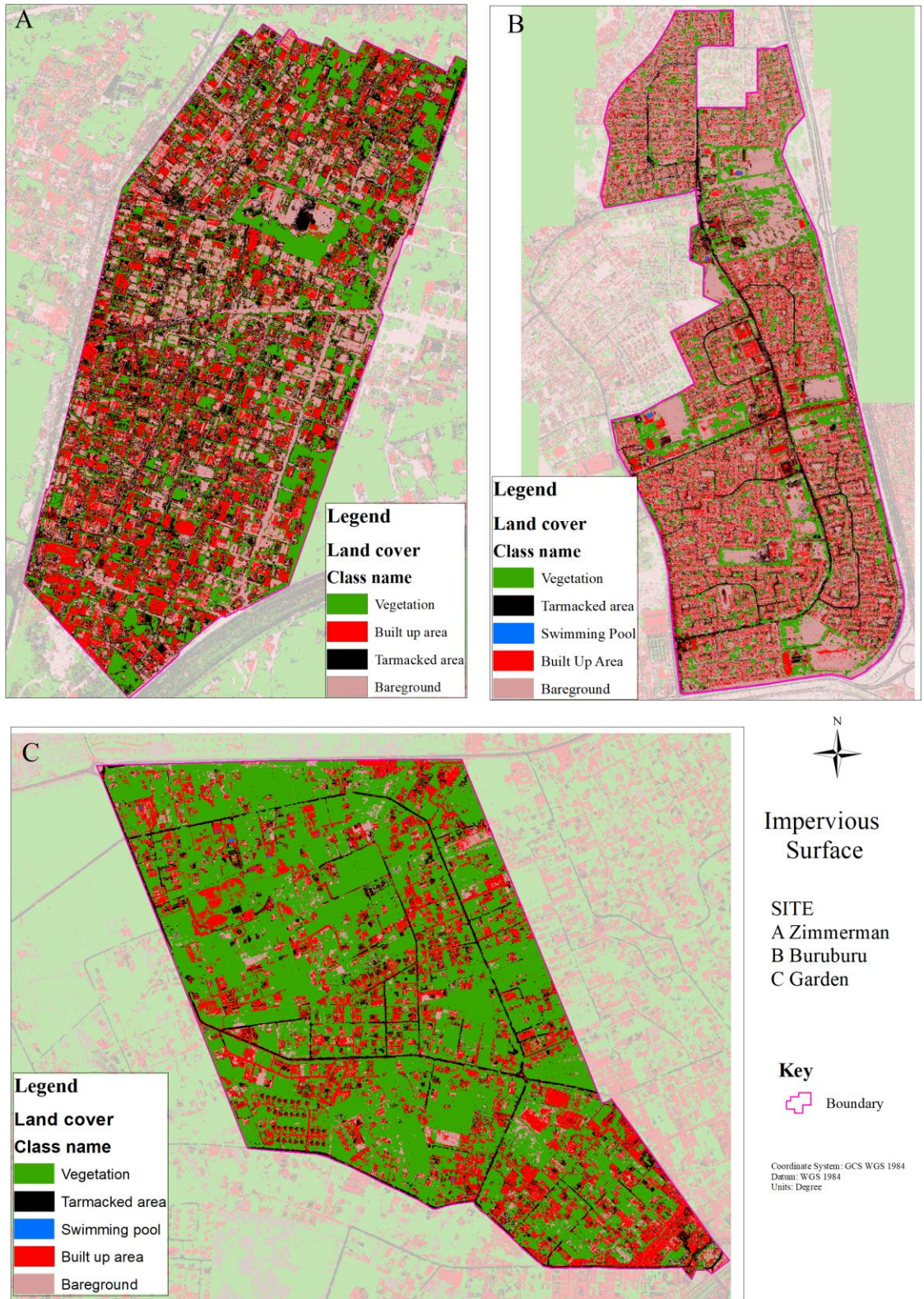


Figure 4-6: Impervious surface maps for Buruburu, Garden and Zimmerman estates

f) Land use mix

The results for the land use mix in Table 4-10 indicate that Buruburu had an index of 0.5, Garden estate 0.3, and Zimmerman 0.2. Zimmerman's estate had five land uses: residential, public utility, public purpose, educational, and commercial. The distribution of land use in terms of percentage shows that commercial had 6%, educational 4%, public purpose 2%, residential 87%, and public utility 1%, resulting in an index of 0.2, which is below the recommended index of 1 (Driscoll *et al.*, 2023) thus the land uses in the area were not balanced, which is depicted in Figure 4-7. Garden has five land uses: residential, recreational, public purpose, educational, and commercial. The distribution of land use in terms of percentage shows that commercial was 4%, educational 7%, public purpose 1%, recreation 6%, and residential 82%, resulting in an index of 0.3, below the recommended 1. This shows that the land used in the Garden Estate was not balanced. Buruburu estate had six land uses ranging from residential, transport, public purpose, recreation, educational, and commercial, as depicted in Figure 4-8. The distribution of land use in terms of percentage shows that commercial had 4%, educational 21%, public purpose 10%, recreation 4%, residential 60%, and transport 1%, resulting in an index of 0.5, indicating the land use in the estate is not balanced since it has a lower index value compared with the recommended index of 1 (Driscoll *et al.*, 2023). Buruburu has an average index; hence, it has a medium-high level of sustainability (4) (Table 4-24), while Garden has a medium-low level of sustainability (2), a value of 2, and Zimmerman has low sustainability (1).

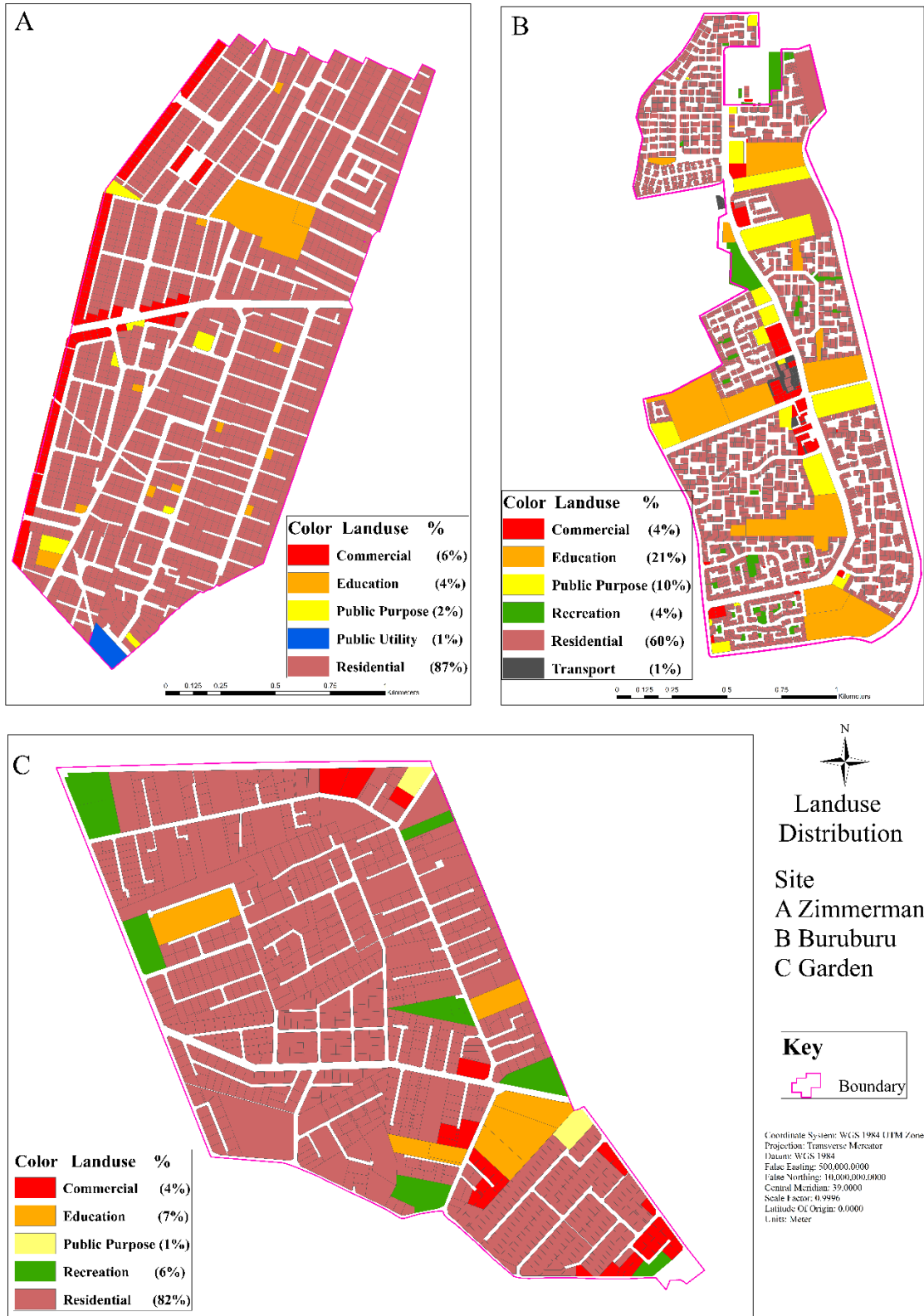


Figure 4-7: Land use map for Buruburu, Garden and Zimmerman estates

Table 4-10: Land use mix computation

Land use	Area (m ²)			Pi(area of each land use/total area)			Log (pi)			(Pi)×-(log(pi))		
	B	G	Z	B	G	Z	B	G	Z	B	G	Z
Commercial	52,552	104,348	37,739	0.04	0.04	0.06	-1.398	-1.397	-1.222	0.05592	0.055896	0.073308
Educational	30,3023	16,4425	29,618	0.21	0.07	0.04	-0.677	-1.155	-1.398	0.142338	0.080843	0.055912
Public Purpose	152,013	23,959	7,938	0.1	0.01	0.02	-1	-2	-1.699	0.1	0.02	0.03398
Recreation	57,470	149,925	0	0.04	0.06	0	-1.398	-1.222	0	0.05592	0.073308	0
Residential	892,612	2,064,809	512,867	0.6	0.82	0.87	-0.222	-0.086	-0.061	0.13308	0.0706068	0.052635
Transport	13,040	0	0	0.01	0	0	-2	0	0	0.02	0	0
Public Utility	0	0	4,928	0	0	0.01	0	0	-2	0	0	0.02
Total	1,470,710	2,507,466	592,460	1	1	1				0.5072	0.300	0.2358

g) Population density

The results for population density (Table 4-11) indicate that Buruburu had a density of 9,090, Garden Estate had 6,621, and Zimmerman 64,329. Zimmerman has an area of 0.77 km² and a population of 49,533 (KNBS, 2019) meaning there are 64,329 people per km²; this shows Zimmerman had a high density. Buruburu has an area of 2.2 km² and a population of 19,999 (KNBS, 2019), translating to 9,090 people per km². Garden estate has an area of 2.9 km² against a population of 19,201 (KNBS, 2019) translating into 6,621 persons per km². This shows that Garden Estate has a lower density due to its small population. Normalization of the raw data (Table 4-24) indicates Zimmerman has high sustainability (5), Buruburu has a medium-low level of sustainability (2), and Garden has low sustainability (1).

Table 4-11: Population density computation

Estate	Buruburu	Garden	Zimmerman
Population (based on 2019 census)	19,999	19,201	49,533
Area (Km ²)	2.2	2.9	0.77
Population density people per km ²	9,090	6,621	64,329

4.3.2 Social Sustainability

a) Accessibility of public transport

The results in Table 4-12 show that accessibility of public transport in Buruburu is 100%, while in Garden estate, it is 34%, and in Zimmerman, it is 89%. Accessibility of public transport is high in Zimmerman and Buruburu because they have many bus stops that are well distributed within the estates (Figure 4-9). Hence, Zimmerman and Buruburu are more sustainable since most residents use public transport. Other researchers support this, saying that more excellent public transport services and better access to bus stops are associated with higher public transport use (Brown *et al.*, 2019), making an area sustainable due to less pollution. Access to public transport promotes sustainable travel patterns since less energy is consumed. Hence, the noise and pollution are reduced (Martins *et al.*, 2021).

Garden estate has few bus stops, as depicted in Figure 4-9; hence, most people use private cars, making the area unsustainable due to the increase in pollution. Normalization of the raw data (Table 4-24) indicates that Buruburu has high sustainability (5), while Zimmerman has a medium-high level of sustainability (4), and Garden has a medium-low level of sustainability (2).

Table 4-12: Accessibility of public transport computation

Estate	Buruburu	Garden	Zimmerman
0-100m	928	23	125
101-200m	1643	45	354
201-300m	1616	63	282
301-400m	726	68	253
401-500m	11	76	236
Number of plots within 500m from bus stations	4924	273	1250
Total number of plots	4924	794	1402
Public transport access (%)	100%	34%	89%

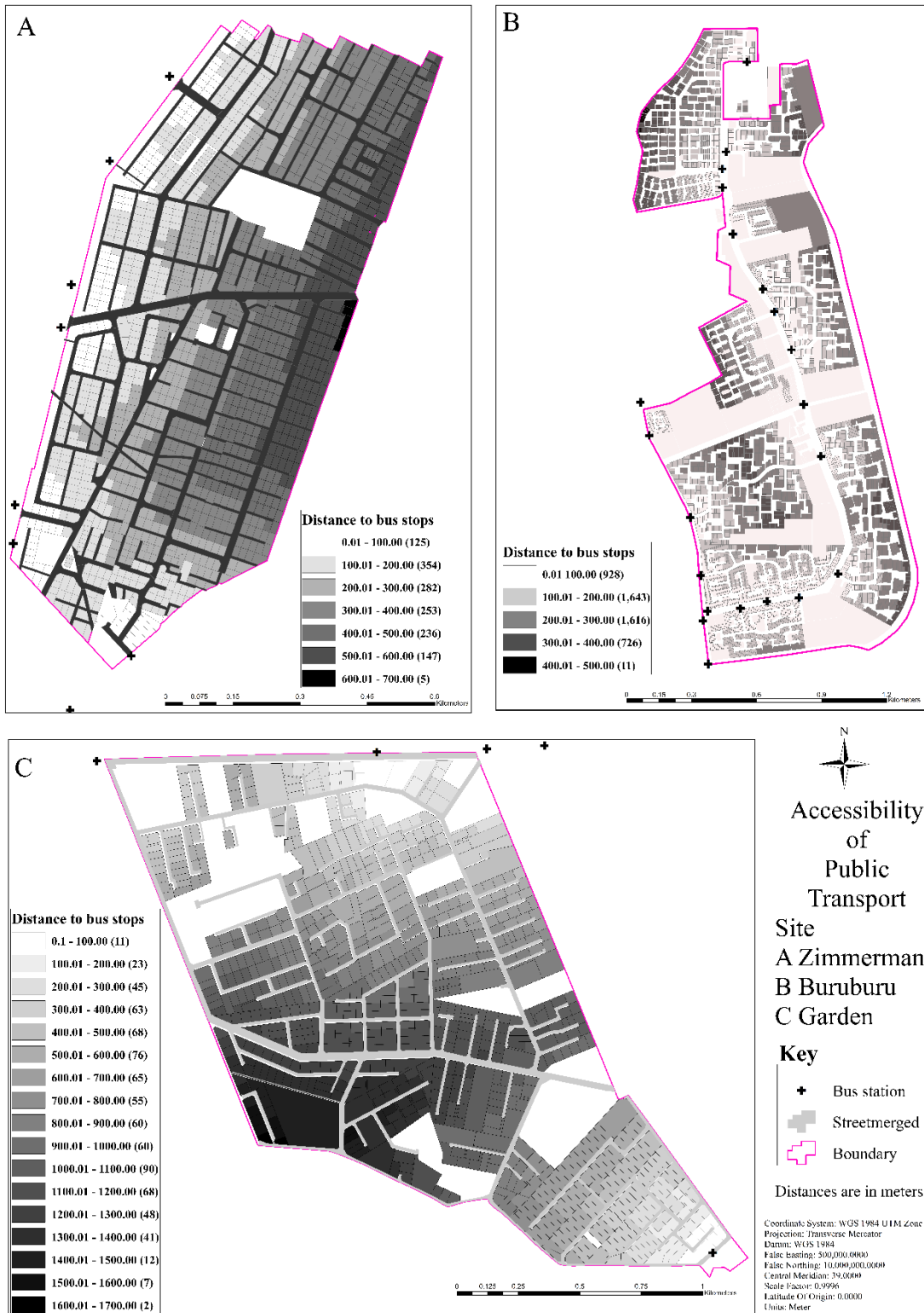


Figure 4-8: Accessibility of public transport facilities in Buruburu, Zimmerman and Garden estates

b) Access to education facilities

The results in Table 4-13 show that the accessibility of schools is 100% in Buruburu, Garden, and Zimmerman. Accessibility of schools is high in the three estates because they have many well-distributed schools, as depicted in Figure 4-9. This shows that all the estates provide a healthy educational environment. Barton *et al.*, (2021) highlighted that a healthy academic environment stimulates, informs, and heightens awareness of all people. Hence, the provision of nurseries, schools, colleges, and training opportunities that are local and accessible can promote this. Normalization of the raw data (Table 4-24) indicates all three estates have high sustainability (5).

Table 4-13: Accessibility of education facilities computation

Estate	Buruburu	Garden estate	Zimmerman
0-100m	2420	232	939
101-200m	1850	175	391
201-300m	586	110	68
301-400m	57	131	4
401-500m	11	100	0
501-600m	0	32	0
601-700m	0	14	0
Number of plots within 3000m from schools	4924	794	1402
Total number of plots	4924	794	1402
School access (%)	100%	100%	100%

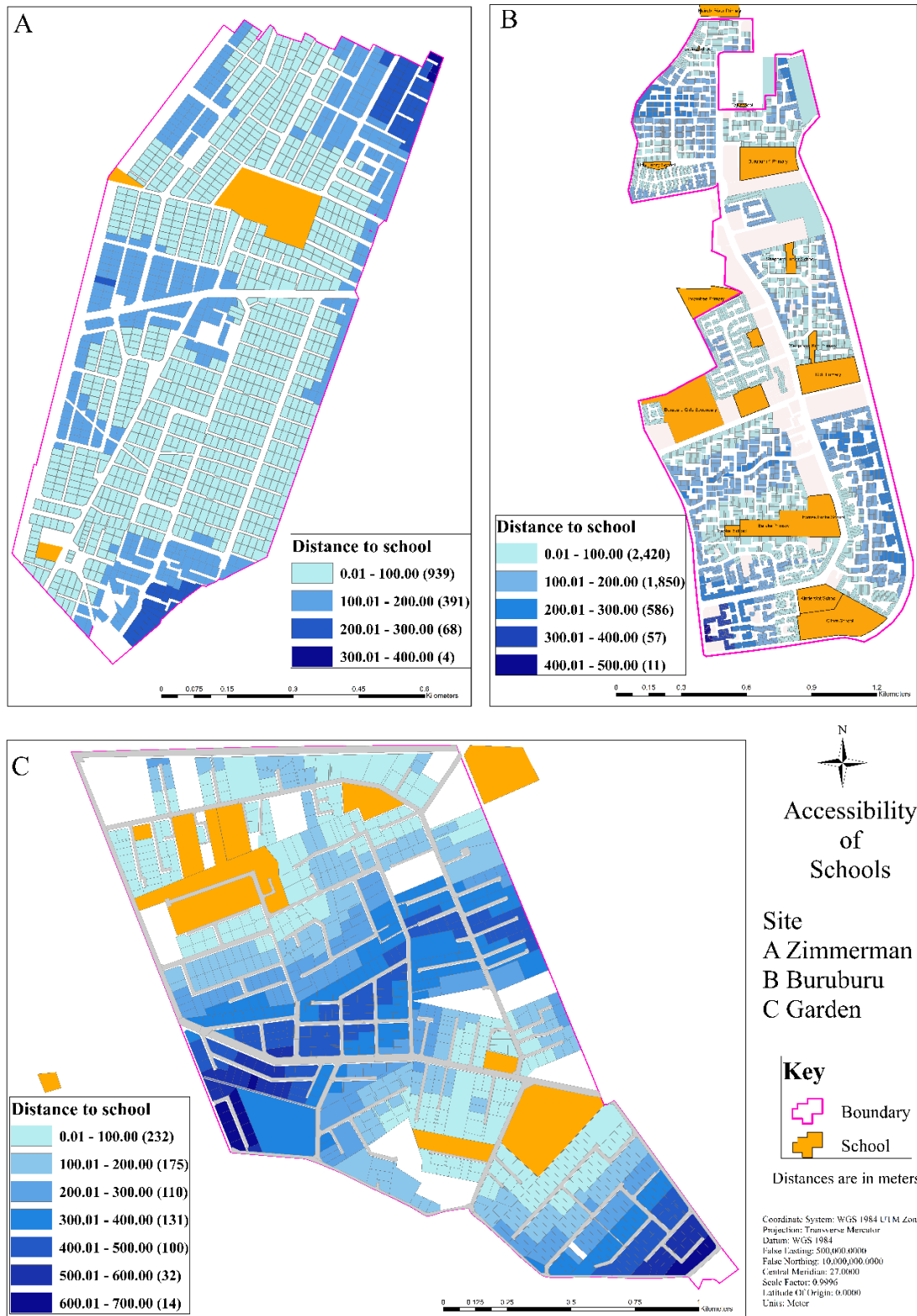


Figure 4-9: Accessibility of education facilities in Buruburu, Zimmerman and Garden estate

c) Accessibility of open spaces

The results in Table 4-14 show that the accessibility of open spaces in Buruburu is 100% while in Garden estate is 90%, and as for Zimmerman, no open spaces were available in the area. This was caused by its unplanned nature, leading to the absence of open spaces. A common spatial feature for unplanned areas is the absence of public open spaces (Abdu & Hashim, 2015; Kuffer & Barros, 2011; Oguiche *et al.*, 2019). Buruburu is a planned area; from the initial plan, open spaces were provided within the neighbourhoods. This is highlighted as one of the characteristics of planned areas: they provide open spaces within the neighbourhood's vicinity (Abdu & Hashim, 2015; Kuffer & Barros, 2011). Due to the low population, the Garden estate has adequate open spaces, as depicted in Figure 4-10. This aligns with study findings that lower-density areas provide more open space than high-density areas (Dempsey *et al.*, 2012), and lower densities decrease accessibility to the facilities (Jenks & Jones, 2010). The availability and accessibility of open spaces within the two neighbourhoods promote social interaction and encourage healthy lifestyles for the residents. This is in line with study findings that access and availability are essential pathways for healthy communities as they provide places to relax, do exercises, and also act as places for people to meet and socialize (Barton *et al.*, 2021; Carter & Horwitz, 2014). Normalization of the raw data (Table 4-24) indicates that Buruburu and Garden estates have high sustainability (5) while Zimmerman has low sustainability (1).

Table 4-14: Accessibility of open spaces computation

Estate	Buruburu	Garden	Zimmerman
0-100m	3981	261	0
101-200m	750	209	0
201-300m	189	134	0
301-400m	4	107	0
Number of plots within 400m from open spaces	4924	711	0
Total number of plots	4924	794	1402
Open spaces access (%)	100%	90%	0%

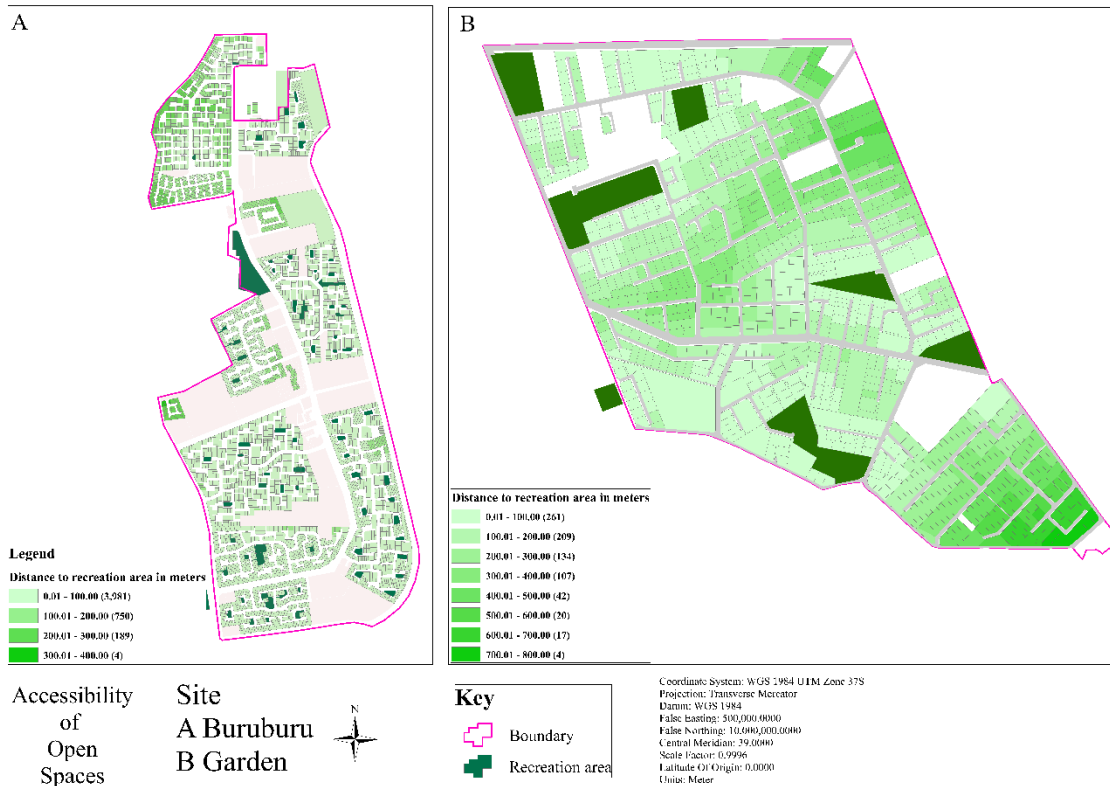


Figure 4-10: Accessibility of open spaces in Buruburu and Garden estates

d) Accessibility to community centre

Community centres refer to places that offer residents the opportunity to congregate, socialize, or perform activities that generate mutual or community benefits (Suharto, 2012). The physical planning handbook community centre should have a library and social hall (RoK, 2024). The community centre enhances social interaction and offers a place of relaxation from normal daily activities. Hence, religious facilities, a library, a neighbourhood centre, and a social hall were community centres. These facilities were considered community centres since they are places where people congregate. Table 4-15 shows that accessibility of community centres is 100% in Buruburu and Zimmerman, while in Garden estate, it is 67%. Zimmerman and Buruburu have many community centres that are spatially distributed in the estate, while Garden Estate has a minimum number of community centres. Buruburu has various community centres ranging from neighbourhood centres, religious facilities, and libraries; hence, it has high accessibility, as depicted in Figure 4-11. This estate had a social hall, but it was demolished in 2022. Zimmerman has

a library and religious facilities, leading to high accessibility. In contrast, the Garden Estate had only religious facilities as community centres, which led to reduced accessibility, as depicted in Figure 4-11. The three estates had places where people could socialize, which improved social sustainability; hence, Buruburu and Zimmerman's estates have high sustainability (5), while Garden estate has medium sustainability (3) (Table 4-24).

Table 4-15: Accessibility of community centres computation

Estate	Buruburu	Garden	Zimmerman
0-200m	3804	120	1369
201-400m	1120	142	33
401-600m	0	135	0
601-800m	0	138	0
Number of plots within 800m from open spaces	4924	535	1402
Total number of plots	4924	794	1402
Open spaces access (%)	100%	67%	100%

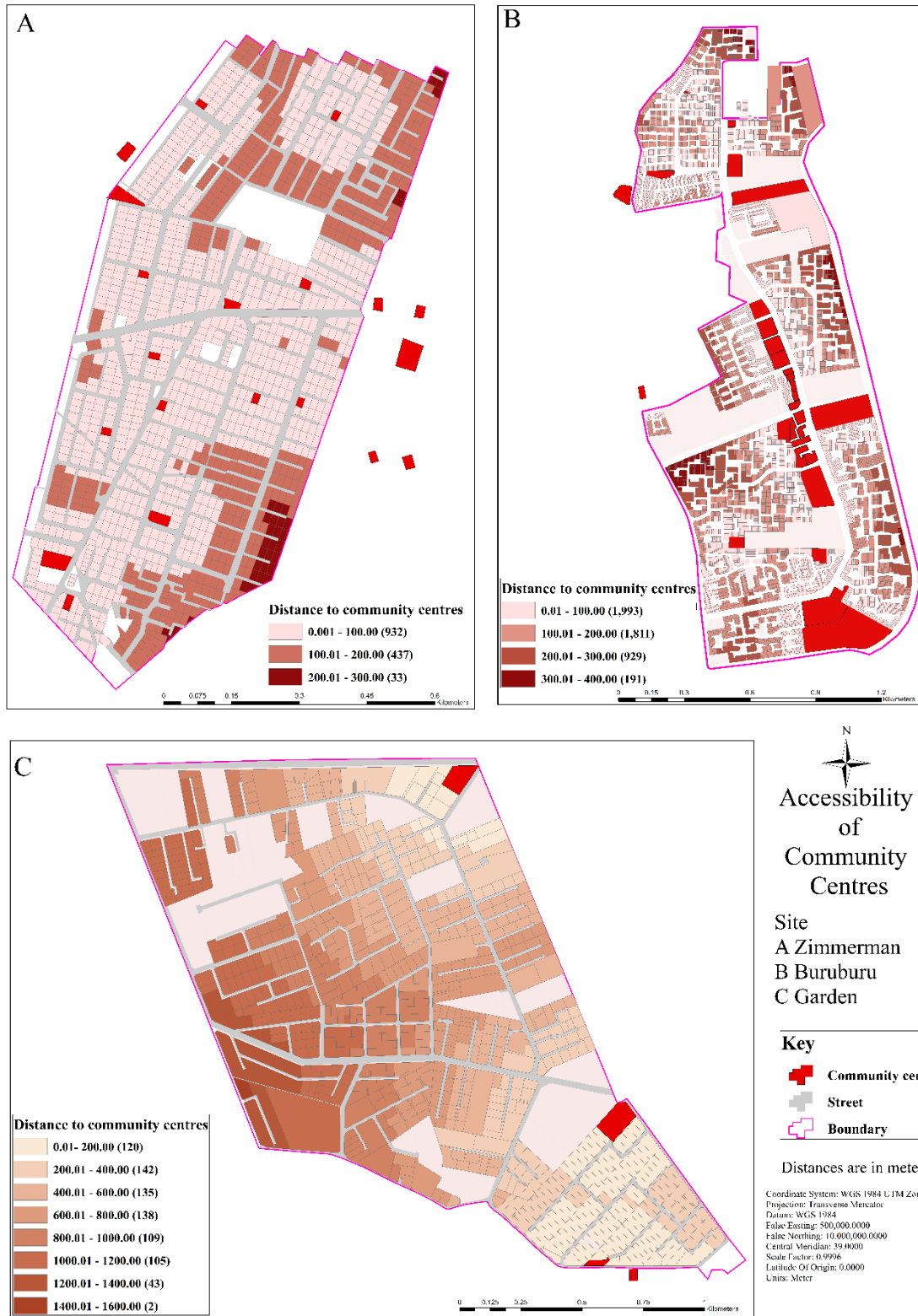


Figure 4-11: Accessibility of community centres in Buruburu, Zimmerman and Garden estates

e) Access of local services

The results in Table 4-16 show that all the plots (100%) are accessible in Buruburu, while in Garden estate, 14% of the plots were accessible, and in Zimmerman, 93% were accessible to local services. Local services are facilities that are used daily or frequently (Suharto, 2012), such as shops, grocery stores, markets, and supermarkets. Accessibility of local services in Buruburu is high, as depicted in Figure 4-12 because the estate has many local services ranging from grocery stores, shops, markets, and supermarkets. Corner shops were planned to be located within each phase of the estate. The informality of the estate has brought the establishment of a market situated along Sonko Road and other shops located within the estate. In Zimmerman, the local services are shops, grocery stores, and supermarkets, which have improved the accessibility of local services within the estate. In Garden estate, no shops are found within the vicinity of the estate; the local services available in this area are only the supermarket, which is located at the edge of the estate, causing the area to have poor accessibility to local services. Zimmerman and Buruburu have high sustainability 5), while Garden estate has low sustainability (1) (Table 24).

Table 4-16: Accessibility of local centre computation

Estate	Buruburu	Garden	Zimmerman
0-100m	2536	14	185
101-200m	1909	17	319
201-300m	342	22	317
301-400m	123	29	300
401-500m	14	26	185
Number of plots within 500m from local services	4924	108	1306
Total number of plots	4924	794	1402
Local services access (%)	100%	14 %	93%

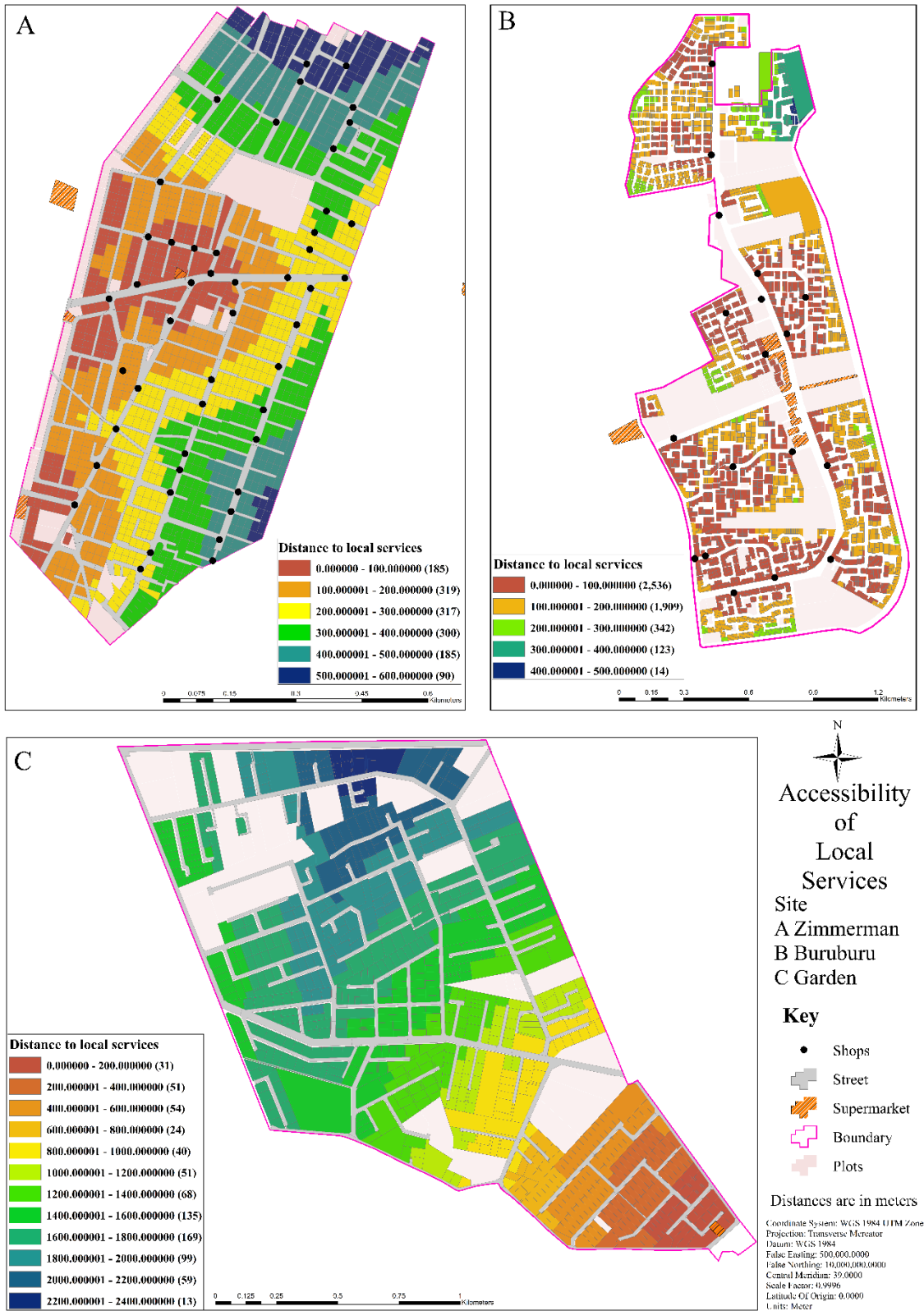


Figure 4-12: Accessibility of local services in Buruburu, Garden and Zimmerman estates

f) Access to emergency services

The results in Table 4-17 indicate that Zimmerman and Buruburu had the lowest response time (1 minute) to emergency services, followed by Garden Estate, which had a time of (2 minutes). The emergency services within the three estates are hospitals and police stations. The average distance to the nearest hospital is 505m, 1438 m, and 255m in Buruburu, Garden, and Zimmerman estates, respectively, as depicted in Figure 4-13. The average distance to the nearest police station is 874m, 1244m, and 872m in Buruburu, Garden, and Zimmerman estates, respectively, as depicted in Figure 4-14. Thus, the average distance between the two emergency services is 690m, 1341m, and 564m in Buruburu, Garden, and Zimmerman estates, respectively. The distance was converted into Km for a more straightforward response time calculation. Response time is the leading indicator in this analysis since, according to WHO, (2021), an ideal response time is equivalent to less than 8 minutes (Cabral et al., 2018). The response time was converted into time taken if the emergency service car traveled at a maximum speed of 50km/hr. The conversion of response distance led Zimmerman and Buruburu to have a response time of 1 minute and Garden estate of 2 minutes. This shows that all emergency services within the three estates follow WHO guidelines. A shorter time indicates a higher sustainability for the neighborhood; hence, an inverse direction was observed when the indicator was normalized. The rationality for providing emergency services is the need for specialized staff and equipment to manage all contingencies or disasters that might occur within a neighborhood (Barton et al., 2021). These facilities aim to enforce law and order, provide security services, investigate crimes, and provide rescue and safety services to the residents against disasters (NCC, 2018). Unfortunately, all three estates lack fire facilities. Only three fire stations in Nairobi are Tom Mboya Street, Industrial Area, and Ruaraka (NCC, 2018). Hence, the provision of a police station and health facilities within easy accessibility has enhanced social equity by reducing disparities when an emergency occurs and promoting the well-being of the community; the provision of a police station has improved safety and security in the estates. Hence, Buruburu and Zimmerman's estates have high sustainability (5), while Garden estates have a medium-low level of sustainability (2) (Table 4-24).

Table 4-17: Emergency response distances computation

Nearest distance to emergency services	Buruburu	Garden	Zimmerman
Average distance to nearest hospital	505 m	1438m	255 m
Average distance to police station	874 m	1244m	872 m
Average distance (m)	690m	1341m	564m
Average distance (Km)	0.69 Km	1.341 Km	0.564 Km
Response time ($\frac{distance}{speed}$)	1 minute	2 minutes	1 minute

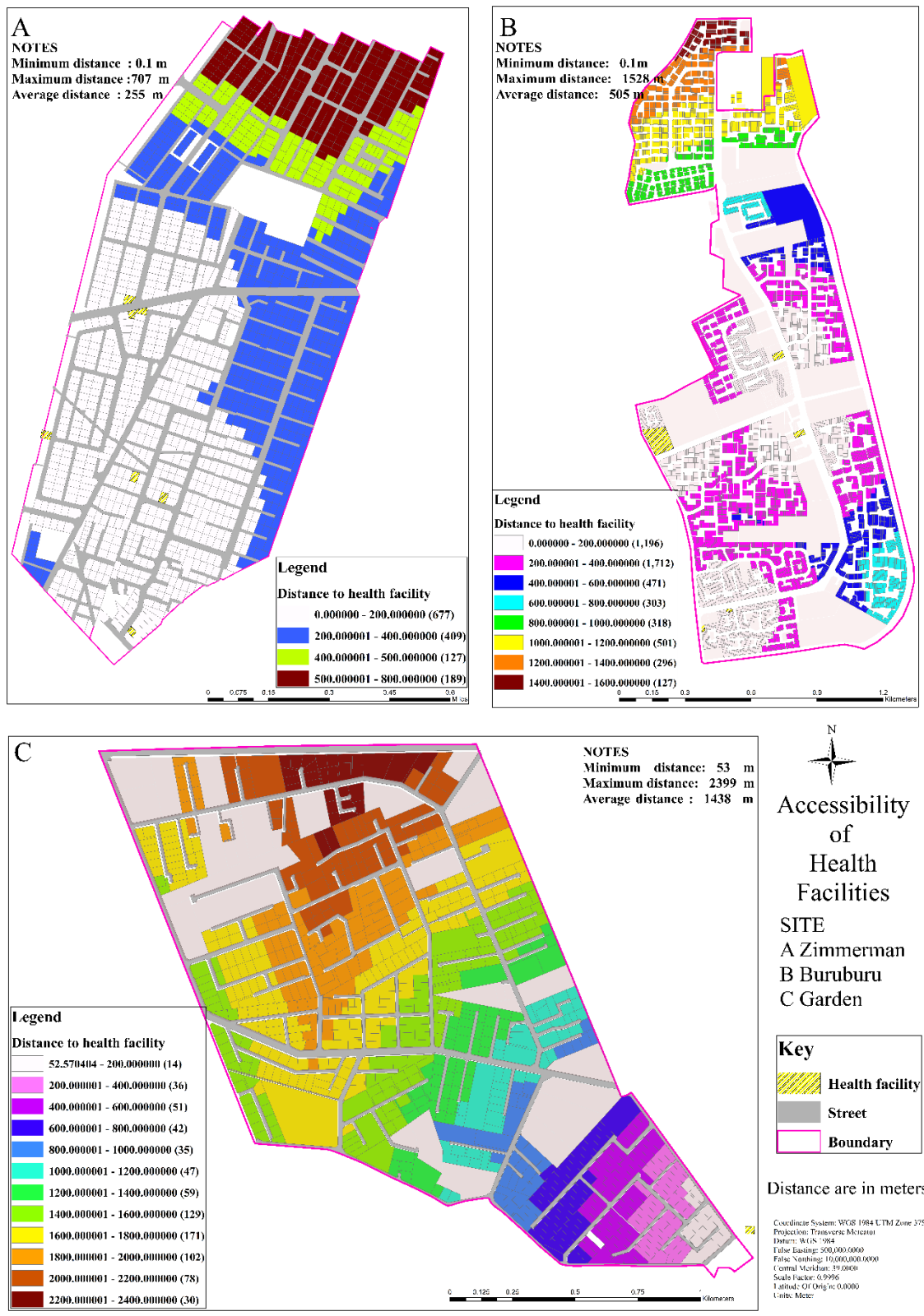


Figure 4-13: Accessibility of health facilities in Buruburu, Garden and Zimmerman estates

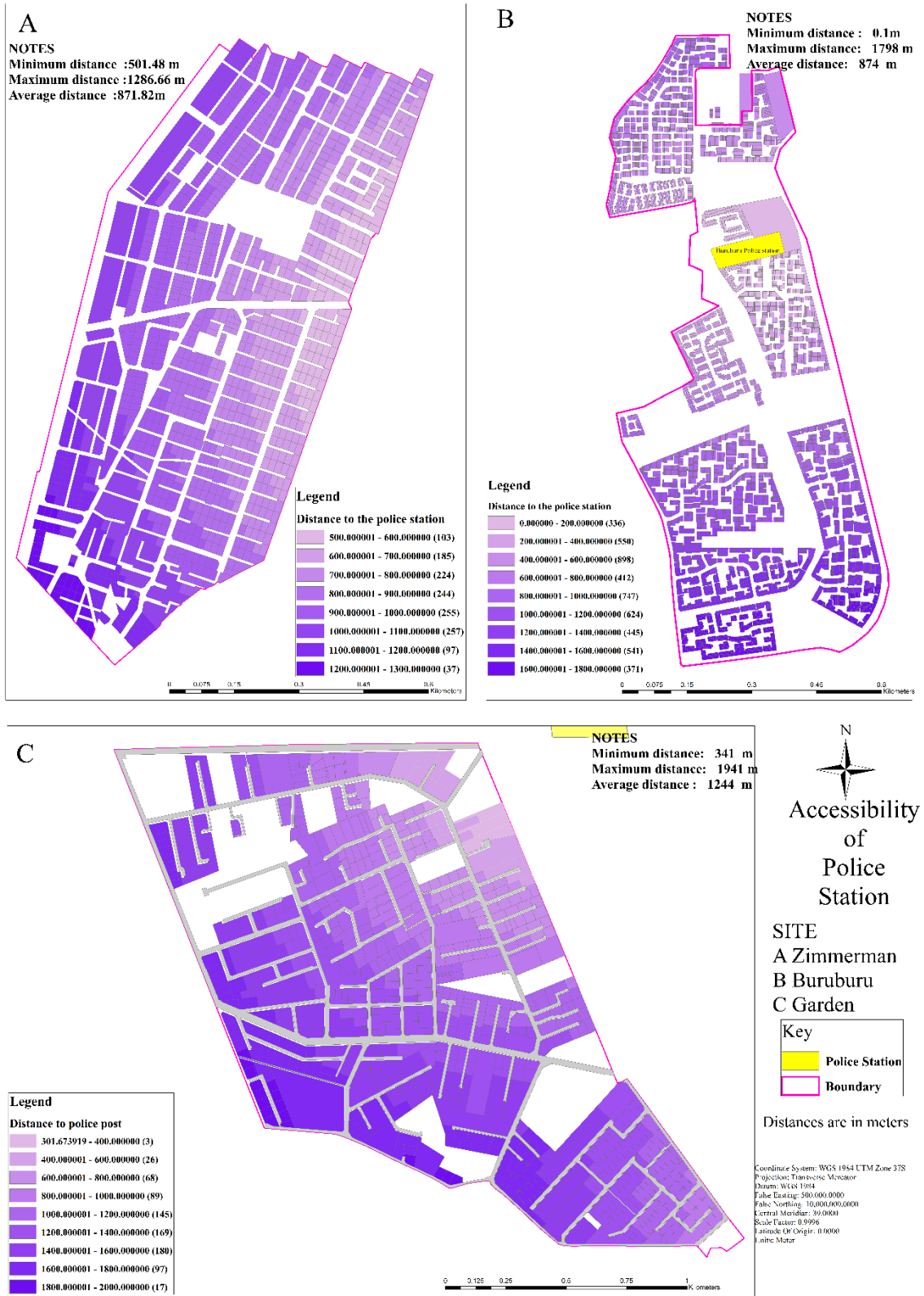


Figure 4-14: Accessibility of police station in Buruburu, Garden and Zimmerman estates

g) Residential satisfaction

Table 4-18 shows that neighbourhood satisfaction were 4.05, 3.95 and 3.19 in Buruburu, Garden and Zimmerman estate respectively. These shows that residents of Buruburu, Garden estate and Zimmerman were all satisfied. Buruburu had the highest score because the neighborhood is safe, was well planned, has various facilities that are adequate and accessible and the area is quiet with moderate density. Garden estate is rated second because it has good facilities, adequate open spaces, serene environment, quiet and not congested and has large parcels of land. The estate lacks NMT facilities and has few public transport facilities causing it to have a lower rating than Buruburu. Zimmerman had a lower satisfaction rating because it is congested, the estate experiences water shortage, has poor roads and poor sanitation. This stated reasons is supported by Huang & Du, (2015) who stated that neighbourhood characteristics such as quietness, aesthetic nature, cleanness and security influence residential satisfaction, while the condition of neighbourhood can lead to residential dissatisfaction.

Table 4-18: Neighbourhood satisfaction of Garden, Zimmerman and Buruburu estates

Estate	Overall satisfaction
Garden estate	3.95
Zimmerman estate	3.19
Buruburu estate	4.05

Kruskal Wallis test was further tested to assess if there was a difference in neighbourhood satisfaction between the three estates (Table 4-19). The Test revealed a significance difference satisfaction level of various facilities across the three estates $p = 0.000$ as shown below. Buruburu had the highest mean of 177.19, Garden estate had a mean of 156.64 and Zimmerman had the lowest mean of 54.20.

Table 4-19: Krusk Wallis test for neighbourhood satisfaction

Neighbourhood Satisfaction	
Chi-Square	132.107
df	2
Asymp . Sig.	.000
Estate	Mean

Buruburu	177.69
Garden	156.64
Zimmerman	54.20

Since the mean of all range from 3 to 5, this shows that the three neighborhoods were sustainable in terms of satisfaction. Buruburu has high sustainability (5) while Garden estate has medium high level of sustainability (4) and Zimmerman has medium sustainability (3) (Table 4-24).

4.3.3 Economic Sustainability

a) Commercial establishments

Provision of commercial establishments was measured by counting the number of different types of businesses within the neighbourhood (Boer et al., 2007). The results for commercial establishment indicate that Zimmerman and Buruburu had the highest number of business types at 7 followed by Garden estate which had 3 (Table 4-20). Zimmerman had the highest number of businesses because of informality, lack on non-compliance to the zoning regulations hence many small scale businesses are established in the area. Most of the residential plots have commercial shops at the ground floor. Buruburu on the other hand has a market and shopping centre. The shopping centre has various diversity of business ranging from banks, supermarkets, boutiques, hotels and private health facilities. Garden estate has low number of business due to high land values hence establishing business in the area may be expensive, land segregation and strict zoning rules that limit establishment of informal business. Provision of commercial establishment helps to boost the economy of the estates since they offer provide employment which in turn promotes economic sustainability of the estates. Buruburu and Zimmerman estate had more commercial establishments hence they have high sustainability (5), while Garden estate has low sustainability (1) (Table 4-24) since it provides low job opportunities hence this does not boost the local economy of the area.

Table 4-20: Type of business in Buruburu, Garden and Zimmerman estates

Type of business available	Buruburu	Garden	Zimmerman
General business	√	x	√
Transport and communication services	√	x	√
Accommodations and catering	√	√	√
Technical and financial services	√	x	√
Private, education, health and entertainment	√	√	√
Industrial services	√	√	√
Small traders	√	x	√
Total business available	7	3	7

Key: √ shows availability x Not available

b) Housing diversity

The results for housing diversity in terms of rent owners indicate that Zimmerman had the highest renters at 87%, followed by Buruburu at 69% and the last was Garden estate had 0% renters as depicted in figure 4-15. This shows that majority of the respondents in Zimmerman and Buruburu were living in rental houses hence the two estates were vibrant and flexible since they enable the residents to have a wide variety of people in terms of household size, age groups and different economic levels. Zimmerman residents were living in rental houses since the area is a high-density area, which provides many residential units as well as variety of houses with different prices, since it is ranging from bedsitters, one bedroom, two bedrooms and three-bedroom housing units. This is line with another study that states that unplanned neighbourhood provides housing for significant proportion of urban dwellers especially the poor and low income, thus such kind of environment offers the cheapest means for owning house or renting (Abdu & Hashim, 2015). In Buruburu, this is attributed to weak development control that led to construction of housing extensions and informality, which has led to home owners to vacate from the area since they felt the quality of services in neighbourhood have reduced and also the attractiveness has reduced the value of the estate. Buruburu was planned to have 3, 4 and 5-bedroom houses. After payment of the mortgage the owners of the houses opted to construct extensions for either income or for their children. This led to construction of single rooms, bedsitter and one

bedroom houses. This has led to the area to have diversity of houses with various prices. This supports study done by Songoro (2015) which states that informality in Buruburu has led to deterioration of services such as water supply, electricity and roads. The social economic characteristics of respondents in Buruburu range from young, middle and elderly people. Zimmerman has high sustainability (5) since it provides highest number of renters while Buruburu has medium high level of sustainability (4) and Garden estate has low sustainability (1) since it did not offer any houses for people to rent (Table 4-24).

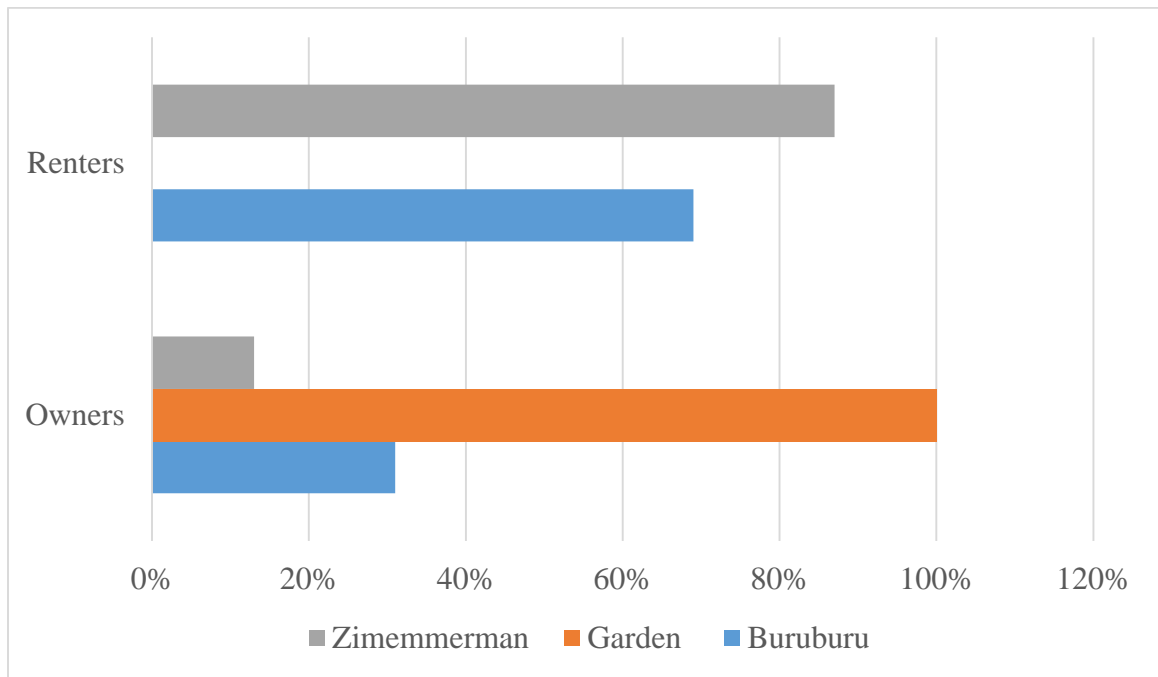


Figure 4-15: House ownership graph for Buruburu, Garden and Zimmerman estates

c) Housing affordability

Table 4-21 shows that results for house affordability, which indicate that Zimmerman had the highest affordable houses at 94%, followed by Buruburu at 86% and the last Garden estate at 0%. Zimmerman had the highest affordable housing since it is a high-density estate hence it can offer more houses because less land is required. Buruburu was planned to accommodate the middle-income earners that were civil servant. The houses were purchased through mortgage payment of 15 years. The first instalment was based on 10% of the total cost. The house cost ranged between KES 36,000 to 320,000. The cost depended

on the number of rooms and phase. According to the respondents who bought the house on mortgage, 77% of them spent less 30% of their income on payment. After complete payment of mortgage, the house owners developed extensions to generate more income. According to the respondents who were renting, 100% of them spent less 30% on rent. The mean value of the two-percentages translated into 86%. Garden estate had no affordable houses since the cost of land is expensive which has reduced affordability. Strict development control standards also limit developers from constructing shanty houses. Zimmerman has high sustainability (5), while Buruburu has medium high level of sustainability (4) and Garden has low level of sustainability (1) (Table 4-24) since the area does not offer affordable houses hence this does not boost the local economy of the area.

Table 4-21: House affordability computation

Estate	Buruburu		Zimmerman		Garden
	Mortgage	Rent	Buying	Rent	Buying
Below 10 %	10.3%	12.8%	-	27.8%	-
10-20%	20.5%	37.2%	-	50.6%	-
21-30 %	46.2%	50%	-	15.2%	-
31-40 %	12.8%	-	-	2.5%	33.3%
Above 40%	10.3%	-	-	3.8%	66.7%
Affordable houses	77%	100%		94%	0
Affordable average	86 %		94%		0%

d) Local job

The results for local job availability (Table 4-21) indicate that Zimmerman had the highest number of people working within the neighbourhood at 78%, followed by Buruburu at 69% and the last Garden estate at 47%. Majority of the residents in Zimmerman work within the neighbourhood and thus they minimize the transport cost. This is supported by various authors that state that low income earners live closer to their work place since they engage in multiple jobs (Nakamura & Avner, 2018), urban residents opt to live closer to job in order to afford food and other expenses (Babijes, 2016) making them to walk to their place of work leading to a reduction of carbon footprint. Majority of respondents in Garden

estate work far away from the neighbourhood since they own cars hence, they don't mind travelling a long distance to place of work. This is in line with the statement that high income people are more likely to commute by personal car or public vehicle to work place (Babijes, 2016) leading to high usage of car in this estate making it to be unsustainable in economic and environmental aspects. The more the estate offers job opportunity the more sustainable it is hence Zimmerman has medium high level of sustainability (4), while Buruburu has a medium sustainability level (3) and Garden estate has a medium low sustainability level (2) (Table 4-23).

Table 4-22: Local job availability computation

Time taken to commute from home to work	B	G	Z
Less than 15 min	45.8%	25%	52.1%
15-30 minutes	23.4%	22.2%	26 %
30minutes – 1 hour	27.1%	11.1%	16.4%
Longer than 1 hour	3.7%	41.7%	5.5 %
Local job	69 %	47 %	78%

Key: B= Buruburu. G= Garden, Z= Zimmerman

Table 4-23: Normalized scores

		Raw scores			Raw values		Normalized scores		
	Indicator	B	G	Z	Min value	Max value	B	G	Z
Environmental	Impervious	33%	30%	75%	30	75	2	2	4
	Intersection density	199	37	212	37	212	4	1	5
	Open space	4.22	13.51	0	0	13.51	2	5	1
	Population density	9,090	6,621	64,329	6,621	64,329	2	1	5
	External connectivity	1,028	1,299	271	271	1299	4	5	1
	NMT	12	0	0	0	12	5	1	1
	Land use mix	0.5	0.3	0.2	0.2	0.5	5	2	1
Social	Access local service	100	14	93	14	100	5	1	5
	Access open space	100	90	0	0	100	5	5	1
	access public transport	100	34	89	34	100	5	2	4
	Access school	100	100	100	100	100	5	5	5
	Access community centre	100	67	100	67	100	5	3	5
	Satisfaction	4.05	3.95	3.19	3.19	4.05	5	4	1
	Emergency services	1	2	1	1	2	1	4	1
Economic	Work within neighbourhood	69	47	78	47	78	3	2	4
	Commercial establishment	7	3	7	3	7	5	1	5
	House affordability	86	0	94	0	94	4	1	5
	House diversity	69	0	87	0	87	3	1	4

Key: B= Buruburu. G= Garden, Z= Zimmerman

Table 4-24: Modified normalized and weighting scores of the sustainability indicators

						Composite scores for each estate		
	Indicator	B	G	Z	Weights	B	G	Z
Environmental	<i>Impervious</i>	4	4	2	0.0475	0.19	0.19	0.095
	<i>Intersection density</i>	4	1	5	0.0475	0.19	0.0475	0.2375
	Open space	2	5	1	0.0475	0.095	0.2375	0.0475
	Population density	2	1	5	0.0475	0.095	0.0475	0.0475
	<i>External connectivity</i>	2	1	5	0.0475	0.095	0.0475	0.2375
	NMT	5	1	1	0.0475	0.2375	0.0475	0.0475
	Land use mix	4	2	1	0.0475	0.19	0.095	0.0475
	Total	23	15	20		1.0925	0.7125	0.95
Social	Access local service	5	1	5	0.0475	0.2375	0.0475	0.2375
	Access open space	5	5	1	0.0475	0.2375	0.2375	0.2375
	access public transport	5	2	4	0.0475	0.2375	0.095	0.19
	Access school	5	5	5	0.0475	0.2375	0.2375	0.2375
	Access community centre	5	3	5	0.0475	0.2375	0.1425	0.2375
	Satisfaction	5	4	3	0.0475	0.2375	0.19	0.1425
	Emergency services	5	2	5	0.0475	0.2375	0.095	0.2375
	Total	35	22	28		1.6625	1.045	1.33
Economic	Local job availability	3	2	4	0.08325	0.24975	0.1665	0.333
	Commercial establishment	5	1	5	0.08325	0.41625	0.08325	0.41625
	House affordability	4	1	5	0.08325	0.333	0.08325	0.41625
	House diversity	3	1	4	0.08325	0.24975	0.08325	0.333
		15	5	18		1.24875	0.41625	1.4985
	Overall sustainability					4	2	3

Sustainability level: 1 = low, 2 = medium-low, 3 = medium, 4 = medium-high and 5 = high sustainability. Indicators highlighted in italics are the ones that were normalized inverse

4.3.4 Overall Sustainability

Normalization of the scores generated from the data on the 7 indicators of environmental sustainability results, it shows that Buruburu and Zimmerman are at a medium sustainability level with a mean of 3, while Garden estate has medium low level of sustainability with a mean of 2 (Table 4-25). Based on the overall normalized indicator scores generated from the data on the 7 indicators of social sustainability, results show that Buruburu has high sustainability with a mean of 5, while Zimmerman is at a medium high level of sustainability (4) and Garden estate is at a medium level of sustainability (3) (Table 4-25). Normalization of the raw indicator scores generated from the data on the 4 indicators of economic sustainability, results show that Zimmerman has high sustainability with a mean of 5, while Buruburu estate has medium level of sustainability with a mean of 3 and Garden estate has a low sustainability level with a mean of 1 (Table 4-25).

Table 4-25: Computation of sustainability index score for different criteria

Sustainability	Buruburu		Garden		Zimmerman	
Economic	15/4	4	5/4	1	18/4	5
Environmental	23/7	3	15/7	2	20/7	3
Social	35/7	5	22/7	3	28/7	4

Key 1= low, 2= medium-low, 3= medium, 4= medium-high and 5= high sustainability.

Through the equal weighting each sustainability dimension had a weighting of 33.3% this was gotten by dividing 100/3 to get 33.3% for each dimension. Economic sustainability had 4 indicators hence the weighting of each indicator in this category was ($\frac{1}{4} \times 0.333 = 0.08325$). Environmental sustainability had 7 indicators hence the weighting of each indicator in this category was ($\frac{1}{7} \times 0.333 = 0.0475$). Social sustainability had 7 indicators hence the weighting of each indicator in this category was 0.0475 (Table 4-36). The aggregated scores for environmental indicators show that Buruburu had the highest score 1.09, followed by Zimmerman at 0.95 Garden estate at 0.71. The aggregated scores for social indicators show that Buruburu had the highest score 1.66, followed by Zimmerman at 1.32 then Garden estate at 1.04. The aggregated scores for economic indicators show that

Zimmerman had the highest score of 1.49, followed by Buruburu at 1.24 then Garden estate at 0.41 (Table 4-26). The composite sustainability index of the three estates is 4.00, 2.17, 3.77 in Buruburu, Garden and Zimmerman estates respectively (Table 4-26). Overall Buruburu has the highest score of 4 indicating a medium high level of sustainability followed by Zimmerman which is at a medium level with a score of 3 and Garden estate which is at a medium low level of sustainability with a score of 2 (Table 4-26).

Table 4-26: Overall sustainability level of Buruburu, Garden and Zimmerman estates

Estate	Environmental	Social	Economic	Composite index score	Overall Sustainability index
Buruburu	1.0925	1.6625	1.24875	4.00375	4
Garden	0.7125	1.045	1.33	2.17375	2
Zimmerman	0.95	0.41625	1.4985	3.7785	3

Key 1= low, 2= medium-low, 3= medium, 4= medium-high and 5= high sustainability.

4.4 Residential Preferences

Nine factors were used to assess residential preference. The factors with a mean of 3 were considered the most important.

4.4.1 Factors Residents Prefer in a Neighbourhood

a) Safety and Security

The results (Table 4-27) show consistency in the three estates, where Garden Estate had a mean of 4.42, Buruburu 4.95, and Zimmerman 4.58, with the majority (75%) in Garden Estate rated it as very important. In contrast (95.2 %) rated it as very important in Buruburu, and (74.7 %) of the respondents rated it as very important in Zimmerman. This shows the factor is very important to residents in low, middle, and high-income areas. Safety is an important aspect to consider when moving into a new area. This supports the study done by Oluwole *et al*, (2022) in Kaduna South, where tenants of this area also indicated security as an important factor. Safety and security make an area attractive for residents and can encourage the residents to stay in the area for a longer time. Safety leads to minimal crime levels, and residents feel safe during the day and night (Shirazi & Keivani, 2019). Buruburu was planned with a police station to enhance the area's security. It is also organized into courts, which enhance the security of the area since a watchman and no one guard in each court can enter the place without the permission of the one in charge. The garden estate is also organized into various courts, which has enhanced the area's security. The estate street design (cul de sac) has further promoted safety, and Zimmerman has a police station that promotes safety in the area.

b) Availability of Open Spaces

Results for availability of open spaces were inconsistent among the three estates. This factor was ranked the 2nd in Garden estate with a mean of 3.77 meaning the residents of this estate considered it as an important factor while in Buruburu this factor was ranked the 6th with a mean of 4.55 hence it was considered as a very important factor in Buruburu even though it a lower ranking. Majority (45%) of the respondents in Garden estate while in Buruburu (69.6 %) and in Zimmerman (32.5 %) of the respondents rated availability of open spaces very important (Table 4-27)

Garden estate residents rated this factor as important due to the value they place for open spaces. Open spaces can be used to sustain a neighbourhood. They can act as buffer zones and separate incompatible land uses, they can also be used to control indoor and outdoor temperature. Open spaces with can be used to regulate greenhouse gases in the atmosphere (Chan, 2014). High vegetation cover makes the area to be pervious hence the area can have minimal floods. The residents of Buruburu also rated this factor as very important since they know the value of open spaces since the area was designed through cluster development. The aim of the design was to provide open spaces within each cluster of houses. The residents of Zimmerman estate do not value open spaces since the area lacks open spaces due to land grabbing, hence overtime they have adopted to stay in an area without open spaces, if these spaces are left vacant or idle, they become spaces for solid waste disposal hence the residents of did not consider this factor as more important. Garden estate is a low-density neighbourhood, with high vegetation cover. The open spaces in the area are adequate. The spaces are used for social gathering, relaxing and as children's playgrounds.

c) Provision of Facilities

Results for the provision of facilities were inconsistent among the three estates. This factor was ranked 5th in Garden Estate, with a mean of 3.2, meaning the residents considered it important. In contrast, in Buruburu, this factor was ranked 2nd with a mean of 4.89, with (92%) stating it as very important; hence, it was considered a very important factor. In comparison, in Zimmerman, the factor was ranked 7th with a mean of 4.16, with the majority (60.2%) stating it as very important (Table 4-27).

Availability of facilities is one factor that affects the demand and choice of residential property because human beings are social beings; hence, they usually seek to dwell in places with maximum facilities at affordable prices. Hence, providing facilities that would enrich the living conditions of people in a neighborhood is essential (Yakubu et al., 2019). One of the main reasons people move to new estates in urban areas is due to the proximity to a range of amenities and convenience made by the availability of these amenities and the ability to walk or use public transport (Allen, 2015). In terms of facilities provision, Zimmerman has inadequate facilities while Buruburu and Garden estate has an adequate

number of facilities. The neighborhood concept used to plan Buruburu ensured the area had various facilities to enhance the estate's quality.

d) Housing of Various Prices

Garden estate residents rated this factor as unimportant, with a mean of 1.87, while Buruburu and Zimmerman rated it as a very important factor, with a mean of 4.54 and 4.20, respectively. This factor was ranked 7th in Garden and Buruburu estates, with the majority (60%) stating it as not important in Garden estate and (71.2 %) rating it as very important in Buruburu. In comparison, it was ranked the 5th in Zimmerman, with the majority (61.4%) rating it as very important (Table 4-27). This shows that residents in low-density areas do not consider the factor important when choosing a residential environment, while residents in high- and medium-density areas consider it important despite the ranking. The residents of Garden Estate don't prefer housing of various prices because they think it will reduce the quality of the neighborhood and their preference for segregation since they are high-income earners. Still, residents of Buruburu and Zimmerman prefer having houses with different price ranges and sizes since they can accommodate anyone regardless of their income. Garden estates have single-dwelling units that come in maisonettes and bungalows. Development control in the area is strict; hence, the permitted land use in the area is only single-family dwelling units. When Buruburu was planned, the houses constructed were 3, 4, and 5 bedrooms. After the mortgage payment, the house owners opted to construct extensions for either income or for their children. This led to the construction of single rooms, bedsitter, and one-bedroom houses. This has led to the area having a diversity of houses with various prices. Zimmerman has various houses at different prices, ranging from bedsitters to one-, two-, and three-bedroom houses. Most of the houses in this estate are bedsitters since the majority of the population in the area are youths. The aim of having different houses is for cohesion and a healthy social network that can make the city develop (UN-Habitat, 2013).

e) Land Use Diversity

The residents of Garden Estate rated this factor as least important, while Buruburu and Zimmerman rated it as very important and important, with a mean of 2.8, 4.46, and 3.73, respectively (Table 4-27). Garden estate residents do not prefer having diverse land use in

the area due to fear of encroachment and informality in a neighborhood. Residents of Buruburu and Zimmerman prefer having a diversity of land use in an estate since it makes the estate lively and promotes social sustainability and economy. Buruburu estate is quite diverse, with land use ranging from commercial, residential, health, education, and recreation, while Zimmerman is mostly commercial cum residential. Diversity of land use should entail mixing various land uses in an area, promoting living, working, and shopping. Mixed-use areas tend to promote social inclusion and walkability; these areas are usually safe and accessible (Bahadure & Kotharkar, 2012). The purpose of having a diversity of land use in an area is to create jobs, promote the local economy, reduce dependency on cars, encourage pedestrian and cyclist traffic, reduce landscape fragmentation, and provide public services closer (UN-Habitat, 2013).

f) Accessibility

The 4th factor in Garden estate is accessibility, with a mean of 3.27, while this factor was the 3rd and the 5th factor in Buruburu and Zimmerman, with a mean of 4.86 and 4.34, respectively (Table 4-27). Accessibility was considered important in Garden Estate and Buruburu and Zimmerman. The more accessible an area is to the various activities in a community, the greater its growth potential. Accessibility is important since it will make an area to be easily accessible.

g) Availability of Local Employment

Availability of local employment was rated as the 8th factor in Garden estate with a mean of 1.67, the 5th with a mean of 4.58 in Buruburu, and the 6th factor with a mean of 4.17 in Zimmerman estate (Table 4-27). Residents of Garden estate consider the availability of local employment within the estate as unimportant since the area is strictly a single-dwelling residential area, and setting up commercial and business facilities will reduce the value of the area. The residents of Buruburu and Zimmerman consider the availability of local employment a very important factor since providing jobs within the estate has boosted the area's economy. The biggest advantage accrued to residents in planned neighborhoods is that they can work and invest in the place they stay without traveling too far. The residents experience economic and non-economic advantages (Murage et al., 2016). Informality in Buruburu has led to increased economic activities due to the creation of new

residential units and commercial buildings, which has increased the area's revenue, leading to economic growth and increased house availability, income, and employment opportunities. The availability of local jobs helps to support the viability of local shops, entertainment places, and recreational places. Community facilities within the neighborhood can help provide diverse work opportunities for the local people. The provision of local jobs also helps to boost the local economy. It allows residents to cycle or walk to their place of work, leading to a reduction of carbon footprint and helping to improve air quality. It increases opportunities for mutual support, local ties, and the need for travel to a client (Barton et al., 2021).

h) Easy Accessibility to Services

The factor was rated important in Garden estate with a mean of 3.3 and very important in Buruburu and Zimmerman with a mean of 4.74 and 4.34, respectively (Table 4-27). This shows residents value providing services such as shops, grocery stores, electricity, water, and waste management. These services are important in a neighborhood since their lack can inhibit an area's development. These services are a key factor in achieving a community's economic and social goals. These services enable an area to function effectively and are essential to residents' well-being and quality of life (Oyedele & Oyesode, 2019).

i) Close Proximity to Workplace

This factor was ranked the last, with a mean of 1.58 and 68.3 % stating it as unimportant in the garden estate. The factor was also ranked the last in Buruburu, with a mean of 3.98 (61.6%), stating it as very important (Table 4-27). This shows that even though this factor was ranked the last, it was still an important aspect for residents of Buruburu. Residents of Garden Estate are high-income earners with cars; hence, they don't mind traveling long distances to their place of work, and this was not an important factor to them. This is in line with the statement by Babijes (2016) that high-income earners are more likely to commute by personal car or public vehicle, making proximity to the workplace a less important factor when choosing a residential area. Buruburu rated it as important since they don't mind traveling, and most of them are car owners; hence, they would not mind traveling a long distance to the workplace, while residents of Zimmerman rated it as the most important factor since they would want to minimize the travel cost. This supports the statement that

low-income earners prioritize proximity to the workplace over more desirable living places. This is important for residents of Zimmerman since they are low-income earners and, hence, engage in multiple jobs (Nakamura & Avner, 2018). Another study supports this statement; it states that urban residents opt to live closer to their jobs to afford food for poor living conditions (Babijes, 2016).

Table 4-27: Residential preference in percentage, mean score and rank

Variable	Estate Rating	Garden estate			Buruburu			Zimmerman estate		
		Percentage	Mean	Rank	Percentage	Mean	Rank	Percentage	Mean	Rank
Safety and security	Not important	0	4.42	1	0	4.95	1	0	4.58	1
	Least important	8.3			0			0		
	Moderate	16.7			0			16.9		
	Important	0			4.8			8.4		
	Very important	75			95.2			74.7		
Open spaces	Not important	6.7	3.77	2	1.6	4.55	6	3.6	3.42	9
	Least important	8.3			0			26.5		
	Moderate	31.7			9.6			26.5		
	Important	8.3			19.2			10.8		
	Very important	45			69.6			32.5		
Provision of facilities	Not important	15	3.20	5	0	4.89	2	3.6	4.16	7
	Least important	16.7			0.8			4.8		
	Moderate	23.3			1.6			24.1		
	Important	23.3			5.6			7.2		
	Very important	21.7			92			60.2		
Housing of various prices	Not important	60	1.87	7	0	4.54	7	0	4.20	5
	Least important	0			0			9.6		
	Moderate	33.3			16.8			21.7		
	Important	6.7			12			7.2		
	Very important	0			71.2			61.4		
Diversity of land use	Not important	30	2.80	6	1.6	4.46	8	9.6	3.73	8
	Least important	16.7			4.8			9.6		
	Moderate	25			5.6			18.1		
	Important	0			22.4			22.9		
	Very important	28.3			65.6			39.8		
Accessibility	Not important	6.7	3.27	4	0	4.86	3	0	4.34	2
	Least important	33.3			1.6			7.2		
	Moderate	23.3			1.6			19.3		

	Important	0			5.6			6		
	Very important	36.7			91.2			67.5		
Availability of local employment	Not important	61.7			0			0		
	Least important	23.3	1.67	8	3.2	4.58	5	10.8	4.17	6
	Moderate	8.3			11.2			18.1		
	Important	0			9.6			14.5		
	Very important	6.7			76			56.6		
Easy accessibility to services	Not important	6.7	3.3	3	0	4.78	4	0	4.34	2
	Least important	23.3			0			6		
	Moderate	33.3			6.4			22.9		
	Important	6.7			9.6			2.4		
	Very important	30			84			68.7		
Close proximity to place of work	Not important	68.3	1.58	9	11.2	3.98	9	0	4.27	4
	Least important	15			7.2			9.6		
	Moderate	8.3			16			16.9		
	Important	6.7			4			10.8		
	Very important	1.7			61.6			62.7		

Key: Mean; Rank

Garden estate residents prefer an area that is secure and safe, with open spaces, easily accessible to services, accessible and has adequate facilities; residents of Buruburu estate prefer an area that is safe and secure, has facilities and is accessible; whereas residents in Zimmerman estate prefer an area that is secure and safe, is accessible and offer easy accessibility to services.

4.4.2 Motivation for Wanting to Leave or Stay in the Estate

The reasons residents live in Garden estate, a low-density area, are that the area is secure, is conducive for a family, and has not changed over time. It is near the CBD, has good facilities and open spaces; the estate is serene, quiet, and not congested; it has a good quality of life and is away from town and large land sizes. Residents prefer low-density areas since they offer more open spaces, large houses, and ample parking spaces (Haque et al., 2020). The upcoming commercial buildings, traffic along Kiambu Road, and noise from the nearest entertainment places are reasons for wanting to move from the estate.

The reasons for living in a medium-density (Buruburu) estate are that the area is secure, accessible facilities are available, houses are owned, the area is quiet and serene, job opportunities are available, accessibility is good, some residents were born there, business opportunities are available, and familiarity and nearness to the workplace are reasons for wanting to move out. The reasons for wanting to move out are increasing congestion, expensive houses, and a decrease in land size.

The reasons the residents stated for living in Zimmerman are the area has affordable houses, has accessible services, and the area is accessible. It also has accessible facilities, is a good business place, has good security, and is available for local jobs. The area is closer to some residents' workplaces. The reasons for wanting to move are the congested area, the water shortage, and poor roads and sanitation. The reasons above support the statement by Alago *et al.*, (2019) they stated that proximity to workplace availability of facilities influences the choice of residents renting the place and that factors such as insecurity make residents dislike the place they would want to move to. An area that is accessible and has land use diversity are attractions that residents consider (Fattah et al., 2018).

4.4.3 Determinants of Residential Preferences

Factor analysis was used to analyse the preference variables and reduce them to more manageable variables. First, Cronbach's alpha was conducted to test the reliability of the variables with a test indicating a value of 0.881 for the 9 variables (Table 4-28), which

shows the variables are consistent and hence are reliable and adequately measured the information obtained from the field. Cronbach's values of 0.7 are acceptable, but 0.8 is preferable (Pallant, 2011). The correlation matrix (Table 4-29) indicates that factor analysis can be used to analyse the variable since the variables are correlated, with (Table 4-30) showing a Kaiser-Meyer Olkin (KMO) value of 0.881, which is above the acceptable limit of 0.5 and the Bartler test of Sphericity χ^2 (1267.181) $p= 0.000$ that shows the test is significant. The Cronbach alpha, KMO, and Bartler test results show the test is appropriate for the variables. Results of the Principal Component Analysis (PCA) using varimax rotation Eigenvalues of >1 retained two factors, which are economic and environmental factors, with variables that had an Eigenvalue less than 1 excluded. Two components had an Eigenvalue of 4.765, accounting for 52.949% of the variance, while the second component had an Eigenvalue of 1.241 accounting for 66.733% (Table 4-31). Table 4-32 also shows that only two components were extracted as factors influencing residential preference. The first component (economic factor) had a significant correlation with seven variables, which are houses of various prices, availability of local employment, proximity to the place of work, easy accessibility to services, accessibility, diversity of land use, and provision of facilities hence this factor can be considered as a socio-economic factor. Houses at various prices, available local employment, and proximity to the place of work had a very high loading of > 0.8 . The second component had a significant loading with six variables: easy accessibility to services, accessibility, availability of open spaces, provision of facilities, and safety and security. The availability of open spaces, the provision of facilities, and safety had a very high loading of >0.7 . Making this factor an environmental factor.

Table 4-28: Reliability test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
.875	.881	9

Table 4-29: Correlation matrix

	SF	OP	FA	HD	DL	AS	AL	ES	CW
SF	1.000								
OP	.280	1.000							
FA	.607	.415	1.000						
HD	.267	.088	.468	1.000					
DL	.259	.287	.443	.508	1.000				
AS	.490	.295	.662	.604	.586	1.000			
AL	.309	.199	.535	.691	.515	.558	1.000		
ES	.466	.253	.637	.581	.577	.768	.589	1.000	
CW	.275	.062	.393	.605	.404	.430	.636	.524	1.000

a. Determinant = .008

SF = safety and security, OP = availability of open spaces, FA = provision of facilities, HD = housing diversity, DL = land use diversity, AS = accessibility, AL = availability of local employment, ES = easy accessibility of services, CW = Close proximity to work place

Table 4-30: KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.881
Bartlett's Test of Sphericity	Approx. Chi-Square	1267.181
	Df	36
	Sig.	.000

Table 4-31: Total variance explained

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	4.765	52.949	52.949
2	1.241	13.784	66.733
3	.780	8.664	75.397
4	.617	6.860	82.257
5	.428	4.758	87.015
6	.374	4.154	91.170
7	.316	3.506	94.676
8	.272	3.019	97.695
9	.207	2.305	100.000

Table 4-32: Rotated component matrix

	Component	
	1	2
House of various prices	.862	
Availability of local employment	.823	
Close proximity to place of work	.814	
Easy accessibility to services	.701	.486
Accessibility	.648	.558
Diversity of land use	.618	
Availability of open spaces		.772
Facilities provided	.466	.727
Safety and security		.712

Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization ^a

Multiple regression was then conducted on the economic (Factor 1) and environment (Factor 2) to test which socioeconomic variables affect them. Table 4-33 shows the overall fit for the model for the two factors. The R square of the model for factor 1 is 0.529, which shows that the regression can explain 52.9% of the variation in the residential preference. The p-value was less than 0.001, making the model significant for the study. The R square of the model for factor 2= 0.227. This shows that the regression can explain 22.7 % of the variation in the residential preference. The p-value was less than 0.001, making the model significant for the study. The f-test for factor 1 in (Table 4-34) shows zero variance in the dependent variables. The test =43.834, and p is < 0.05. This shows the test is highly significant, and the model explains a significant amount of the variance in residential preference. The f-test for factor 2 shows zero variance in the dependent variables. The test =12.189, and p is < 0.05. This shows the test is highly significant, and the model explains a significant amount of the variance in residential preference.

Table 4-33: Model summary for factor 1 and factor 2

Model Summary									
		Std. Error			Change Statistics				
		R	Adjusted	of the	R Square	F	Sig. F		
Model	R	Square	R Square	Estimate	Change	Change	df1	df2	Change

1	.736 ^a	.541	.529	.68636329	.541	43.824	7	260	.000
Model	.497a	.247	.227	.87930795	.247	12.189	7	260	.000
2									
a. Predictors: (Constant), Household size, age, education, residential class, gender, years lived in the estate, house ownership									
b. Dependent Variable: A-R factor score 1 and 2									

Table 4-34: F test for factor 1 and factor 2

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	144.515	7	20.645	43.824	.000 ^b
	Residual	122.485	260	.471		
	Total	267.000	267			
Model 2	Regression	65.973	7	9.425	12.189	.000 ^b
	Residual	201.027	260	.773		
	Total	267.000	267			

Table 4-35 shows the significant variables in the overall model for factors 1 and 2. House ownership ($\beta = -0.229$, $t = -3.712$, $p = 0.000$), residential density ($\beta = 0.488$, $t = 9.942$, $p = 0.000$), age ($\beta = -0.235$, $t = -5.164$, $p = 0.000$) and household size ($\beta = -0.15$, $t = -3.339$, $p = 0.001$) were found to be significant. Years lived in the estate, density, and income had a positive effect on economic factors, while house ownership, gender, age, education, and household size had a negative effect on preference. It is evident from (Table 4-35 that) the residential class has the highest beta coefficient of 0.488. This means that residential density was the major contributor to residential preference. The results show that economic factors such as local employment provision, houses of various prices, and proximity to jobs are highly influenced by density, income, house ownership, age, and household size. This shows that residents of high-density areas prefer economic factors, while residents of low-density areas do not value these factors. Factor 2, House ownership ($\beta = -0.289$, $t = 3.663$, $p = 0.000$), years lived in the estate ($\beta = -2.17$, $t = -2.957$, $p = 0.003$, residential class ($\beta = 0.477$, $t = 7.585$, $p = 0.000$), education ($\beta = 0.202$, $t = 3.516$, $p = 0.001$) and household size ($\beta = 0.212$, $t = 3.679$, $p = 0.000$). House ownership, residential class, education, and household size

positively affected environmental factors, while years lived in the estate had a negative effect. The results show that income, house ownership, age, education, and household size are highly influenced by environmental factors such as the availability of open spaces, provision of facilities, and safety. This shows that residents of low density, house owners, elderly and educated people, and households of > 3 people value environmental factors. It is evident from (Table 4-35) that residential density also has the highest beta coefficient of 0.477 in factor 2. This shows residential preferences among residents of different neighbourhood densities differ.

Table 4-35: Coefficients for factor 1 and factor 2

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.529	.342		1.548	.123
	House ownership	-.464	.125	-.229	-3.712	.000
	Years lived in the estate	.059	.036	.095	1.659	.098
	Residential density	.612	.062	.488	9.942	.000
	Gender	-.080	.089	-.040	-.892	.373
	Age	-.073	.014	-.235	-5.164	.000
	Education	-.128	.051	-.113	-2.518	.012
	Household size	-.090	.027	-.150	-3.339	.001
	Model	(Constant)	-3.460	.438		-7.900
2	House ownership	.587	.160	.289	3.663	.000
	Years lived in estate	-.135	.046	-.217	-2.957	.003
	Residential density	.599	.079	.477	7.585	.000
	Gender	.013	.114	.006	.111	.912
	Age	.046	.018	.147	2.532	.012
	Education	.229	.065	.202	3.516	.001
	Household size	.127	.034	.212	3.679	.000

5 CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the findings of the research on neighbourhood sustainability assessment. Each paragraph summarizes an objective. The aim of the study was to:

- 1 To examine adequacy of facilities in Buruburu, Zimmerman and Garden residential neighbourhoods.
- 2 To assess environmental, social and economic sustainability in Buruburu, Zimmerman and Garden residential neighbourhoods.
- 3 To assess factors that influence residential sustainability preference in Buruburu, Zimmerman and Garden residential neighbourhoods.

5.2 Summary of Findings

5.2.1 Adequacy of Facilities

The provision of facilities in the estates has been overwhelmed by urbanization, poor management, land-grabbing population, and informality. Buruburu estate had inadequate facilities due to the increase in population and informality in the area. Informality led to the grabbing of open spaces and deficient land size for some facilities. Zimmerman Estate had inadequate facilities due to informality in the area and high population density, which led to facilities with deficient land sizes. Garden Estate had adequate facilities due to the low population and unchanged nature; hence, no spaces were grabbed, and all facilities had the required land sizes. Facilities usage varied across the three estates. The usage of facilities was high in Zimmerman due to the high population, which led to high demand, availability, and accessibility, encouraging many residents to use them. Facilities usage in the garden estate was moderate due to low accessibility and quality. Facilities usage was high in the Buruburu estate due to availability and accessibility, with a preference for adequacy and affordability. Accessibility of facilities in the three estates varied across the three neighbourhoods. Accessibility of facilities in the neighbourhood depended on type, location, and number. Buruburu estate offered greater accessibility to facilities due to high numbers and their location. Facilities such as schools, recreation areas, and bus stops were

evenly distributed and high in numbers, which made accessibility great. Banks, supermarkets, and colleges were not spatially distributed across the Buruburu estate but were centrally located, leading to greater accessibility. Garden estates offered lower accessibility of facilities due to low numbers and location. Schools and open spaces were evenly distributed, which led to high accessibility. In contrast, facilities such as banks, supermarkets, and bus stops were unevenly distributed and low in numbers, leading to low accessibility in Garden estate. Zimmerman also offered greater accessibility due to the evenly distributed facilities and high numbers. Accessibility was the most considered factor in encouraging the use of facilities within a neighbourhood regardless of income level, gender, or age. Accessibility of facilities by mode was consistent in two estates while inconsistent in one estate, with the majority of residents in Buruburu accessing facilities by walking due to the location of facilities and design of the neighbourhood, which provided mixed transport options. In Zimmerman estate, access to the majority of the facilities was by walking due to the street design, which offered shorter routes—in Garden estate, the majority of the residents used cars due to the street design of the area and the dispersed distribution of facilities.

5.2.2 Neighbourhood Sustainability

Assessment of neighbourhood sustainability across the three estates reveals strengths, challenges and opportunities for improvement. Each neighbourhood had its strengths and weaknesses. Regarding environmental sustainability, the Buruburu estate had a higher index, followed by Zimmerman, then Garden estate. Buruburu had high levels of sustainability in the following indicators: Non-motorised transport, impervious surface, intersection density, and land use mix due to its planned nature. However, it scored lower in indicators such as open space provision, population density, and external connectivity. Zimmerman Estate had high sustainability scores in the following indicators: intersection density, population density, external connectivity due to its design, and high density. However, it had a lower score in the following indicators: open space provision, land use mix, non-motorized transport, and impervious surface and external connectivity. Garden estate had a high sustainability score on two indicators: impervious surface and open spaces

provision due to low density. However, it scored lower in intersection density, population density, land use mix, external connectivity, and non-motorized transport.

Regarding social sustainability, the Buruburu estate had a higher index, followed by the Zimmerman and Garden Estate. Buruburu estate also had the highest score in all the assessed indicators. Zimmerman estate had high scores for indicators such as access to local services, school, community centre, emergency services, public transport, and satisfaction. However, it had a lower score in open space accessibility due to informality. Garden estate scored higher for indicators such as school accessibility, open spaces, satisfaction, and community centre. However, it had a lower score in accessibility of local and emergency services.

Regarding economic sustainability, Zimmerman estate scored highest, followed by Buruburu, then the Garden estate. Zimmerman estate had a higher score on all the indicators. Buruburu estate also had high scores for all four indicators. Garden estate, on the other hand, had lower scores in all four indicators. Overall, Buruburu emerged to be the most sustainable in terms of social and economic sustainability even though it had experienced informality. Informality in the area boosted economic sustainability since it established many businesses and a diversity of housing. However, informality affects environmental sustainability, especially regarding open space provision. The planned nature of the estate has enhanced its social sustainability by enhancing its accessibility to facilities. Zimmerman's estate was highly sustainable in economic sustainability due to high opportunities such as affordable housing, housing diversity, and commercial establishments, which have helped boost the area's economy. Garden estate had a medium social sustainability rating but a lower economic sustainability rating due to the lack of diversity of businesses and houses. The design of the streets in this estate also led to a lower sustainability level of environmental indicators.

5.2.3 Residential Preferences

This study also seeks to understand sustainability factors residents consider important when moving into an estate. Residential preferences guide the development of sustainable neighborhoods by influencing design priorities that the residents like. Aligning

neighborhood planning with these preferences ensures the long-term sustainability of the neighborhoods. The results for preferences among the three estates were inconsistent. Residents of Garden estate preferred an area that is secure and safe, with open spaces, easily accessible to services, accessible and has adequate facilities; residents of Buruburu estate preferred an area that is safe and secure, has facilities, and is accessible, whereas residents in Zimmerman estate preferred an area that is secure and safe, is accessible and offer easy accessibility to services. Safety and security were important factors across the three estates. Residents in Garden estate prefer an area with single land use, are likely to commute to work, and have more housing choices, unlike the residents in Buruburu and Zimmerman estate, who prefer an area with mixed land use that is closer to a place of work since it reduces dependency on daily communicating to save on transport cost. Socioeconomic characteristics such as density, income, education, household size, house ownership, and age influenced residential preferences for households.

5.3 Conclusion

The provision of facilities is not in harmony with the neighbourhoods' population due to the twin problem of increased population and lack of adequate land. There is a need, therefore, for clustering through merging and consolidation to attain the required land size and provide adequate and accessible facilities within walking distance of the residents. Accessibility of facilities should be encouraged in every neighbourhood regardless of income or density. Neighbourhood street design influences the mode of transport used to access the facilities. In contrast, curvilinear design favours private cars since the streets are longer, while grid pattern design encourages walking as the streets are shorter and one can have many alternative routes. The assessment of the adequacy of facilities within residential neighbourhoods underscores the critical importance of ensuring that residential neighbourhoods have access to essential facilities that meet the diverse needs of the residents. Adequate facilities enhance quality of life, promote community well-being, and foster social cohesion.

High-density neighbourhoods are sustainable in economic sustainability due to the provision of diverse housing, affordable housing, and diverse business activities that provide employment to the locals and contribute to the local economy. However, they are

accessible with inadequate open spaces due to their unplanned nature. Low-density neighbourhoods have low sustainability in economic criteria because of low business activities, lack of housing diversity, and affordable houses. Still, they also exhibit some strength in environmental sustainability due to adequate open spaces and low pervious surfaces. The major challenge is the curvilinear street design, a key feature of neighbourhood security that reduces connectivity and leads to the high usage of private cars. The medium-density neighbourhood is sustainable in terms of social criteria since it is accessible and economic criteria due to its planned nature and has diverse housing, affordable houses, and business activities that boost the local economy. The major challenges are weak public and private resident association enforcement, which has led to irregular extensions and grabbing of open and public spaces, increased business activity, and housing diversity. Low density was found to increase environmental sustainability by reducing impervious surfaces and increasing open spaces but reduces economic sustainability due to a decrease in housing diversity, affordable housing, and commercial establishment. High density increases economic sustainability due to increased housing diversity, affordable houses, and a high number of commercial establishments. High-density areas can become more sustainable by having adequate facilities such as open spaces while low-density areas can become sustainable by having more accessible facilities. Assessing the sustainability of the different neighbourhood densities shows that each neighbourhood has strengths and weaknesses across the assessment criteria and indicators, which calls for striking a delicate balance between them. Thus, planning policy should maximize the area's strengths while addressing their weaknesses to enhance overall sustainability. The study's findings also provided the guidelines for determining residential development sustainability.

Without intervention, the environmental degradation in these high density areas could worsen, affecting both quality of life and resilience to climate change. Addressing these issues would require incorporating more green spaces, and increasing the permeable areas to balance the density. Low density neighbourhoods face long-term challenges in becoming economically vibrant unless there are interventions to promote business development, affordable housing, and better connectivity. Sustainable mobility solutions such as public transport and bike lanes could help reduce car dependence. Medium-density

neighbourhoods present the most promising model for sustainable urban development. With proactive planning and policies to preserve green spaces, improve environmental practices, and support inclusive business development, these neighbourhoods could serve as sustainable models for Nairobi and similar cities.

Assessment of residential preferences across high, medium, and low-density neighbourhoods reveals the desires of the residents. Each neighbourhood had advantages and challenges that influenced residents' preferences when moving into an estate. Thus, understanding residential preferences among high, medium, and low-density neighbourhoods is important for planners and policy makers in the development of residential areas.

5.4 Recommendations

1. Inadequacy of facilities was caused by land grabbing hence the set-aside land uses (plots) for utilities and facilities during planning should be surrendered and titling be done to curb land grabbing
2. Kenya lacks planning standards and guidelines for sustainable neighbourhoods, which needs to be included especially in planning guidelines and design principles.
3. Kenya lacks accessibility standards for health, commercial, religious institution and bus stops in a neighbourhood. There is need, therefore, for adoption of planning standards, like Rwanda planning standards for neighbourhood, since most of the facilities were accessible by this standard.
4. Buruburu was planned but undergone informality which led to change its pattern hence planned neighbourhoods require post-development enforcement to maintain neighbourhood character, avoid overcrowding, and maintain sustainability level.
5. Planners should align urban policies with residential preferences, neighbourhoods can achieve long-term sustainability while enhancing liveability for residents

5.5 Areas for Further Study

1. Explore how zoning laws influence sustainability of residential neighbourhoods
2. Assess neighbourhood sustainability across different cities in Kenya
3. Assess sustainability across neighbourhoods with same density

REFERENCES

- Abdu, A., & Hashim, A. H. (2015). Comparison of Residential Satisfaction among Young Households in Three Unplanned Neighbourhoods in Kano Metropolis , Nigeria. *Journal of Humanities and Social Science*, 20(3), 42–53.
<https://doi.org/10.9790/0837-20344253>
- Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and How of it ? *Indian Journal of Medical Specialities*, 4(2), 330–333.
<https://doi.org/10.7713/ijms.2013.0032>
- Adewumi, S. A., Onyango, V., Moyo, D., Waer, A. H., & Dawodu, A. (2023). Conceptualising the characteristics of the indicators of a neighbourhood sustainability assessment framework in a developing country context. *Environmental Impact Assessment Review*, 102. <https://doi.org/10.1016/j.eiar.2023.107197>
- Agwa, A. K. (2014). *Urban Informality in Planned Neighbourhoods A case of Home Based Enterprises in Buru-Buru Estate in Nairobi County*. University of Nairobi.
- Ahmad, S. (2020). Sustainable Neighbourhood Development in Emerging Economies: A Review. *SHLC*, 1–30.
- Ahmad, S., Wong, K. Y., Zahid, I., Hussain, Z., Salman, M., & Sarfraz, M. (2019). Normalization and weighting methods for precise and standardized sustainability assessment : recent practices in manufacturing Normalization and weighting methods for precise and standardized sustainability assessment : recent practices in manufacturing. *IOP Conference Series: Materials Science and Engineering*, 670, 8–15. <https://doi.org/10.1088/1757-899X/670/1/012016>
- Ahmed, K. G. (2013). Social sustainability in public neighbourhoods in the UAE: The case of Al Ain. *International Journal of Sustainable Society*, 5(4), 309–335.
<https://doi.org/10.1504/IJSSOC.2013.056842>
- Akinbamide, S., & Adegoke, O. (2022). Housing Preference and Choice of Nigerians : Evidence from the Organised Private Sector Housing. *Advances in Social Sciences Research Journal*, 9(3), 361–371.
- Al-Hagla, K. S. (2008). Towards a Sustainable Neighborhood: the Role of Open Spaces. *International Journal of Architectural Research: ArchNet-IJAR*, 2(2), 162–177.

<https://doi.org/10.26687/archnet-ijar.v2i2.239>

- Alago, D., Kilika, J. M., & Oringo, J. O. (2019). Consumer Behavior and Choice of Housing in Kenya : A Case of Selected Residential Rental Estates in Nairobi City County. *American Scientific Research Journal for Engineering, Technology and Sciences*, 51(1), 13–27.
https://www.asrjetsjournal.org/index.php/American_Scientific_Journal/article/view/4559/1616
- Alanbari, M. A., Alisawy, A. J., & Abdulqader, W. A. M. (2014). Selecting Urban Sustainability Indicators For Residential Neighborhoods In Iraqi City. *Journal of Babylon University/Engineering Sciences*, 22(4).
- Alasmari, N. (2020). Mixed Methods Research: An Overview. *International Journal of Social Science and Human Research*, 03(09). <https://doi.org/10.47191/ijsshr/v3-i9-04>
- Allen, N. (2015). Understanding the Importance of Urban Amenities: A Case Study from Auckland. *Buildings*, 5, 85–99. <https://doi.org/10.3390/buildings5010085>
- Anjali, A., Narad, V., Priya, A., & Gupta, V. (2014). Role of Sustainable Neighbourhood in Urban Built Environment. *IOSR Journal of Mechanical and Civil Engineering*, 27(2005), 27–31.
- Anyamba, T. (2011). Informal Urbanism in Nairobi. *Built Environment*, 37(1), 57–77.
- APHA. (1960). Planning the Neighborhood Standards for Healthful Housing. In A. A. Twichell (Ed.), *The University of Michigan: Vol. XXX*.
- Armin, R., Pouria, F., & Hossein, E. (2021). *Sustainable Neighborhood Planning*.
- Aurbach, L. (2005). *TND Design Rating Standards 2.2*.
- Awad, Z. E. (2019). Sustainable Urban Growth of Neighborhoods-A Case Study of Alryad-Khartoum. *Journal of Engineering and Architecture*, 7(1).
<https://doi.org/10.15640/jea.v7n1a10>
- Azmi, D. I., Abdul, H. K., & Ahmad, P. (2013). Comparative Study of Neighbourhood Walkability to Community Facilities between Two Precincts in Putrajaya. *Procedia - Social and Behavioral Sciences*, 105, 513–524.
<https://doi.org/10.1016/j.sbspro.2013.11.055>
- Azmi, D. I., & Ahmad, P. (2015). A GIS Approach: Determinant of Neighbourhood

- Environment Indices in Influencing Walkability between Two Precincts in Putrajaya. *Procedia - Social and Behavioral Sciences*, 170, 557–566.
<https://doi.org/10.1016/j.sbspro.2015.01.057>
- Azmi, D. I., & Karim, H. A. (2012). A Comparative Study of Walking Behaviour to Community Facilities in Low-Cost and Medium Cost Housing. *Procedia - Social and Behavioral Sciences*, 35, 619–628. <https://doi.org/10.1016/j.sbspro.2012.02.129>
- Babijes, R. M. (2016). *Kenya Urbanization Review* (No. AUS8099; 13).
- Baffoe, G., Malonza, J., Manirakiza, V., & Mugabe, L. (2020). *Understanding the Concept of Neighbourhood in Kigali City, Rwanda*.
- Bahadure, S., & Kotharkar, R. (2012). Social Sustainability and Mixed Landuse , Case Study of Neighborhoods in Nagpur , India. *Bonfring International Journal of Industrial Engineering and Management Science*, 2(4), 76–83.
<https://doi.org/10.9756/BIJIEMS.1744>
- Bahadure, S., & Kotharkar, R. (2015). Assessing sustainability of mixed use neighbourhoods through residents’ travel behaviour and perception: The case of Nagpur, India. *Sustainability (Switzerland)*, 7(9), 12164–12189.
<https://doi.org/10.3390/su70912164>
- Bahadure, S., & Kotharkar, R. (2018). *Framework for measuring sustainability of neighbourhoods in Nagpur , India*. 127(October 2017), 86–97.
- Bahale, S., & Schuetze, T. (2023). Comparative Analysis of Neighborhood Sustainability Assessment Systems from the USA (LEED–ND), Germany (DGNB–UD), and India (GRIHA–LD). *Land*, 12(1002). <https://doi.org/10.3390/land12051002>
- Banyikwa, W. F. (1990). Signatures of four generations of urban planning in Nairobi,Kenya. *Journal of Eastern African Research & Development*, 20, 186–201.
- Barton, H., Grant, M., & Guise, R. (2003). *Shaping Neighborhoods A guide for health, sustainability and vitality* (1st editio). Spon Press Taylor & Francis.
- Barton, H., Grant, M., & Guise, R. (2006). *Shaping Neighborhoods* (2nd editio). Spon Press.
- Barton, H., Grant, M., & Guise, R. (2021). *Shaping Neighbourhoods: For Local Health and Global Sustainability* (Third Edit). Routledge.
- Beatley, T., & Collins, R. (2000). *Smart Growth and Beyond : Transitioning to a*

- Sustainable Society. *Virginia Environmental Law Journal*, 19(3), 287–322.
- Berrigan, D., Pickle, L. W., & Dill, J. (2010). Associations between street connectivity and active transportation. *International Journal of Health Geographics*, 9(20), 1–18.
- Blair, R., & Wellman, G. (2011). Smart growth principles and the management of urban sprawl. *Community Development*, 42(4), 494–510.
<https://doi.org/10.1080/15575330.2011.567419>
- Boer, R., Zheng, Y., Overton, A., Ridgeway, G. K., Cohen, D. A., Survey, T., & Urbanism, T. N. (2007). *Neighborhood Design and Walking Trips in Ten U.S. Metropolitan Areas*. 32(4), 298–304. <https://doi.org/10.1016/j.amepre.2006.12.012>
- Brown, V., Barr, A., Scheurer, J., Magnus, A., Zapata-diomed, B., & Bentley, R. (2019). Better transport accessibility , better health : a health economic impact assessment study for Melbourne , Australia. *International Journal of Behavioral Nutrition and Physical Activity*, 1–10. <https://doi.org/10.1186/s12966-019-0853-y>
- Byun, N., Choi, Y., & Choi, J. (2014). Neighborhood unit: Effective or obsolete? *Journal of Asian Architecture and Building Engineering*, 13(3), 617–624.
<https://doi.org/10.3130/jaabe.13.617>
- Cabral, E. L. dos S., Wilkson, R. S. C., Florentino, D. R. de M., Viana, D. de A., Junior, J. F. da C., Souza, R. P. de, Amália, C. M. R., Irami, A.-F., & Medeiros, A. C. (2018). *Response time in the emergency services . Systematic*. 33(12), 1110–1121.
- Carter, M., & Horwitz, P. (2014). Beyond Proximity : The Importance of Green Space Useability to Self-Reported Health. *EcoHealth*. <https://doi.org/10.1007/s10393-014-0952-9>
- Chakraborty, A., & Mcmillan, A. (2018). Is Housing Diversity Good for Community Stability ?: Evidence from the Housing Crisis. *Journal of Planning Education and Research*, 1–12. <https://doi.org/10.1177/0739456X18810787>
- Chan, E. H. W. (2014). *Design considerations for environmental sustainability in high density development : A case study of Hong Kong. April 2009*.
<https://doi.org/10.1007/s10668-007-9117-0>
- Choguill, C. L. (2008). Developing sustainable neighbourhoods. *Habitat International*, 32, 41–48. <https://doi.org/10.1016/j.habitatint.2007.06.007>
- CNU. (2001). *Charter of the New Urbanism*. Congress for the New Urbanism.

www.cnu.org

- Cochran, W. G. (1977). *Sampling techniques*. John Wiley & Sons.
- Cockx, K., & Canters, F. (2020). Determining heterogeneity of residential location preferences of households in Belgium. *Applied Geography, 124*.
<https://doi.org/10.1016/j.apgeog.2020.102271>
- Creswell, J. W. (2014). *Research Design Qualitative, Quantitative and Mixed Methods Approaches* (V. Knight (ed.); Fourth Ed.). SAGE Publications.
- Crowe, S., Cresswell, K., Robertson, A., Hubby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology, 11*(1), 100.
<https://doi.org/10.1186/1471-2288-11-100>
- Dehghanmongabadi, A., Hoskara, S., & Shir Khanloo, N. (2014). Introduction to Achieve Sustainable Neighborhoods. *International Journal of Arts and Commerce, 3*(9), 16–26.
- Dempsey, N., Brown, C., & Bramley, G. (2012). The key to sustainable urban development in UK cities ? The influence of density on social sustainability. *Progress in Planning, 77*(3), 89–141. <https://doi.org/10.1016/j.progress.2012.01.001>
- Dierkx, D. (2019). *The Process of Urban Renewal in Nairobi , Kenya : A Case Study on Citizen Participation within the Renewal of Nairobi City County Estates*. [Wageningen University]. <https://edepot.wur.nl/476345>
- Dill, J. (2004). Measuring network connectivity for bicycling and walking. In *83rd Annual Meeting of the Transportation Research Board* (No. 04–3550).
<http://reconnectingamerica.org/assets/Uploads/TRB2004-001550.pdf>
- Dos Santos, G. P. D. O., Gonçalves, A., & Mezzomo, M. M. (2017). Sustainability Indicators Applied To Neighbourhood Scale. *4th Responsible Management Education Research Conference*.
- Driscoll, C. O., Crowley, F., Doran, J., & McCarthy, N. (2023). Measuring land-use mixing across the Republic of Ireland : source data comparisons. *Journal of Maps, 19*(1), 1–7. <https://doi.org/10.1080/17445647.2023.2214165>
- Duggan, P. D. (2007). *Incorporating Neighborhood Social Patterns into Neighborhood Planning Models* [Clemson University]. https://tigerprints.clemson.edu/all_theses/
169

- EU. (2008). *Handbook on Constructing Composite Indicators*. OECD.
<https://doi.org/10.1787/533411815016>
- Fakere, A. A., & Ayeni, D. A. (2013). Communal Facilities and Residential Neighbourhoods in Akure, Nigeria. *The International Institute for Science, Technology and Education (IISTE)*, 3(1), 48–57.
- Falk, N., & Carley, M. (2012). *Sustainable urban neighbourhoods: Building communities that last*.
- Fattah, H. A., Badarulzaman, N., & Ali, K. (2018). *Residential Preferences in Residential Location Choice Household Preferences in Penang Island, Malaysia*. 5(2), 43–56.
- Forkuor, D., Kyei, P. O., & Forkuor, J. B. (2013). Land Usage Changes and its Effects on the Provision of Social Facilities to Residents of the Kumasi Metropolis of Ghana. *Ethiopian Journal of Environmental Studies and Management*, 6(3).
<https://doi.org/10.4314/ejesm.v6i3.14>
- Gan, X., Fernandez, I. C., Guo, J., Wilson, M., Zhao, Y., Zhou, B., & Wu, J. (2017). When to use what : Methods for weighting and aggregating sustainability indicators. *Ecological Indicators*, 81, 491–502. <https://doi.org/10.1016/j.ecolind.2017.05.068>
- Geodev. (2015). *Digital Topographical Mapping and Preparation of Integrated Strategic Urban Development Plan for Cluster III Towns*.
- Gibberd, J. (2014). *Neighbourhood Facilities for Sustainability Neighbourhood facilities for sustainability. September 2013*. <https://doi.org/10.2495/SC130191>
- Hajjar, I. (2015). *The implications for neighbourhood social sustainability of the governance process in the provision of local facilities : case studies in Aleppo, Syria*.
- Haque, B., Choudhury, C., & Hess, S. (2020). Understanding differences in residential location preferences between ownership and renting: A case study of London. *Journal of Transport Geography*, 88(October), 102866.
<https://doi.org/10.1016/j.jtrangeo.2020.102866>
- Harris, J. M. (2003). Sustainability and Sustainable Development. *International Society for Ecological Economics*, 1–12.
- Harris, R., & Hay, A. (2007). New plans for housing in urban Kenya , 1939 – 63. *Planning Perspectives*, 22(2), 195–223. <https://doi.org/10.1080/02665430701213580>
- Hasanzadeh, K., Kyttä, M., & Brown, G. (2019). Beyond Housing Preferences : Urban

- Structure and Actualisation of Residential Area Preferences. *Urban Science*.
<https://doi.org/10.3390/urbansci3010021>
- Henry, A. B., Ernest, A. A., & Akpabio, A. M. U.-. (2021). *Causes and Environmental Problems of Petrol Filling Stations in Residential Domain of Nigeria Town. VIII(I)*, 272–276.
- Herbert, C., Hermann, A., & Mccue, D. (2018). Measuring Housing Affordability : Assessing the 30 Percent of Income Standard. *Joint Center for Housing Studies of Harvard University*.
- Hilley, J., & Sim, S. (2020). Context-Based Neighborhood Sustainability Assessment in Birmingham , Alabama. *Sustainability*.
- Huang, Z., & Du, X. (2015). Assessment and determinants of residential satisfaction with public housing in Hangzhou, China. *Habitat International*, 47, 218–230.
<https://doi.org/10.1016/j.habitatint.2015.01.025>
- Iannillo, A., & Fasolino, I. (2021). Land-Use Mix and Urban Sustainability : Benefits and Indicators Analysis. *Sustainability*, 13.
- Ikenna, S. E., & Hoskara, S. O. (2019). Methodological weaknesses in the measurement approaches and concept of housing affordability used in housing research : A qualitative study. *Plos ONE*, 14(8), 1–27. <https://doi.org/10.1371/journal.pone.0221246>
- Im, N. H., & Choi, C. G. (2019). The hidden side of the entropy-based land-use mix index : Clarifying the relationship between pedestrian volume and land-use mix. *Urban Studies*, 56(9), 1865–1881. <https://doi.org/10.1177/0042098018763319>
- Isaacs, R. R. (1948). The Neighborhood Theory: An Analysis of its Adequacy. *Journal of the American Planning Association*, 14(2), 15–23.
<https://doi.org/10.1080/01944364808978605>
- Jabareen, Y. (2005). Culture and Housing Preferences in a Developing City. *Environment and Behavior*, 37(1), 134–146. <https://doi.org/10.1177/0013916504267640>
- Jacobs, J. (1961). *The Death and Life of Great American Cities* (1st ed.). Random House.
<https://doi.org/10.4324/9780203873960-8>
- Jansen, S. J. T. (2020). Urban , suburban or rural ? Understanding preferences for the residential environment. *Journal of Urbanism: International Research on*

- Placemaking and Urban Sustainability*, 13(2), 213–235.
<https://doi.org/10.1080/17549175.2020.1726797>
- JCWG, & SJPTWG. (2022). *Towards the Just City in Kenya*. <https://library.fes.de/pdf-files/bueros/kenia/19072-20220531.pdf>
- Jenks, M., & Dempsey, N. (2005). *Future Forms and Design for Sustainable Cities* (First Edit). Elsevier.
- Jenks, M., & Jones, C. (2010a). *Dimensions of Sustainable City*. Springer.
- Jenks, M., & Jones, C. (2010b). *Dimensions of the Sustainable city* (M. Jenks & C. Jones (eds.); 2nd ed.). Springer.
- Jia, P., Pan, X., Liu, F., He, P., Zhang, W., Liu, L., Zou, Y., & Chen, L. (2021). *Land use mix in the neighbourhood and childhood obesity*. 22, 1–11.
<https://doi.org/10.1111/obr.13098>
- Jia, Y., Zheng, Z., Zhang, Q., Li, M., & Liu, X. (2020). Associations of Spatial Aggregation between Neighborhood Facilities and the Population of Age Groups Based on Points-of-Interest Data. *Sustainability*, 1–16.
- Jimmy, E. N., Martinez, J., & Verplanke, J. (2020). Spatial Patterns of Residential Fragmentation and Quality of Life in Nairobi City , Kenya. *Applied Research in Quality of Life*, 15, 1493–1517.
- Jozsa, A., & Brown, D. (2005). *Neighborhood Sustainability Indicators Report on a Best Practice Workshop*.
- Kamble, T., & Bahadure, S. P. (2022). A sustainability assessment framework for population density in central Indian cities. *International Journal of Architectural Research*, 16(1), 134–153. <https://doi.org/10.1108/ARCH-05-2021-0142>
- Kataoka, Y. (2020). Analysis on accessibility to urban facilities using the flexible distance attenuation function. *Japan Architectural Review*, 3(3).
<https://doi.org/10.1002/2475-8876.12158>
- Khajouei, A. S. (2017). *Urban Form and Social Sustainability in Neighborhood Level*. Univeristy of Texas.
- Khan, A. M. (2020). Revisiting Planning standards of Community Facilities for Urban Areas in Bangladesh. *Journal of Bangladesh Institute of Planners*, 13, 47–68.
- Khatibi, M., Khaidzir, M. K. A., & Mahdzar, S. S. S. (2023). Measuring the sustainability

- of neighborhoods: A systematic literature review. *IScience*, 26(2).
<https://doi.org/10.1016/j.isci.2023.105951>
- Khavarian-Garmsir, A. R., Sharifi, A., Abadi, H. M. H. H., & Moradi, Z. (2023). From Garden City to 15-Minute City : A Historical Perspective. *Land*, 1–15.
- Khavarian-Garmsir, A. R., Sharifi, A., & Sadeghi, A. (2023). The 15-minute city: Urban planning and design efforts toward creating sustainable neighborhoods. *Cities*, 132(October 2022), 104101. <https://doi.org/10.1016/j.cities.2022.104101>
- Kieti, R. M., Rukwaro, R. W., & Olima, W. (2020). Affordable Housing in Kenya :Status, Opportunities and Challenges. *Africa Habitat Review Journal*, 14(1).
- Kipngeno, P. (2014). *A Study on Housing Preferences of Low Income Tenant Households in Shauri Moyo, Nairobi, Kenya* (Vol. 3, Issue 2).
<http://journal.stainkudus.ac.id/index.php/equilibrium/article/view/1268/1127>
- KNBS. (2019). *Kenya Population and Housing Census Volume I : Population by County and Sub-County: Vol. I*. <https://www.knbs.or.ke/2019-kenya-population-and-housing-census-results/>
- KNBS. (2023). *Economic Survey 2023*.
- Kolbadi, N., Mohammadi, M., & Namvar, F. (2015). Smart Growth Theory as One of the Main Paradigms of Sustainable City. *International Journal of Review in Life Sciences*, 5(9), 209–219.
- Kuffer, M., & Barros, J. (2011). Urban Morphology of Unplanned Settlements : The Use of Spatial Metrics in VHR Remotely Sensed Images. *Procedia Environmental Sciences*, 7, 152–157. <https://doi.org/10.1016/j.proenv.2011.07.027>
- Laari, P. B., Bayorbor, S. A., & Sagoe, G. (2019). Urban land use planning and its effects on the provision of public sanitation facilities in the Wa Municipality , Ghana. *Journal of Geography and Regional Planning*, 12(4), 60–75.
<https://doi.org/10.5897/JGRP2019.0741>
- Landis, R., & Koch, G. G. (1977). A One-Way Components of Variance Model for Categorical Data. *International Biometric Society*, 33(4), 671–679.
<https://www.jstor.org/stable/2529465>
- Lang, W., Chen, T., Chan, E. H. W., Yung, E. H. K., & Lee, T. C. F. (2018). Understanding livable dense urban form for shaping the landscape of community

- facilities in Hong Kong using fine-scale measurements. *Cities*, 135, 0–1.
<https://doi.org/10.1016/j.cities.2018.07.003>
- Li, J., Auchincloss, A. H., Rodriguez, D. A., Moore, K. A., Roux, A. V. D., & Sánchez, B. N. (2019). Determinants of Residential Preferences Related to Built and Social Environments and Concordance between Neighborhood Characteristics and Preferences. *J Urban Health*. <https://doi.org/10.1007/s11524-019-00397-7>
- Lin, K. W., & Shih, C. M. (2018). The comparative analysis of neighborhood sustainability assessment tool. *Environment and Planning B: Urban Analytics and City Science*, 45(1), 90–105. <https://doi.org/10.1177/0265813516667299>
- Lotfi, S., & Javad, M. (2009). Measuring objective accessibility to neighborhood facilities in the city (A case study: Zone 6 in Tehran, Iran). *Cities*, 26, 133–140.
<https://doi.org/10.1016/j.cities.2009.02.006>
- Lucky, E. U. (2021). *A Technical Report for A Proposed Residential Neighborhood Design along Oda/ Cocoa Board Road, Oda Akure South Local Government, Ondo State.*
- Maiyo, E. K. (2020). *Assessment of Urban Neighborhood Sustainability : A Case Study of Ngara Estate , Nairobi.*
- Makachia, P. A. (2013). Design strategy and informal transformations in urban housing: A study of the contribution of design strategy to dweller-initiated transformations using comparative case study analyses of Buru-Buru and Kaloleni housing estates in Nairobi, Kenya. *Journal of Housing and the Built Environment*, 28(1), 167–186.
<https://doi.org/10.1007/s10901-012-9310-9>
- Martins, M. S., Rosa, F. D. R., & Kalil, L. R. M. (2021). Sustainable neighbourhoods : applicable indicators through principal component analysis. *Urban Design and Planning*, 174(1), 25–36.
- Masiga, E. S. (1975). *The Neighborhood Unit Concept and its Application to Planning in Nairobi, Kenya.* University of Nairobi.
- Mavoja, S., Boulangé, C., Eagleson, S., Stewart, J., Badland, H. M., Giles-corti, B., & Gunn, L. (2018). Identifying appropriate land-use mix measures for use in a national walkability index. *The Journal of Transport and Land Use*, 11(1), 681–700.

- Meenakshi. (2011). Neighborhood Unit and its Conceptualization in the Contemporary Urban Context. *India Journal, September*, 81–87.
- Miri, S. H., Miri, S. B., & Maghsoudi, M. R. (2020). Urban Renewal through Sustainable Development: A Case Study in Iran. *American Journal of Engineering and Applied Sciences, 13*(1), 10–20. <https://doi.org/10.3844/ajeassp.2020.10.20>
- Mitullah, W., Vanderschuren, M., & Khayesi, M. (2017). *Non-Motorized Transport Integration into Urban Transport Planning in africa* (W. Mitullah, M. Vanderschuren, & M. Khayesi (eds.); First, Issue June). Routledge.
- Mokhtar, A. H., & ElDabosy, M. M. (2017). Urban Sustainability Evaluation of New Communities in Nile Delta Northern Coast. *The 1st International Conference: Towards A Better Quality of Life*, 1–12. <https://doi.org/10.2139/ssrn.3162310>
- Molaei, P., Tang, L., & Hardie, M. (2021). Measuring Walkability with Street Connectivity and Physical Activity: A Case Study in Iran. *World, 2*(1), 49–61. <https://doi.org/10.3390/world2010004>
- Moreno, C. (2022). The 15-minute city offers a new framework for sustainability, liveability, and health. *Planetary Health, 6*(3). [https://doi.org/10.1016/S2542-5196\(22\)00014-6](https://doi.org/10.1016/S2542-5196(22)00014-6)
- Moroke, T., Schoeman, C., & Schoeman, I. (2020). Neighbourhood Sustainability Assessment Model for Developing Countries: A Comprehensive Approach to Urban Quality of Life. *Int. J. Sus. Dev. Plann., 15*(1), 107–123. <https://doi.org/10.2495/SDP-V15-N1-107-123>
- Muchiri, L. K. (2014). *Provision of Solid Waste Management System in Zimmerman Area, Nairobi County*.
- Muiga, J. G., & Rukwaro, R. W. (2016). Satisfaction of Residents with Gated Community Lifestyle: The Case of Nairobi County; Kenya. *BEST:International Journal of Humanities ,Arts,Medicine and Sciences, 4*(12), 85–104.
- Muiga, J., & Rukwaro, R. (2017). *Satisfaction among Residents over Recreation Facilities : A Case of Kasarani Neighbourhood in Nairobi City*. 22(2), 70–84. <https://doi.org/10.9790/0837-2202037084>
- Murage, C. (2019). *The Quality of an Urban Residential Neighbourhood: a Case Study of Umoja I Estate, Nairobi*.

- Murage, C., Mwaura, A., & Ayonga, J. (2016). The Quality of an Urban Residential Neighbourhood: A Case Study of Umoja I Estate, Nairobi. *African Journal of Emerging Issues (AJOEI)*, 2(8), 41–60.
- Mwangi, J., Abiero, G., & Micah, M. (2021). The Impact of Street Layout Design on Non-Motorized Activities with Nairobi City, Kenya. *Current Urban Studies*, 09(02), 252–278. <https://doi.org/10.4236/cus.2021.92017>
- Mwaniki, B. W., Gakuya, D. W., Mwaura, A. M., & Muthama, N. J. (2019). A New Frontier in Collaborative Approaches in Sustainable Open Spaces Delivery in Nairobi City. *Africa Habitat Review*, 13(1), 1587–1599.
- Nakamura, S., & Avner, P. (2018). *Spatial Distributions of Job Accessibility, Housing Rents, and Poverty in Nairobi, Kenya* (No. 8654). <http://www.worldbank.org/research>.
- NCC. (2004). *A guide of Nairobi City Development Ordinances and Zones*.
- NCC. (2018a). *Nairobi County Intergrated Development Plan*.
- NCC. (2018b). *Nairobi County Intergrated Development Plan (CIDP) 2018-2022*. <https://nairobi.go.ke/download/cidp-county-integrated-development-plan-2018-2022/>
- Ng'etich, J., Kiplagat, A., Khazenzi, J., Odhiambo, K., & Lagat, M. J. (2022). Citizen Perception of Green Spaces Prioritization in Urban Kenya : The Case of Kisumu City and Eldoret Municipality. *Africa Environmental Review*, 5(2), 68–76.
- Njeri, P., Munala, G., & Letema, S. (2023). Environmental sustainability performance of eleven upgraded informal settlements in Kenyan cities. *Journal of Housing and the Built Environment*. <https://doi.org/10.1007/s10901-023-10060-y>
- Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys : what can be done ? *Assessment & Evaluation in Higher Education*, 33(3), 301–314. <https://doi.org/10.1080/02602930701293231>
- Oguche, C., Noah, A., & Gwani, S. (2019). The Implications of Unplanned Settlement On Environmental Quality in Gwagwalada Town Abuja, Nigeria. *International Journal of Academic Research in Business, Arts and Science*, 1(1), 12–31. <https://doi.org/10.5281/zenodo.3362600>
- Olayiwola, A. M., & Adeyemi, O. A. (2019). Spatial Preference of Urban Residential

- Location in Osogbo , Nigeria. *Ghana Journal of Geography*, 11(1), 140–158.
<https://dx.doi.org/10.4314/gjg.v11i1.9>
- Olima, W. (2013). Residents’ Participation in Neighbourhood Management and Maintenance: Experiences and Lessons from Nairobi, Kenya. *Housing Symposium*, 3, 293–305.
- Oluwole, O. A., Yaro, U. H., & Remilekun, S. A. (2022). Effects of Socio-Economic Factors on Tenants’ Residential Preference in Barnawa and Television Areas in Kaduna South. *Journal of Applied Ecology Env. Design*, 22(4), 225–238.
www.hummingpubng.com
- Onyango, V., & Adewumi, A. S. (2021). Selecting Indicators for Assessing Neighbourhood Sustainability : The Metropolitan Lagos Workflow. *European Scientific Journal*, 17(2), 170. <https://doi.org/10.19044/esj.2021.v17n2p170>
- Owoicho, B. C., & Ogwuche, J. A. (2018). Assessment of Social Factors that Influence Residential Area Preference in Otukpo Town, Benue State. Nigeria. *Global Journal of Human Social Science*, 18(1).
- Oyedele, J. B., & Oyesode, M. F. (2019). Residents’ Perception of Importance and Satisfaction with Infrastructure in Selected Public Housing Estates in Osun State, Nigeria. *Nigerian Journal of Environmental Sciences and Technology*, 3(2), 398–409. <https://doi.org/10.36263/nijest.2019.02.0152>
- Pallant, J. (2011). SPSS Survival Manual. In *Automotive Industries AI* (4th editio, Vol. 181, Issue 4).
- Patricios, N. N. (2002). The Neighborhood Concept: A Retrospective of Physical Design and Social Interaction. *Journal of Architectural and Planning Research*, 19(1), 70–90.
- Pauzi, H. M., Hajar, S. B. A., & Lukman, Z. M. (2017). The Evaluation of Neighborhood Facilities and Services of Low Cost Housing (LCH) in Kuala Terengganu : Residential Satisfaction Perspective. *International Journal of Academic Research in Business and Social Sciences*, 7(3). <https://doi.org/10.6007/IJARBSS/v7-i3/2770>
- Perola, G., & Dos, D. E. O. (2017). Sustainability Indicators Applied to Neighbourhood Scale. *4th Responsible Management Education Reserach Conference*.
- Perry, C. (1929). The Neighborhood Unit. In *Regional New York and Its Environs: Vol.*

- VII (pp. 636–637).
- Phrasisombath, K. (2009). *Sample size and sampling methods*.
- Pollesch, N. L., & Dale, V. H. (2016). Normalization in sustainability assessment : Methods and implications. *Ecological Economics*, 130, 195–208.
<https://doi.org/10.1016/j.ecolecon.2016.06.018>
- PPD. (2007). *Draft Physical Planning Handbook*. Ministry of Lands, Physical Planning Department.
- Rahman, M., & Neema, M. N. (2015). A GIS Based Integrated Approach to Measure the Spatial Equity of Community Facilities of Bangladesh. *AIMS Geosciences*, 1(1), 21–40. <https://doi.org/10.3934/geosci.2015.1.21>
- Rahnama, M. R., Roshani, P., Hassani, A., & Hossienpour, S. A. (2012). Use Principles of New Urbanism Approach in Designing Sustainable Urban Spaces. *International Journal of Applied Science and Technology*, 2(7), 195–203.
- Rani, M. W. N. W. M. (2013). *Understanding the usage pattern of local facilities in urban neighbourhood towards creating a livable city*.
- Rani, M. W. N. W. M. (2014). Understanding the Usage Pattern of Local Facilities in Urban Neighbourhood towards Creating a Livable City. *American Transactions on Engineering & Applied Sciences*, 3(2), 129–148.
- Rohe, W. M. (2009). From Local to Global: One hundred Years of Neighborhood Planning. *Journal of the American Planning Association*, 75(2), 209–230.
<https://doi.org/10.1080/01944360902751077>
- RoK. (2010). *The Constitution of Kenya*.
- RoK. (2016). *National Housing Policy Sessional Paper No.3*.
- RoK. (2018a). *Kenya Affordable Housing Programme Urban Design Guidelines*.
- RoK. (2018b). *Sector Plan for Population, Urbanization and Housing*.
- RoK. (2019). *Nairobi City County Trade Licensing Act (No. 2)*. Government Printer.
- RoK. (2024). *First Draft Physical and Landuse Planning Handbook*.
- RoR. (2015). *Rwanda Urban Planning Code*.
- RPC, & NCC. (2019). *Nairobi Metropolitan Services Improvement Project Urban Renewal of Eastlands, Nairobi*.
- Rukwaro, R. W., & Olima, W. H. A. (2003). Developer profits undermine residents'

- satisfaction in Nairobi's residential neighbourhood : Implications for local government in Kenya. *Habitat International*, 27, 143–157.
- Rwanga, S. S., & Ndambuki, J. M. (2017). Accuracy Assessment of Land Use / Land Cover Classification Using Remote Sensing and GIS. *International Journal of Geosciences*, 8, 611–622. <https://doi.org/10.4236/ijg.2017.84033>
- Saif, M. A., Zefreh, M. M., & Torok, A. (2018). Public Transport Accessibility : A Literature Review. *Periodica Polytechnica Transportation Engineering*, 1–8. <https://doi.org/10.3311/PPtr.12072>
- Salazar, S. del S., & Menéndez, L. G. (2007). Estimating the non-market benefits of an urban park: Does proximity matter? *Land Use Policy*, 24(1), 296–305. <https://doi.org/10.1016/j.landusepol.2005.05.011>
- Satterthwaite, D. (2015). *Sustainable cities – and how cities can contribute to sustainable development*. 1–23.
- Saville-smith, K., Lietz, K., Bijoux, D., & Howell, M. (2005). *Neighbourhood Sustainability Framework : Prototype*.
- Schmidt, S., & Barron, C. (2020). Mapping Impervious Surfaces Precisely — a GIS-Based Methodology Combining Vector Data and High-Resolution Airborne Imagery. *Journal of Geovisualization and Spatial Analysis*, 4(14).
- Seto, K. C., & Dhakal, S. (2014). Human Settlements, Infrastructure, and Spatial Planning. In R. Cervero & J. T. Martinez (Eds.), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, (pp. 923–1000)*. Cambridge University Press.
- Shao, Z., Fu, H., Fu, P., & Yin, L. (2016). Mapping Urban Impervious Surface by Fusing Optical and SAR Data at the Decision Level. *Remote Sensing*, 1–21. <https://doi.org/10.3390/rs8110945>
- Sharifi, A. (2016). From Garden City to Eco-urbanism: The quest for sustainable neighborhood development. *Sustainable Cities and Society*, 20, 1–16. <https://doi.org/10.1016/j.scs.2015.09.002>
- Sharifi, A., & Murayama, A. (2012). A critical review of seven selected neighborhood sustainability assessment tools. *Environmental Impact Assessment Review*, 38, 73–

87. <https://doi.org/10.1016/j.eiar.2012.06.006>
- Shekhar, S. (2015). *Smart Neighbourhood : A way to Sustainable Development*. 978, 773–789.
- Shi, H., Zhao, M., Simth, D. A., & Chi, B. (2021). Behind the Land Use Mix : Measuring the Functional Compatibility in Urban and Sub-Urban Areas of China. *Land*, 11(2). <https://doi.org/10.3390/land11010002>
- Shirazi, M. R., & Keivani, R. (2019). The triad of social sustainability : Defining and measuring social sustainability of urban neighbourhoods. *Urban Research & Practice*, 12(4), 448–471. <https://doi.org/10.1080/17535069.2018.1469039>
- Shrivastava, R., & Sharma, A. (2011). Smart Growth : A Modern Urban Principle. *Architecture Research*, 1(1), 8–11. <https://doi.org/10.5923/j.arch.20110101.02>
- Silverman, B. W. (2003). *Density Estimation for Statistics and Data Analysis*.
- Smith, M. E. (2010). The archaeological study of neighborhoods and districts in ancient cities. *Journal of Anthropological Archaeology*, 29(2), 137–154. <https://doi.org/10.1016/j.jaa.2010.01.001>
- Sobieraj, J., Marín, M. F., & Metelski, D. (2023). Mapping of impervious surfaces with the use of remote sensing imagery : Support Vector Machines classification and GIS-based approach. *Archives of Civil Engineering*, 129–146. <https://doi.org/10.24425/ace.2023.146071>
- Songoro, D. O. (2015). *Influence of Informalisation of Planned Housing Neighborhoods on Management of Public Inftasructure Assests: A case of Buruburu Estate, Nairobi, Kenya*.
- Spencer, J., & Angeles, Æ. G. (2007). Kernel density estimation as a technique for assessing availability of health services in Nicaragua. *Health Serv Outcomes Res Method*, 7, 145–157. <https://doi.org/10.1007/s10742-007-0022-7>
- Suhaida, M. S., Tawil, N. M., Hamzah, N., Che-ani, A. I., Basri, H., & Yuzainee, M. Y. (2011). Procedia Engineering Housing Affordability : A Conceptual Overview for House Price Index. *The 2nd International Building Control Conference 2011 Housing*, 20, 346–353. <https://doi.org/10.1016/j.proeng.2011.11.176>
- Suharto, T. (2012). *Measuring Neighbourhood Sustainability : A Comparative Analysis of Residential Types in Malaysia*. Queensland University of Technology.

- Taherdoost, H. (2016). Sampling Methods in Research Methodology ; How to Choose a Sampling Technique for Research. *SSRN Electronic Journal*, 5(2), 18–27.
<https://doi.org/10.2139/ssrn.3205035>
- Talukder, B., Hipel, K. W., & W. van Loon, G. (2017). Developing Composite Indicators for Agricultural Sustainability Assessment: Effect of Normalization and Aggregation Techniques. *Resources*. <https://doi.org/10.3390/resources6040066>
- Teddlie, C., & Yu, F. (2007). Mixed Methods Sampling: A Typology With Examples. *Journal of Mixed Methods Research*, 1(1), 77–100.
<https://doi.org/10.1177/2345678906292430>
- Thuo, M. D. A. (2013). Impacts of Urbanization on Land Use Planning , Livelihood and Environment in The Nairobi Rural-Urban Fringe, Kenya. *International Journal of Scientific & Technology Research*, 2(7), 70–79.
- Tregoning, H., Agyeman, J., & Shenot, C. (2002). Sprawl , Smart Growth and Sustainability Sprawl , Smart Growth and Sustainability. *Local Environment*, 7(4), 341–347. <https://doi.org/10.1080/1354983022000027464>
- Umdu, D. Ç., & Alakavuk, E. (2022). Sustainable Communities , Neighborhoods , Cities and Their Criteria. *The European Journal of Research and Development*, 2(2), 287–300.
- UN-Habitat. (2013). *New strategy of sustainable neighborhood planning Five Principles*.
- UN-Habitat. (2014). *Urban Planning for City Leaders* (2nd editio).
- UN-Habitat. (2015). A New Strategy of Sustainable Neighbourhood Planning: Five Principles. In *Urban Planning Discussion Note 3*.
- UN-Habitat. (2016a). *UN-Habitat Support to Sustainable Urban Development in Kenya Addressing Urban Informality* (Vol. 4).
- UN-Habitat. (2016b). *Urbanization and development: Emerging Futures World Cities Report 2016*.
- UN-Habitat. (2020a). *Public Space Inventory & Assessment Nairobi City County Kenya*.
- UN-Habitat. (2020b). *World Cities Report , The Value of Sustainable Urbanization*.
<https://doi.org/10.18356/c41ab67e-en>
- UN-Habitat. (2023). *My Neighbourhood*. <https://unhabitat.org/my-neighbourhood>
- UN-Habitat, & RoK. (2018). *Urban planning for city leaders A handbook for Kenya*.

- UN. (2020). *NUA Monitoring Framework and related indicators*.
- UNDESA. (2018). *World Urbanization Prospects 2018*. <https://population.un.org/wup/>
- UNDESA. (2019). *World Urbanization Prospects: The 2018 Revision*.
<https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf>
- UNDP. (2016). Sustainable Urbanisation Strategy. In *UNDP's support to sustainable, inclusive and resilient cities in the developing world*.
<http://www.undp.org/content/undp/en/home/librarypage/poverty-reduction/sustainable-urbanization-strategy.html>
- Vasanen, A. (2012). Beyond stated and revealed preferences : the relationship between residential preferences and housing choices in the urban region of Turku , Finland. *J Hous and the Built Environ*, 27, 301–315. <https://doi.org/10.1007/s10901-012-9267-8>
- Veluru, K. R. V. (2020). Role of the Neighborhood Planning in Containing the Future Epidemics , in the Wake of COVID-19. *Irjet*, 07(09), 2740–2745.
<https://www.irjet.net/archives/V7/i9/IRJET-V7I9487.pdf>
- WCED. (1987). World Commission On Environment And Development. In *Our Common future* (Vol. 17).
- Wey, W., & Hsu, J. (2014). New Urbanism and Smart Growth : Toward achieving a smart National Taipei University District. *Habitat International*, 42, 164–174.
<https://doi.org/10.1016/j.habitatint.2013.12.001>
- Whittick, A. (1975). *Encyclopedia of Urban Planning* (A. Whittick, D. N. Fishel, H. B. Crawford, & L. B. Hander (eds.); 1st ed., Vol. 16, Issue 2). McGraw-Hill Book Company. <https://doi.org/10.2307/3103508>
- WHO. (2016). *Urban green spaces and health - A review of evidence*.
- WHO. (2021). *Classification and minimum standards for emergency medical teams*.
- Wijesundara, J., Weerasinghe, U. G. ., & Perera, L. S. . (2021). Inhabitants ' Satisfaction in Neighbourhood Sustainability : Insights from Colombo. *Journal of the International Society for the Study of Vernacular Settlements*, 8(1), 64–76.
- Willberg, E., Fink, C., & Toivonen, T. (2023). The 15-minute city for all ? – Measuring individual and temporal variations in walking accessibility. *Journal of Transport Geography*, 106.

- Witten, K., Exeter, D., & Field, A. (2003). The Quality of Urban Environments: Mapping Variation in Access to Community Resources. *Urban Studies*, 40(1), 161–177. <https://doi.org/10.1080/0042098032000035581>
- Xia, Z., Li, H., & Chen, Y. (2018). Assessing Neighborhood Walkability Based on Usage Characteristics of Amenities under Chinese Metropolises Context. *Sustainability*, 10(3879). <https://doi.org/10.3390/su10113879>
- Xu, H., Zhao, J., & Yu, X. (2023). A Community-Oriented Accessibility Index of Public Health Service Facilities : A Case Study of Wuchang District , Wuhan, China. *Sustainability*, 15(10870).
- Yakubu, H. O., Abayomi, A. S., Olaitan, P. A., & Ibukun, T. J. (2019). A Study of Infrastructure and Utilities on Residential Estate Development in Ikorodu , Lagos , Nigeria. *International Journal of Research and Scientific Innovation (IJRSI)*, VI(X), 69–78.
- Yigitcanlar, T., Kamruzzaman, M., & Teriman, S. (2015). Neighborhood sustainability assessment: Evaluating residential development sustainability in a developing country context. *Sustainability*, 7(3), 2570–2602. <https://doi.org/10.3390/su7032570>
- Zainal, Z. (2007). *Case study as a research method*.
- Zandieh, R., Flacke, J., Martinez, J., Jones, P., & Maarseveen, M. Van. (2017). Do Inequalities in Neighborhood Walkability Drive Disparities in Older Adults ' Outdoor Walking ? *International Journal of Environmental Research and Public Health*. <https://doi.org/10.3390/ijerph14070740>
- Zhang, Q., Yung, E. H. K., & Chan, E. H. W. (2018). Towards sustainable neighborhoods: Challenges and opportunities for neighborhood planning in transitional Urban China. *Sustainability (Switzerland)*, 10(2). <https://doi.org/10.3390/su10020406>
- Zhang, Q., Yung, K. H. E., & Chan, W. H. E. (2020). Comparison of perceived sustainability among different neighbourhoods in transitional China : The case of Chengdu. *Habitat International*, 103(August), 102204. <https://doi.org/10.1016/j.habitatint.2020.102204>
- Zhang, Q., Zheng, Z., Kang, D., Zhou, Y., Zhang, Y., & Zhang, X. (2023). Prioritizing Neighbourhood Amenities to Enhance Neighbourhood Satisfaction : A Case Study in

- Wuhan , China. *International Journal of Environmental Research and Public Health*, 20(3528).
- Zheng, A. W. (2015). *An Indicator-based Approach to Neighbourhood Sustainability Assessment for Urban Renewal. 1.*
- Zhou, L., Tokos, H., Krajnc, D., & Yang, Y. (2012). Sustainability performance evaluation in industry by composite sustainability index. *Clean Techn Environ Policy*, 14, 789–803. <https://doi.org/10.1007/s10098-012-0454-9>
- Zhou, P., & Zhang, L. P. (2018). *Composite Indicators for Sustainability Assessment : Methodological Developments* (Issue 66). Springer Singapore. <https://doi.org/10.1007/978-981-10-7919-1>

APPENDICES

Appendix I: Household Questionnaire

Declaration: The information obtained from the questionnaire is confidential and for academic purposes only. **Instruction:** Please tick and respond where appropriate

SECTION A: Respondent Biodata

1	Gender	Male [] Female []
2	Age	18-29 [] 30- 39[] 40- 49[] 50- 59[] 60- 69 []
3	Education	No formal education[] Primary[] Secondary[] College [] University []
4	No of years you have lived in the estate	1 – 5years [] 6 – 10years [] 10 years and above[]
5	Household size?	
6	Religion	Christian [] Muslim []

SECTION B: Facilities

- The types of facilities present in the estate, which facilities do you use within the estate and how frequently do you use them and the mode of transport used in accessing these facilities?

Facility	Availability (Yes/No)	Usage (Yes/No)	Means of transport 1. Public transport 2. Walk 3. Cycle 4. Car, van or taxi 5. N/A	Frequency of use 1) Daily 2) Weekly 3) Monthly 4) Weekends 5) Occasionally 6) N/A
Primary school				
Secondary school				
Polytechnic				
College				

Library				
Hospital				
Dispensary				
Clinic				
Police station				
Market				
Social hall				
Post office				
Recreation area /open space				
Place of worship				
Shopping centre				
Playground				
Bus station				

2. Adequacy of facilities and accessibility

Facility	Inadequate	Adequate	Not Available	Do you enjoy using the facility (Yes/No)	Distance 1)1-100m 2)101m-200m 3)201-300m 4)301m-400m 5)401m-500m 6)501m-600m 7)Above 601m
Primary school					
Secondary school					
College					
Library					
Hospital					
Dispensary					

Clinic					
Police station					
Market					
Social hall					
Post office					
Recreation area /open space					
Church					
Mosque					
Entertainment joints					
Shopping Centre					
Others					

3. How satisfied are you by the condition of facilities and services within the estate?

Facility	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Transportation					
Education					
Health					
Housing					
Recreation					
Security					
Open space					
Shopping centre					
Places of worship					
Library					
Market					
Social hall					

Post office					
Market					
Playground					
Waste collection					
Water					
Electricity					
Sanitation					
Drainage					

4. What are some of the factors that encourage you to use the facilities in your neighbourhood?
- 5.
6. What are some of the factors that discourage you from using the facilities in your neighbourhood?

SECTION C: Housing and residential satisfaction

1. When did you move in the residential estate?
.....
2. What motivated you to move in the estate?
3. What are the most attractive features in the estate?
4. If you were currently living elsewhere, would you be motivated to move in the estate? Yes [] No []
If yes, state the reason?
If no, state the reason?
5. Do you pay rent? (Yes/No)
If yes, what percentage of your household income do you spend on your rent?
.....
If no, what percentage of your total income did you spend on buying the house/pay for mortgage?
6. Types of house you are living in?
7. In terms of housing how do you feel the estate is?

(Not congested, slightly congested, too crowded)

8. How satisfied are you by the following parameters within the estate?

Parameters	Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied
Location of the neighbourhood?					
How satisfied you are with your neighbourhood?					
Maintenance of the neighbourhood?					
Safety of pedestrians and cyclists in your neighbourhood?					
Public transport?					
Walking in your neighbourhood?					
Commuting time to work?					
Safety of the neighbourhood?					
Ability to meet basic needs in your neighbourhood?					
The landscape of the estate?					
How satisfied are you with the density (height) of buildings in your estate?					
Type of houses in the estate?					
Road conditions in the estate?					
Convenience of shopping?					
Quantity and quality of facilities?					
Living in the estate?					
Current housing situation?					

9. Which factor do you value most in an estate? *Rate according to importance*

	Not at all important	Slightly important	Important	Fairly important	Very important
Safety and security					
Open space/recreation area					

Affordable houses					
Provision of facilities (school, hospital)					
Mixed land use (diverse of uses)					
Accessibility					
Variety of business					
Houses in various prices					
Availability of local employment within the neighbourhood.					
Easy to access services such as grocery shops and other necessary local services					

10. Are you satisfied with you the quality of the environment in the estate? (Yes, No)

If no, state the reason?

11. What are some of the challenges in the estate?

12. What can be done to improve the condition in the estate?

Appendix II: Interview Schedules

Interview schedule for Garden and Ridgeways Residential Association

A sustainable neighborhood is place where residents would want to live and work now and in future. It is an estate/neighborhood with a variety of uses and provides of feeling of belonging in a community. It offers an environment with high quality of life that is safe, well planned, built and offers quality of opportunity and good services to all.

General Information

Name of institution.....

Title of respondent.....

1. Kindly give a brief history of Garden estate?
2. What are the current land uses in the estate?
3. Which are the major land use changes that have occurred in the estate since its establishment?
4. What is your role in the estate?
5. What are the laws used by GARRA in the management of the estate?
6. What are the type of facilities in the estate? What role is played by GARRA on the management of facilities in the estate?
7. What challenges do you encounter in the management of estate?
8. What development control measures specifically for the estate have been put in place?
9. What is the total number of housing units in Garden estate?
10. What income group is the estate meant for? (Approximate the income)
11. What are the houses prices range and is it affordable?
12. Over the past years, do you think the following has improved, declined or stayed?

	Improved	Remained the same	Declined	Reason (for the selected choice)
Transportation				
Sanitation				
Water				
Education				
Housing				

Security				
Electricity				
Waste collection				
Environment				

Interview Schedule for Roysambu Physical Planner

A sustainable neighbourhood is place where residents would want to live and work now and in future. It is an estate/neighbourhood with a variety of uses and provides of feeling of belonging in a community. It offers an environment with high quality of life that is safe, well planned, built and offers quality of opportunity and good services to all

Name of the institution

Title of respondent

1. What are the requirements for provision of facilities in a neighbourhood?
2. What development control measures specifically for the estate have been put in place recently?
3. What are the laws that guide neighbourhood planning in Kenya?
4. What successes/constraints have you encountered in implementing the development control measures in the estate?
 - a. Zimmerman
 - b. Garden estate
5. What would you say about the development situation and compliance in Garden and Zimmerman estate?
6. What have been the main land use changes taking place in Buruburu and Zimmerman Estate and what would associate these changes with?
7. What role is played by NCC on the management of facilities in the estate?
8. Which type of facilities are to be provided in a neighbourhood?
9. What management measures can be put to ensure best use of open spaces in a neighbourhood?

10. What challenges do you face in developing sustainable neighbourhoods?
11. Major facilities in the Zimmerman and Garden estate?
12. What can be done to enhance the quality of the estates?
13. Major land use in the estate?

Zimmerman

Garden estate

Interview schedule for Community Leader

Position of the leader

Name of the leader

Name of Estate.....

A sustainable neighbourhood is place where residents would want to live and work now and in future. It is an estate/neighbourhood with a variety of uses and provides a feeling of belonging in a community. It offers an environment with high quality of life that is safe, well planned, built and offers quality of opportunity and good services to all.

1. Kindly give a brief history of the estate/neighbourhood?
2. What are the current land uses in the estate/neighbourhood?
3. Which are the major land use changes that have occurred in the estate/neighbourhood since its establishment?
4. What is your role in the estate/neighbourhood?
5. What are the available facilities and services in the estate? Are there adequate facilities for the residents of estate?
6. Which kind of open spaces/recreation area exists in the estate?
7. What measures can be put to ensure best use of the space (land use) such as facilities allocated in the estate?
8. What role is played by the (Ward administrator) in the management of facilities and services in the estate?
9. What development control measures have been put in place for the estate?
10. What is the total number of housing units in the estate?
11. What income group is the estate meant for and what is the approximate income range?
12. What are the houses prices range and are they affordable?

Interview Schedule for New Roysambu Housing Cooperative Society

1. What is your role in the estate?
2. Briefly explain the history of Zimmerman estate?
3. What was the design used in the subdivision of the Zimmerman estate?

 Advantage of the design
 Disadvantage of the design
4. Which facilities / amenities were provided when the subdivision was done?
5. What was the land use of the estate when the subdivision was being done?

 Residential
6. Average plot sizes
7. What are the current land uses in Zimmerman estate?
8. What development control measures in Zimmerman estate?

Appendix III: Checklist

Street Name

Estate

1. Facilities

Type	Number	Condition(Good/Bad)	Coordinates Latitude/Longitude
Primary school			
Secondary school			
Polytechnic			
College			
Library			
Hospital			
Dispensary			
Clinic			
Police station			
Market			
Social hall			
Post office			
Recreation area			
Open space			
Church			
Mosque			
Entertainment joints			
Shopping Centre			

2. Roads and Parking

Street Name	Condition (Good/Bad)	Provision For Side walk(Yes/No) and size	Parking Availability (Yes/No)	Distribution of side walk (One side of the road/Both
-------------	-------------------------	---	-------------------------------------	---

				sides of the road)

3. Building Types

Location	Typology (Bungalow, Maisonnete, Apartment)	Floor Elevation	Use


4. Open Spaces Types

Type (parking, playground, green space)	Location	Condition

5. Type of business


Classification	Type of business	Availability
General traders	Supermarket	
	Retail shop	
	Kiosk	
	Chemists	
	Boutiques	
	Butchery	
	General shop	
	Salon	
	Hardware	
	Electronics	
Transport storage	Driving school	
	Petro stations	
	Parking's	
Technical and Financial	ATM	
	BANKING Agency	
	Bank/sacco offices	
	Real estate	
	Cyber	
Accommodation	lodging	
	Restaurant	
	bar	
	Hotel	
	Club	
Private, health, education and entertainment	school	
	college	
	University	
	Private Clinic	
	gyms	
	sports club	
Small traders	Hawkers	
	Groceries store	

Appendix IV: NACOSTI Permit


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