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**DEPARTMENT OF CIVIL ENGINEERING**  
**OPTION OF CONSTRUCTION TECHNOLOGY**

ASSESSMENT OF URBAN DENSIFICATION, IN RWANDA  
CASE STUDY: GASABO DISTRICT, GISOZI SECTOR

*Submitted in partial fulfillment of the requirement of the award of Advanced Diploma in  
Construction Technology*

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Kigali, October 2024

**DECLARATION**

I, **UWASE Henriette**, hereby declare that the final text presented in this study entitled **ASSESSMENT OF URBAN DENSIFICATION, CASE: GASABO DISTRICT, GISOZI SECTOR** is my original work and has not been submitted elsewhere for the academic qualification or for any other reason.

Signature.....

Date:...../...../2024

**CERTIFICATION**

I, **Eng. MUNYANEZA Jean Pierre** hereby certify that this study entitled **ASSESSMENT OF URBAN DENSIFICATION, CASE: GASABO DISTRICT, GISOZI SECTOR** was carried out under my supervision.

Signature.....

MUNYANEZA Jean Pierre

Date:...../...../2024

## **DEDICATION**

To almighty GOD

To my family

To my relatives and friends,

To all researchers

For their unconditional love, tolerance, and care;

To my colleagues.

## **ACKNOWLEDGEMENT**

I would like to express my sincere gratitude to all those who have supported me throughout this journey. to my family and friends, your unwavering love and encouragement have been my greatest motivation. I extend my heartfelt thanks to my mentors and colleagues, whose guidance and insights have been invaluable in shaping this work. I am particularly grateful to the participants who generously shared their experiences, as their contributions were essential to this project. additionally, I wish to acknowledge ULK for providing the resources and support that made this endeavor possible. your collective belief in my work has inspired me, and I am truly thankful for everyone.

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## **ABBREVIATIONS AND ACRONYMS**

**%:** Percentage: Percent

**Sq. Km:** Square Kilometer

**Sq. m:** Square meter

**GIS:** Geographic Information System

**ULK:** Universite Libre de Kigali

**RS:** Remote Sensing

**USGS:** United States Geological Survey

## **ABSTRACT**

This study assesses the impact of urban densification in the Gisozi sector of Kigali, Rwanda, where rapid urbanization has led to a population density of 10,166 people per square kilometer, with a growth rate of 5.6%. The research explores the drivers of densification, such as rural-to-urban migration and the perceived affordability of living in Gisozi. It evaluates how this densification affects land use, infrastructure, and housing, highlighting the increasing strain on resources and the need for sustainable development practices. The study uses data from the Rwanda National Institute of Statistics and GIS mapping to analyze population distribution and land use patterns, providing a clear understanding of how urban density is evolving in Gisozi.

The research further suggests strategic approaches to manage this growth, including vertical construction, reducing plot sizes, and increasing the number of households per plot. These strategies aim to optimize land use while maintaining sustainable urban development. By drawing comparisons with densification practices in cities such as Addis Ababa and New York, the study identifies best practices for addressing urban growth challenges in Kigali. The findings offer practical recommendations for policymakers, urban planners, and developers to enhance infrastructure resilience and promote balanced, sustainable urban growth in Gisozi and similar urban areas in Rwanda.

**Keywords:** urbanization, Population density, migration, population growth

## **CHAPTER ONE: GENERAL INTRODUCTION**

### **1.0.Introduction**

Urban densification involves increasing population density within urban areas by constructing taller buildings, promoting mixed-use developments, and improving infrastructure. The goal is to create vibrant, efficient, and sustainable cities.

Urban densification is a key trend in Rwanda's development, especially in cities like Kigali. With rapid urbanization, there is a higher demand for housing and services. While densification can lead to efficient land use and vibrant urban centers, it also poses challenges that need to be managed for sustainable growth. (World bank, 2022)

The construction industry plays a crucial role in facilitating urban densification. Engineers and urban planners must grapple with the complexities of building in denser environments, where space is limited, and the need for efficient use of resources is paramount. High-density urban areas require innovative construction techniques and materials to ensure that buildings are not only safe and durable but also environmentally sustainable. Moreover, the infrastructure must be designed to handle increased loads, whether it be in terms of transportation networks, water and sewage systems, or energy supplies. (Lehmann, 2019)

Urban densification in Rwanda comes with challenges such as traffic congestion, inadequate waste management, and overburdened public services. The construction industry faces pressures to deliver housing and infrastructure quickly, potentially leading to compromises in building standards and sustainability practices. Careful planning and regulation are essential to prevent long-term issues.

A comprehensive assessment of urban densification in Rwanda is crucial from a construction engineering standpoint to evaluate existing infrastructure, identify weaknesses in construction practices, and propose solutions for resilient and sustainable urban development. Addressing these issues will enable Rwanda to benefit from urban densification while minimizing risks and creating sustainable urban environments. (This a personal statement, no reference needed)

## **1.1. Background of the Study**

Urban densification is a global trend driven by the need to accommodate growing urban populations within existing city boundaries. In the US, cities like New York, San Francisco, and Chicago are promoting higher-density developments, mixed-use buildings, and efficient public transportation to create more sustainable urban environments and enhance urban life. (Lehmann, 2019)

The urban densification rate in the United States has varied across cities. From 1990 to 2014, cities like Los Angeles saw a minimal increase in urban density, while cities like Riverside-San Bernardino and Atlanta experienced significant infill growth. This reflects a trend towards denser urban development to accommodate growing populations. (Cavicchia, R., & Cucca, R., 2021)

Ethiopia's urbanization is growing at 4.4% annually, with 22.2% of the population currently living in urban areas. The country faces challenges like urban sprawl and inefficient land use, with an average of 223 square meters of land per person allocated for urban development. Without changes, Ethiopia's land resources could be completely built up in 127 years. (Alemayehu, 2019)

Rwanda, too, has been focusing on urban densification as part of its broader urban development strategy. Kigali, the capital city, has seen significant efforts to manage population growth through structured urban planning and the promotion of high-density housing projects. These efforts aim to ensure sustainable urban growth, reduce urban sprawl, and improve living standards by making better use of available land resources. (World Bank, 2020)

Similarly, Tokyo has effectively managed urban density through strategic land use policies, the promotion of high-density housing, and a comprehensive public transportation system. By adopting a multi-nodal urban development model and creating sub-centers to decentralize its core, Tokyo has reduced congestion. The city's reliable public transportation network supports high-density living by offering efficient mobility, reducing private vehicle use, and minimizing traffic congestion. These measures have resulted in a high quality of life, improved air quality, shorter commute times, and vibrant, connected communities. (Pinca, 2023)

With an emphasis on sustainable growth, Rwanda has put many plans into place to address urban densification, especially in Kigali. Organized urban expansion is guided by the Kigali Master Plan,

which supports public areas, mixed-use projects, and effective transportation systems. The government has collaborated with private developers to expand affordable housing developments that facilitate higher-density living to prevent informal settlements. Rwanda strongly emphasizes sustainable urbanization by constructing livable urban settings with green construction techniques and eco-friendly infrastructure. Congestion is intended to be reduced by investments in contemporary public transportation, such as extended bus services and upcoming fast transit systems. Kigali also encourages vertical buildings to make the most use of available space and handle urban growth without requiring horizontal expansion. These initiatives demonstrate Rwanda's dedication to effectively and sustainably managing urbanization. (Gideon Baffoe, Sohail Ahmad, and Ramjee Bhandari, 2020)

This study will examine how urban densification is impacting Kigali's construction sector, drawing lessons from the experiences of the United States and Ethiopia. The goal is to identify effective strategies that can be adopted in Rwanda to enhance the resilience and sustainability of its urban infrastructure in the face of increasing urban density.

## **1.2.Problem Statement**

Urban densification is a significant and growing trend in Rwanda, particularly in its capital city, Kigali, and other rapidly developing urban areas. As a construction engineer, the implications of this densification are profound, affecting infrastructure planning, construction practices, and urban sustainability. While urban densification can lead to more efficient land use and support the development of vibrant, economically dynamic cities, it also presents a series of challenges that must be carefully managed to ensure sustainable urban growth. ( World Bank, 2017)

The current pace of urban densification in Rwanda is exerting pressure on existing infrastructure, including roads, water supply systems, and waste management facilities. High-density developments can lead to overcrowded urban environments, exacerbating traffic congestion, increasing the demand for utilities, and putting a strain on public services. Additionally, the rapid construction of high-density buildings often occurs without adequate planning or adherence to sustainable building practices, which can compromise structural integrity and environmental sustainability. Furthermore, the lack of comprehensive urban planning frameworks to guide densification efforts risks leading to uncoordinated and haphazard development. (Carmona, 2014)



Thus, there is a critical need to assess the impacts of urban densification in Rwanda from a construction engineering perspective. This assessment should focus on evaluating the capacity of existing infrastructure to support increased density, identifying potential weaknesses in current construction practices, and proposing solutions to enhance the resilience and sustainability of urban development. Addressing these issues is essential to ensure that urban densification contributes positively to Rwanda's growth, providing safe, efficient, and sustainable urban environments for its residents. ( World Bank, 2017)

### **1.3.Purpose of the Study**

The purpose of this study is to evaluate the impact of urban densification on the construction sector in Rwanda, with a specific focus on Kigali-Gisozi. By assessing the current state of infrastructure and construction practices, the study aims to identify the challenges and opportunities associated with increasing urban density. The research will provide insights into how existing infrastructure is coping with higher population densities, evaluate the adequacy of current construction standards and practices, and propose strategies for enhancing the resilience, safety, and sustainability of urban development. Ultimately, the goal is to inform policymakers, urban planners, and construction professionals on how to effectively manage urban densification to support sustainable urban growth and improve the quality of life for residents.

### **1.4.Research Objectives**

#### **1.4.1.General Objectives**

This research aims to assess the impact of urban densification on residential land use in Rwanda.

#### **1.4.2.Specific Objectives**

- Identify the number of people living in Gisozi
- Evaluate the area of Gisozi sector.
- To calculate the densification rate.
- To suggest ways to increase urban densification

### **1.5. Research Questions**

- What is the current population density and demographic distribution of the Gisozi sector, and how does this compare to the available land area?
- How do current construction practices in Gisozi align with the sector's capacity to accommodate the increasing rate of urban densification?
- What strategies and practices can be developed to address the land use challenges in Gisozi, considering the sector's unique opportunities and constraints?

### **1.6. Research Hypothesis**

This study hypothesizes that urban densification in Kigali, Rwanda, while intended to create more efficient and vibrant urban spaces, is exerting significant pressure on existing infrastructure and construction practices, leading to potential inadequacies in managing increased population density. Since Gisozi sector is populated with 84,423 people which implies 10,166/km<sup>2</sup> at an annual growth of 5.6% on 8.304 km<sup>2</sup>. It is anticipated that the current infrastructure may be insufficiently resilient to cope with higher-density demands, resulting in challenges such as overcrowding, structural vulnerabilities, and environmental degradation. By improving construction practices, adopting sustainable building standards, and enhancing infrastructure planning, Kigali can effectively manage urban densification, ensuring sustainable and resilient urban development that meets the needs of its growing population. (City Population, 2023)

### **1.7. Scope Of The Study**

This study focuses on evaluating the impact of urban densification on Kigali's construction sector, aiming to understand the implications for infrastructure resilience, safety, and sustainability. The research will assess the current state of urban infrastructure, including transportation, water supply, sewage, and waste management systems, and evaluate the adequacy of existing construction practices in supporting high-density development. It will also analyze the environmental and socio-economic effects of increased urban density, perform hydrological and structural simulations to predict future infrastructure performance and engage with stakeholders to gather input and feedback. The ultimate goal is to develop actionable recommendations to enhance Kigali's urban infrastructure resilience and sustainability in the face of ongoing densification.

### **1.7.1. Geographical scope**

This study encompasses the Gisozi sector within the Gasabo district of Kigali, Rwanda. The selection of the location refers to the popularity of the area vis à vis the rest of the areas.

### **1.7.2. Content scope**

This research study is divided into several areas, including the general introduction, literature review, research methodology, interpretation of results, general conclusion, suggestions, and a list of references. The order in which these components were included was determined by the Independent University of Kigali's research criteria.

## **1.8. Significance of the study**

This study is significant as it aims to guide the sustainable urban development of Kigali, Rwanda, by providing a comprehensive evaluation of the impacts of urban densification on infrastructure and construction practices. The findings will inform policymakers, urban planners, and construction professionals about the current state of Kigali's infrastructure, identifying areas that require improvement to cope with increased population density. By highlighting necessary changes to construction standards and practices, the study will promote safe, resilient, and sustainable building practices. Additionally, the research will offer predictive insights into future infrastructure performance under various densification scenarios, enabling proactive planning and resource allocation. Ultimately, this study will contribute to creating a more liable, efficient, and sustainable urban environment in Kigali, enhancing the quality of life for its residents.

### **1.8.1. To the researcher**

The study on urban densification in Gisozi will enhance the researcher's understanding of sustainable construction methods and infrastructure challenges in high-density urban areas, providing valuable insights for future urban development projects. It also contributes to the body of knowledge on urban planning in Kigali, aiding in the formulation of effective policies and strategies.

### **1.8.2.To the University**

The study on urban densification in the Gisozi sector will bolster the university's reputation as a leading institution in urban planning and construction engineering research, providing valuable data and insights for academic and practical applications. Additionally, it will enhance the university's engagement with local and international urban development projects, fostering partnerships and collaborations.

### **1.8.3.To future researchers**

The study on urban densification in Gisozi will provide future researchers with a comprehensive framework for analyzing the impacts of high-density urban development on construction practices and infrastructure. It will also serve as a reference point for comparative studies, offering valuable data and insights that can inform and guide further research in urban planning and sustainable development.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.0. Introduction**

This chapter outlines research and data on urban densification in Rwanda, while drawing comparisons with case studies from the United States and Ethiopia. It explores how these countries have addressed the challenges of urban growth and land use, offering valuable insights into the dynamics of densification. By examining policies, infrastructure development, and housing strategies, this review provides a contextual understanding of Rwanda's approach within a global framework. The comparison highlights the unique challenges and opportunities faced by Rwanda in managing urban expansion, particularly in Kigali-Gasabo, and underscores the relevance of international practices in shaping local urbanization strategies.

### **2.1. Conceptual Framework of Urban Densification**

#### **2.1.0. Definition and Theories of Urban Densification**

Urban densification refers to the process of increasing the population density within existing urban areas, typically through the development of higher-density housing and the more efficient use of land and infrastructure. This concept is grounded in urban planning and development theories that advocate for compact cities, reduced urban sprawl, and the sustainable use of resources. Key theories include Smart Growth, which promotes mixed-use development, walkable neighborhoods, and the preservation of open spaces, and New Urbanism, which emphasizes the design of livable, human-scaled urban environments. These theories support the idea that well-managed densification can lead to more vibrant, efficient, and sustainable cities. (Cavicchia, R., & Cucca, R. , 2021)

#### **2.1.1. Historical Context and Global Trends in Urban Densification**

Historically, urban densification has been driven by the need to accommodate growing urban populations within limited geographical areas. In the early 20th century, cities in Europe and North America began to densify as a response to industrialization and the influx of people seeking economic opportunities. Over time, the focus shifted towards creating more livable urban environments through better urban planning and design. In recent decades, global trends have shown a renewed interest in urban densification as cities seek to combat the negative effects of

urban sprawl, such as traffic congestion, pollution, and inefficient infrastructure use. This shift is evident in cities like New York, Tokyo, and Paris, which have implemented policies to promote higher-density development and sustainable urban growth. (Wheeler, S. M., & Beatley, T. , 2009)

### **2.1.2. Comparative Analysis of Urban Densification in Developed and Developing Countries**

The approach to urban densification varies significantly between developed and developing countries, influenced by different economic, social, and regulatory contexts. In developed countries, urban densification is often driven by policy frameworks that encourage mixed-use development, investment in public transportation, and the revitalization of urban cores. For instance, cities in the United States and Europe have adopted zoning reforms and incentives for developers to build higher-density housing. In contrast, developing countries, including Ethiopia and Rwanda, face unique challenges such as rapid urbanization, informal settlements, and limited infrastructure. These countries often focus on upgrading existing urban areas and integrating informal settlements into the formal urban fabric, while also promoting high-density development to accommodate population growth. (Cox, New Geography, 2012)

### **2.1.3. Construction Engineering Perspectives on Urban Densification**

From a construction engineering perspective, urban densification presents both challenges and opportunities. High-density development requires advanced construction techniques and materials to ensure the structural integrity and safety of buildings. Innovations in construction technology, such as prefabrication, modular construction, and the use of sustainable materials, play a crucial role in supporting densification efforts. Engineers must also address the need for resilient infrastructure, including transportation systems, water supply, and waste management, which can handle increased usage without compromising efficiency or sustainability. Effective planning and execution of construction projects in densified urban areas require collaboration between engineers, urban planners, and policymakers to ensure that the built environment meets the needs of its inhabitants. (McFarlane, 2016)

#### **2.1.4. Implications for Sustainable Urban Development**

Urban densification has significant implications for sustainable urban development. By concentrating development within existing urban areas, cities can reduce their ecological footprint, preserve natural landscapes, and promote more efficient use of resources. Densification supports the creation of compact, walkable communities that reduce reliance on automobiles, thereby decreasing greenhouse gas emissions and improving air quality. Moreover, higher-density urban environments can enhance social equity by providing more affordable housing options and better access to amenities and services. For cities like Kigali, adopting urban densification strategies can lead to more resilient and sustainable urban growth, ensuring that infrastructure development keeps pace with population increases while enhancing the overall quality of urban life. (Haas, 2012)

### **2.3. Lessons from Other Cities**

#### **2.3.1. Case Studies of Successful Urban Densification**

Urban densification has been successfully implemented in various cities around the world, providing valuable lessons for Kigali. In the United States, cities like New York and Portland have adopted comprehensive urban planning strategies to manage growth and densification. New York City, for example, has leveraged its zoning laws to encourage high-density development while preserving historical districts and green spaces. The city's approach includes incentives for developers to build affordable housing units, which helps maintain socio-economic diversity within dense urban areas. Similarly, Portland's urban growth boundary (UGB) policy effectively contains urban sprawl by limiting expansion beyond a designated perimeter, thereby promoting infill development and higher density within the city core. (Cavicchia, R., & Cucca, R. , 2021)

In Ethiopia, Addis Ababa provides another instructive example. The city has implemented the Addis Ababa City Structure Plan, which focuses on high-density, mixed-use development to accommodate rapid population growth. This plan includes the development of condominium housing projects, which provide affordable, high-density housing solutions. Additionally, Addis Ababa's light rail transit system has been a key component in supporting urban densification by enhancing connectivity and reducing reliance on private vehicles. These efforts illustrate the importance of integrated planning that combines housing, transportation, and infrastructure development to achieve successful densification. (McFarlane, 2016)

### **2.3.2. Strategies and Best Practices from Global Cities**

Several strategies and best practices from global cities can be applied to Kigali. One key strategy is the use of transit-oriented development (TOD), which focuses on creating high-density, mixed-use communities around public transit hubs. This approach not only promotes efficient land use but also encourages public transportation use, reduces traffic congestion, and lowers carbon emissions. Cities like Tokyo and Singapore have successfully implemented TOD to create vibrant, accessible urban areas. Another best practice is the inclusion of green infrastructure, such as parks, green roofs, and urban gardens, which enhance the quality of life in dense urban environments and contribute to environmental sustainability. (Jenks, M., & Jones, C., 2010)

### **2.3.3. Analysis of Policy Frameworks**

Effective policy frameworks are crucial for supporting urban densification. In cities like Vancouver, the introduction of flexible zoning laws has allowed for greater density while maintaining community character. Vancouver's policies encourage the development of secondary suites and laneway houses, which provide additional housing options without drastically altering existing neighborhoods. Furthermore, the city's commitment to public engagement ensures that residents have a voice in the planning process, fostering community support for densification initiatives. Such policy frameworks demonstrate the importance of balancing regulatory flexibility with community involvement to achieve successful urban densification. (Bishop, P., & Williams, L., 2012)

### **2.3.4. Urban Planning Approaches**

Urban planning approaches that emphasize sustainability and resilience are also critical for successful densification. In Copenhagen, the city's urban planning strategy includes extensive cycling infrastructure, pedestrian-friendly streets, and mixed-use developments that reduce the need for car travel. Copenhagen's approach to urban planning prioritizes the creation of livable, human-scaled environments that support high-density living. Additionally, the city's focus on renewable energy and sustainable building practices aligns with broader environmental goals. These planning approaches highlight the need for holistic strategies that integrate transportation,



housing, and environmental sustainability to create thriving, dense urban areas. (Cavicchia, R., & Cucca, R. , 2021)

### **2.3.5. Implementation Challenges**

Despite the benefits, urban densification presents several implementation challenges. Issues such as gentrification, displacement, and the strain on existing infrastructure must be addressed to ensure equitable outcomes. In cities like San Francisco, rapid densification has led to increased housing costs and displacement of lower-income residents. To mitigate these challenges, effective measures such as rent control, affordable housing mandates, and investment in infrastructure upgrades are essential. Additionally, fostering strong public-private partnerships can facilitate the implementation of densification projects by leveraging diverse resources and expertise. By learning from the experiences of other cities, Kigali can develop strategies to overcome these challenges and achieve sustainable urban growth. (Bishop, P., & Williams, L., 2012)

## **2.4. Impacts of Urban Densification**

### **2.4. 1. Economic Impacts**

Urban densification significantly influences housing markets and real estate development. By increasing the supply of housing units in high-demand areas, densification can help stabilize or even reduce housing prices, making housing more affordable for a broader segment of the population. It also promotes more efficient land use, encouraging the redevelopment of underutilized or abandoned properties, which can revitalize neighborhoods and stimulate economic growth. Additionally, densification often leads to increased property values and higher tax revenues, which can be reinvested in public infrastructure and services. Economic activities flourish in denser urban environments due to the proximity of businesses and consumers, which fosters a vibrant economic ecosystem. The clustering of businesses, particularly in sectors like retail, hospitality, and services, can create jobs and economic opportunities. (Lehmann, 2019)

### **2.4. 2. Job Creation and Economic Opportunities**

Urban densification generates job creation and economic opportunities in various sectors. The construction industry benefits directly from the increased demand for new residential, commercial, and mixed-use developments. Beyond construction, the influx of residents supports local

businesses, including retail, restaurants, and service providers, leading to a robust local economy. Densification can also attract investment in public transportation, utilities, and infrastructure projects, further creating employment opportunities. The concentration of people and businesses facilitates innovation and entrepreneurship, as ideas and resources can be more easily exchanged in a dense urban setting. Additionally, high-density urban areas often become hubs for knowledge-based industries, such as technology and finance, which thrive on the availability of skilled labour and the exchange of information. (Morriello, 2023)

### **2.4. 3. Social Impacts**

Urban densification impacts demographics, community structures, and social dynamics. Higher population densities can lead to more diverse and vibrant communities, as people from different backgrounds live and interact closely. This diversity can enhance social cohesion and cultural exchange but may also present challenges related to social integration and potential conflicts. Changes in community structures are evident as traditional single-family homes give way to multi-family dwellings and mixed-use developments. These changes can disrupt established social networks but also create new opportunities for social interactions and community building. Densification impacts public services, healthcare, and education by increasing the demand for these services. Efficient planning and investment are crucial to ensure that public services can keep pace with the growing population, maintaining or improving the quality of life for residents. (Haas, 2012)

### **2.4. 4. Environmental Impacts**

Urban densification has mixed effects on the environment. On the positive side, higher-density development can reduce urban sprawl, preserving green spaces and natural habitats outside urban areas. (Dunham-Jones, E., & Williamson, J., 2011) By concentrating development within existing urban footprints, densification minimizes the ecological footprint of cities. It can also improve air quality and reduce carbon emissions by promoting public transportation, walking, and cycling over car use. However, increased population density can strain existing green spaces within cities, potentially leading to their reduction or degradation. The urban heat island effect, where dense urban areas become significantly warmer than their rural surroundings, is another environmental concern. Strategies such as increasing urban greenery, utilizing reflective building materials, and

enhancing energy efficiency are essential to mitigate these effects and promote environmental sustainability in high-density areas. (Dunham-Jones, E., & Williamson, J., 2011)

#### **2.4. 5. Sustainability and Environmental Conservation Efforts**

To ensure that urban densification contributes to sustainability and environmental conservation, cities must adopt proactive measures. Incorporating green infrastructure, such as parks, green roofs, and urban forests, can help mitigate the environmental impacts of densification. These green spaces not only provide recreational areas for residents but also improve air quality, manage stormwater, and reduce urban heat island effects. Sustainable building practices, including energy-efficient designs, the use of renewable energy sources, and the implementation of waste reduction measures, are crucial. Effective public transportation systems and pedestrian-friendly urban designs can reduce reliance on private vehicles, lowering carbon emissions and promoting a healthier urban environment. By integrating these strategies, cities like Kigali can ensure that urban densification aligns with broader sustainability goals, creating livable, resilient, and environmentally friendly urban spaces. (Wheeler, S. M., & Beatley, T. , 2009)

#### **2.5. Infrastructure and Construction Challenges**

##### **2.5. 1. Current State of Urban Infrastructure in Kigali**

Kigali, the capital city of Rwanda, has made significant strides in developing its urban infrastructure over the past few decades. The city's road network has expanded and improved, enhancing connectivity within the city and with other regions. Public transportation has also seen developments, with the introduction of modern buses and plans for further expansion. However, despite these advancements, Kigali's infrastructure is still catching up with its rapid urbanization. The water supply and distribution systems are under considerable pressure, often resulting in shortages in various parts of the city. Similarly, the sanitation infrastructure, including sewage and waste management systems, struggles to cope with the increasing population, leading to environmental and health concerns. (Kigali city, 2019)

### **2.5.2. Challenges Related to Transportation, Water Supply, Sanitation, and Waste Management**

Transportation infrastructure in Kigali faces challenges such as traffic congestion, limited public transport options, and inadequate road maintenance. These issues are exacerbated by the growing number of vehicles and the city's expanding population. Water supply systems are another critical challenge; while efforts have been made to increase water availability, many areas still experience intermittent supply. The sanitation infrastructure is also inadequate, with many households lacking access to proper sewage systems. This leads to reliance on septic tanks and pit latrines, which can contaminate groundwater if not properly managed. Waste management is another pressing issue; the city generates substantial solid waste, but the collection and disposal systems are not yet efficient enough to handle the volume, resulting in illegal dumping and environmental pollution. (Dunham-Jones, E., & Williamson, J., 2011)

### **2.5.3. Construction Practices and Standards in High-Density Urban Environments**

In high-density urban environments like Kigali, construction practices and standards need to adapt to the unique challenges posed by urban densification. There is a growing need for high-rise residential and commercial buildings to maximize land use efficiency. However, this requires stringent building standards to ensure structural integrity, safety, and sustainability. The use of modern construction techniques such as prefabrication, modular construction, and green building materials is essential to meet these standards. Moreover, adherence to building codes and regulations is critical to prevent substandard construction practices that could lead to building failures and safety hazards. Training and capacity-building initiatives for local construction professionals are also necessary to ensure that they can implement these advanced construction techniques effectively. (Dunham-Jones, E., & Williamson, J., 2011)

### **2.5.4. Resilience and Sustainability of Urban Infrastructure Under Increasing Density**

As Kigali continues to densify, the resilience and sustainability of its urban infrastructure become paramount. Resilient infrastructure can withstand the pressures of increasing density, climate change, and other external shocks. For instance, stormwater management systems need to be robust enough to handle heavy rainfall and prevent flooding, which is increasingly important in the context of climate change. Sustainable infrastructure, on the other hand, minimizes

environmental impact and promotes long-term ecological balance. This includes the adoption of renewable energy sources, energy-efficient buildings, and sustainable waste management practices. Kigali's urban planning must integrate these principles to ensure that infrastructure development supports a high quality of life for its residents while protecting the environment. (Carmona, 2014)

### **2.5.5. Addressing Infrastructure and Construction Challenges**

Addressing Kigali's infrastructure and construction challenges requires a multi-faceted approach. Investment in infrastructure development is crucial, with a focus on expanding and upgrading transportation, water supply, sanitation, and waste management systems. Public-private partnerships can play a significant role in mobilizing the necessary resources and expertise. Additionally, comprehensive urban planning and regulatory frameworks are essential to guide sustainable development and ensure compliance with construction standards. Community engagement and participation are also vital, as they ensure that infrastructure projects meet the actual needs of the residents and gain public support. By tackling these challenges holistically, Kigali can build resilient, sustainable urban infrastructure that supports its growing population and enhances the city's livability. (Carmona, 2014)

## **2.6. Urban Densification in Rwanda**

### **2.6.1. Overview of Urban Growth and Densification Trends in Rwanda**

Rwanda, particularly its capital Kigali, has experienced significant urban growth over the past few decades. This growth is largely driven by rapid population increases and rural-to-urban migration as people seek better economic opportunities. Kigali's population has been rising steadily, and with limited land available for horizontal expansion, urban densification has become a crucial strategy for accommodating this growth. The city's urban planning efforts have focused on maximizing land use efficiency, promoting vertical development, and creating more compact urban forms. This approach helps to mitigate the challenges of urban sprawl, such as increased transportation costs, environmental degradation, and inefficient infrastructure utilization. (Rwanda Housing Authority, 2018)

### **2.6.2. Government Policies and Strategies Promoting Urban Densification in Rwanda**

The Rwandan government has implemented several policies and strategies to promote urban densification. The Kigali Master Plan, first introduced in 2013 and updated periodically, outlines a vision for sustainable urban growth through high-density development. This plan includes zoning regulations that encourage the construction of multi-story buildings, mixed-use developments, and the redevelopment of underutilized areas. Additionally, the government has invested in infrastructure projects that support densification, such as improved public transportation systems, road networks, and utility services. Policies also emphasize the importance of affordable housing to ensure that densification benefits all residents, not just higher-income groups. The Rwandan Housing Authority (RHA) and the City of Kigali have been active in facilitating public-private partnerships to drive these initiatives forward. (Rwanda Housing Authority, 2018)

### **2.6.3. Case Studies of Specific Urban Densification Projects in Kigali**

Several urban densification projects in Kigali illustrate the practical application of these policies and strategies. One notable example is the Vision City project, a large-scale residential and commercial development that includes high-density housing units, shopping centers, and recreational facilities. This project aims to create a self-sustained urban community that reduces the need for long commutes and enhances the quality of urban life. Another significant project is the development of the Kigali Innovation City, which focuses on creating a high-density, mixed-use environment that supports the tech industry and innovation-driven businesses. These projects demonstrate the city's commitment to integrating densification with economic development and sustainability goals. (Vision city, 2021)

Moreover, Kigali has also focused on upgrading informal settlements through initiatives like the Integrated Development Program (IDP), which aims to improve living conditions and infrastructure in high-density areas. These projects typically involve community participation and collaboration with various stakeholders to ensure that densification efforts are inclusive and beneficial to all urban residents. (Vision city, 2021)

In conclusion, urban densification in Rwanda, particularly in Kigali, is being driven by a combination of strategic urban planning, supportive government policies, and targeted

development projects. These efforts are aimed at creating a more sustainable, efficient, and livable urban environment that can accommodate the city's growing population while promoting economic development and social equity. (Kigali city, 2019)

## **2.7. Stakeholder Engagement and Community Participation**

### **2.7.1. Role of Local Government, Private Sector, and Community Organizations in Urban Densification**

Urban densification in Kigali requires the collaboration of various stakeholders, including the local government, the private sector, and community organizations. The local government plays a critical role in setting policies, creating regulatory frameworks, and ensuring compliance with urban planning standards. It is responsible for zoning laws, infrastructure development, and the provision of essential services. The private sector, including real estate developers and construction companies, drives the physical development of high-density housing and commercial projects. Their investment and innovation are crucial for implementing densification initiatives effectively. Community organizations act as intermediaries, representing the interests and needs of residents. They ensure that the voices of the community are heard and considered in the planning and execution of densification projects, fostering a sense of ownership and collaboration among all stakeholders. (Haas, 2012)

### **2.7.2. Importance of Stakeholder Engagement in Planning and Executing Densification Projects**

Engaging stakeholders is essential for the successful planning and execution of urban densification projects. Stakeholder engagement ensures that projects align with the needs and expectations of the community, enhancing public support and reducing resistance. It allows for the identification and mitigation of potential issues early in the planning process, leading to more efficient and effective project implementation. Collaborative planning can also bring innovative solutions to complex urban challenges by leveraging the diverse perspectives and expertise of different stakeholders. Furthermore, transparent and inclusive engagement processes build trust among stakeholders, fostering long-term partnerships and a shared commitment to sustainable urban development. (Lehmann, 2019)

### **2.7.3. Case Studies of Successful Community Participation in Urban Development**

One notable example of successful community participation in urban development is the Medellín River Parks project in Colombia. This initiative transformed the riverbanks of Medellín into vibrant public spaces through extensive community involvement. Local residents were actively engaged in the planning process, contributing ideas and feedback that shaped the final design. The project not only improved the urban environment but also strengthened social cohesion and community pride. Another example is the participatory slum upgrading program in Nairobi, Kenya, known as the Kibera Integrated Water, Sanitation, and Waste Management Project. This project involved local community members in every stage, from planning to implementation, ensuring that the solutions were culturally appropriate and widely accepted. (Jenks, M., & Jones, C., 2010)

### **2.7.4. Best Practices for Stakeholder Engagement in Urban Densification**

Several best practices can enhance stakeholder engagement in urban densification projects. First, early and continuous engagement is crucial. Involving stakeholders from the initial stages of planning ensures that their input is considered throughout the project lifecycle. Second, utilizing various engagement methods, such as public consultations, workshops, and digital platforms, can reach a broader audience and accommodate different preferences for participation. Third, providing clear and accessible information about the project helps stakeholders understand its goals, benefits, and potential impacts. Lastly, establishing feedback mechanisms allows stakeholders to voice concerns and suggestions, fostering a responsive and adaptive planning process. (Wheeler, S. M., & Beatley, T. , 2009)

### **2.7.5. Addressing Challenges in Stakeholder Engagement**

Despite its benefits, stakeholder engagement in urban densification can face several challenges, including conflicting interests, power imbalances, and limited resources. To address these challenges, it is important to create inclusive and equitable engagement processes that give voice to all stakeholders, especially marginalized groups. Building capacity among community organizations and providing technical support can empower them to participate effectively. Additionally, fostering a culture of collaboration and mutual respect among stakeholders can help



reconcile differing interests and build consensus. By addressing these challenges, Kigali can ensure that its urban densification efforts are not only successful but also equitable and inclusive, benefiting all residents and contributing to sustainable urban growth. (Wheeler, S. M., & Beatley, T. , 2009)

### 2.7.6. Pros and Cons of urban densification

Here's a table outlining the advantages and disadvantages of urban densification. (Carmona, 2014)

Table 2. 1. Advantages and disadvantages of urban densification

Advantages	Disadvantages
<p><b>Efficient Land Use:</b> Densification optimizes the use of available land, reducing urban sprawl and preserving rural and agricultural areas.</p>	<p><b>Infrastructure Strain:</b> High-density areas can place significant pressure on existing infrastructure, including roads, water supply, and sewage systems, potentially leading to overuse and degradation.</p>
<p><b>Reduced Transportation Costs:</b> Higher density can lead to shorter commutes and reduced transportation costs, both for individuals and public transport systems.</p>	<p><b>Increased Construction Costs:</b> Building high-density structures often requires more complex engineering solutions and higher initial investments, which can increase overall construction costs.</p>
<p><b>Improved Public Services:</b> Densification can make it more cost-effective to provide public services such as healthcare, education, and emergency services, as they can serve a larger population in a concentrated area.</p>	<p><b>Potential for Overcrowding:</b> Without proper planning, densification can lead to overcrowded living conditions, which may negatively impact the quality of life and social dynamics.</p>
<p><b>Enhanced Economic Opportunities:</b> Higher population densities can support a wider range of businesses and economic activities, fostering economic growth and job creation.</p>	<p><b>Environmental Impact:</b> Increased density can exacerbate environmental issues, such as urban heat islands, pollution, and reduced green spaces, unless mitigated by sustainable practices.</p>
<p><b>Sustainable Development:</b> Encourages the use of sustainable construction practices and green building technologies, as efficient resource use becomes more critical.</p>	<p><b>Social Inequality:</b> If not managed inclusively, densification can lead to gentrification and displacement of lower-income residents, exacerbating social inequality.</p>

<p><b>Improved Public Transport:</b> Supports the development and efficient operation of public transportation systems, reducing reliance on private vehicles and associated emissions.</p>	<p><b>Architectural and Design Challenges:</b> High-density projects require innovative architectural and engineering solutions to ensure safety, livability, and aesthetic appeal.</p>
<p><b>Vibrant Urban Life:</b> Higher densities can create more vibrant urban environments with diverse cultural, recreational, and social opportunities.</p>	<p><b>Maintenance Challenges:</b> High-density infrastructure requires regular and often costly maintenance to ensure safety and functionality over time.</p>
<p><b>Energy Efficiency:</b> High-density buildings can be more energy-efficient due to shared walls and more efficient heating and cooling systems.</p>	<p><b>Noise and Pollution:</b> Increased density can lead to higher levels of noise and pollution, which may require additional mitigation measures.</p>
<p><b>Walkability:</b> Dense urban areas tend to be more walkable, promoting healthier lifestyles and reducing reliance on cars.</p>	<p><b>Fire Safety Risks:</b> High-rise buildings and dense neighborhoods can present significant fire safety challenges, necessitating advanced planning and infrastructure.</p>
<p><b>Resilient Communities:</b> Higher population density can lead to stronger, more resilient communities due to closer proximity and more frequent interactions among residents.</p>	<p><b>Limited Green Spaces:</b> Urban densification can limit the availability of parks and recreational areas, impacting the overall well-being of residents.</p>

**2.7.7. Other Major Cities and the strategies they adopted to address urban densification**

**2.7.7.1. Tokyo Strategies**

Tokyo has effectively addressed urban density through a series of strategic measures and policies focused on efficient land use, high-density housing, and comprehensive public transportation systems. The city adopted a multi-nodal urban development model, decentralizing its core by creating sub-centers that host commercial, residential, and recreational facilities. This approach helped to distribute population density more evenly and reduce congestion in the central areas.

Furthermore, Tokyo's extensive and reliable public transportation network, including subways and commuter trains, supports high-density living by providing efficient and convenient mobility for residents, thereby reducing reliance on private vehicles and alleviating traffic congestion. (Pinca, 2023)

The results of these measures have been significant. Tokyo has managed to accommodate a growing population while maintaining a high quality of life. The city has seen improved air quality and reduced urban heat island effects due to increased green spaces and sustainable building practices. Additionally, the emphasis on transit-oriented development has led to shorter commute times and more accessible urban amenities, fostering vibrant and connected communities. (Cox, New Geography, 2012)

#### **2.7.7.2. Barcelona Strategies**

Barcelona has tackled urban density through a series of innovative and sustainable strategies that prioritize both environmental and social aspects. The city has developed numerous high-density housing projects that focus on reducing the carbon footprint by using local materials and implementing advanced climate control strategies. Projects like the Illa Glòries, which includes 238 homes, exemplify Barcelona's commitment to sustainable urban development. Additionally, the city has integrated large-scale social housing initiatives, such as the cooperative housing model, which promotes environmental, social, and economic value. (Cox, New Geography, 2012)

Barcelona's approach also involves transforming underutilized spaces into vibrant urban areas. The Superblocks program, for instance, reclaims streets for pedestrians and cyclists by restricting car traffic in certain areas. This has led to improved air quality, enhanced public spaces, and increased community interaction. By focusing on mixed-use developments and green infrastructure, Barcelona has managed to create livable, dense urban environments that balance growth with quality of life. (Cox, New Geography, 2012)

These efforts have resulted in a significant transformation of the city's urban fabric, making it more sustainable and resilient. The success of these projects demonstrates how well-planned urban densification can enhance economic activity, improve social cohesion, and protect the environment. (Cox, New Geography, 2012)

### **2.7.7.3. Singapore Strategies**

Singapore has successfully addressed urban density through a combination of strategic urban planning, sustainable development practices, and innovative housing solutions. The Housing & Development Board (HDB) has played a key role in creating high-density housing that is both liveable and affordable, incorporating amenities and green spaces to enhance quality of life. Initiatives such as the Pinnacle@Duxton exemplify high-density living with community-centric design, featuring sky gardens and communal facilities. (Tovar, 2022)

The Urban Redevelopment Authority (URA) has also focused on decentralizing urban growth and developing regional centers to distribute population density more evenly across the city. Additionally, Singapore's commitment to green building standards and the promotion of Green Mark buildings have significantly contributed to sustainability goals. The Active, Beautiful, Clean (ABC) Waters program and other green initiatives have integrated nature into urban areas, improving both environmental quality and residents' well-being. (Tovar, 2022)

These efforts have resulted in Singapore being recognized as a leading example of a sustainable and liveable high-density urban environment, attracting international investment and fostering economic growth while maintaining high standards of living and environmental sustainability. (Tovar, 2022)

### **2.7.7.4. Copenhagen, Danmark Strategies**

Copenhagen has effectively addressed urban density through a combination of strategic urban planning and innovative policies aimed at creating a sustainable urban environment. Since the early 1990s, the Danish national government has delegated significant urban planning responsibilities to local authorities, allowing Copenhagen to tailor its approach to urban densification. This decentralization has enabled the city to focus on developing high-density, mixed-use areas while preserving green spaces and enhancing public transportation. (city.org, Next, 2017)

One notable initiative in Copenhagen is the redevelopment of the Østerbro district, where significant investments have been made to transform former industrial and harbor areas into vibrant urban spaces. This district saw the construction of new housing, offices, and retail spaces,

contributing to a 5.9% increase in population density. The densification efforts have been supported by policies that encourage energy efficiency and the use of public transport, resulting in lower energy consumption per capita. (UBC, 2013)

The city's approach to densification has also included measures to enhance social sustainability. By integrating community facilities and public spaces into new developments, Copenhagen has aimed to foster stronger community ties and improve the quality of urban life for residents. However, challenges remain, particularly in ensuring that the benefits of densification are equitably distributed. The rise in property values in redeveloped areas has often priced out lower-income residents, highlighting the need for inclusive urban planning policies. (city.org, Next, 2017)

Overall, Copenhagen's experience with urban densification demonstrates the importance of a balanced approach that combines environmental sustainability, economic development, and social equity. The city's efforts have resulted in a more efficient urban environment with improved public transportation and reduced energy use, setting an example for other cities aiming to manage urban growth sustainably (UBC, 2013)

## **2.8. Urban densification Technics**

Urban densification techniques are essential for creating more sustainable and efficient cities. In-fill development focuses on utilizing vacant or underused parcels within existing urban areas, preventing outward expansion. Mixed-use development combines residential, commercial, and recreational spaces, fostering vibrant neighborhoods and reducing the need for long commutes. Vertical expansion involves constructing taller buildings to accommodate more people within the same footprint. Transit-oriented development (TOD) encourages the use of public transportation by developing areas around transit hubs, reducing car dependency. Adaptive reuse repurposes old or unused buildings for new functions, such as converting warehouses into apartments or offices. Lastly, integrating green spaces like parks and green roofs helps maintain environmental quality and provides recreational areas within dense urban settings. These techniques collectively help manage urban growth sustainably, reduce sprawl, and enhance residents' quality of life. (Tovar, Rethinking Urban Development, 2023)

## **2.9. The Importance of Urban densification**

Urban densification is essential for sustainable city development as it optimizes land use, reduces urban sprawl, and lowers the environmental footprint of cities. By concentrating development within existing urban areas, densification promotes more efficient public transportation, reduces the need for extensive road networks, and lowers reliance on automobiles, thereby decreasing greenhouse gas emissions. Additionally, higher density supports vibrant communities with better access to amenities, services, and employment opportunities, which can improve the overall quality of life. Densification also preserves natural landscapes and agricultural land by limiting outward expansion, contributing to more resilient and adaptive urban environments. (Teller, 2021)

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.0. Introduction**

Research methodology refers to the systematic process employed to gather, analyze, and interpret data in order to address specific research questions or problems. It encompasses the theoretical framework and procedural techniques used to ensure that the research is valid, reliable, and credible. This methodology involves selecting appropriate research methods such as qualitative, quantitative, or mixed methods designing the research process, and applying rigorous data collection and analysis techniques. By adhering to a well-defined methodology, researchers can ensure that their findings are based on sound evidence and contribute meaningfully to the body of knowledge in their field. (Sreekumar, 2023)

This section discusses the research methodology that was used throughout the study. This chapter goes into more detail about the study's design, study population, sampling strategy, data collection methods, data presentation and analytical techniques, ethical considerations, and major challenges encountered.

### **3.1. Research Structure**

The following graph shows the structure of the research made and the methodology used to conclude and recommendation

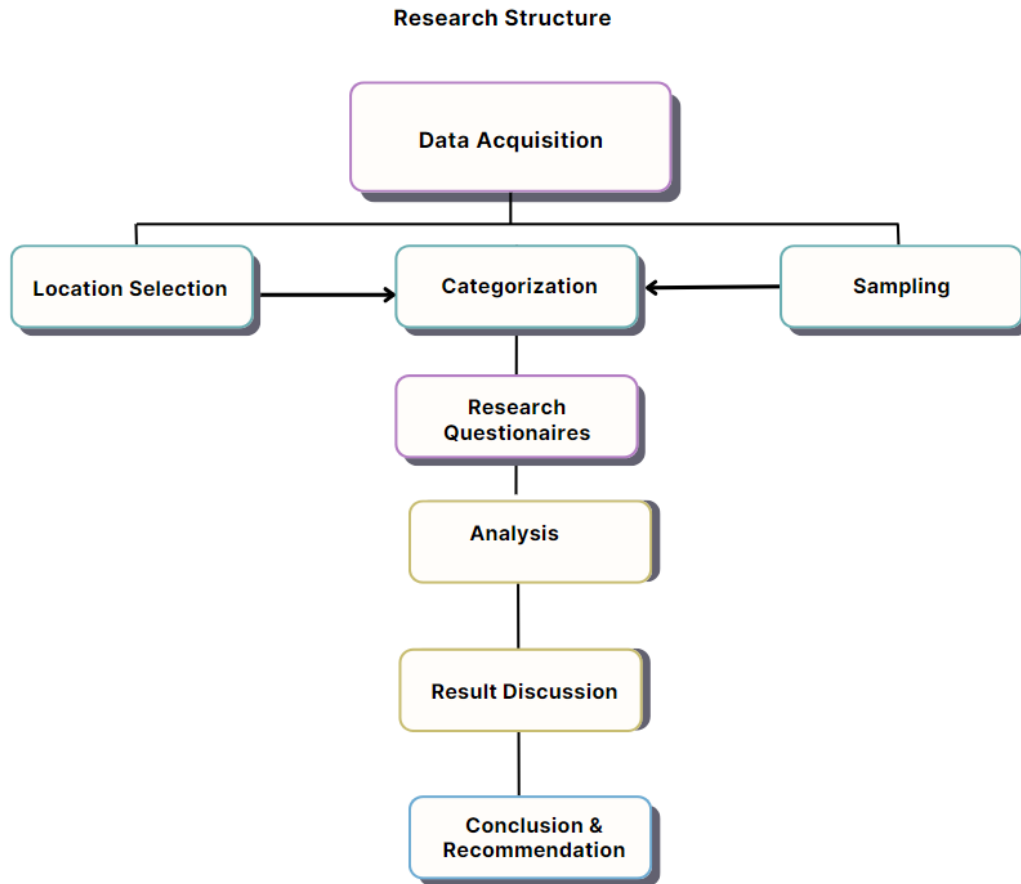


Figure 3. 1. Research structure Flow Chart

### 3.2. Research location

This research was conducted in Gisozi sector, which is one of 15 sectors that made up Gasabo district in Kigali. It has an area of 8.304 km<sup>2</sup>, This sector is neighbored to Gatsata, Muhima, Kinyinya, Jabana and Kakiru and a latitude with 1° 38' 0" S longitude 29° 48' 0" E.



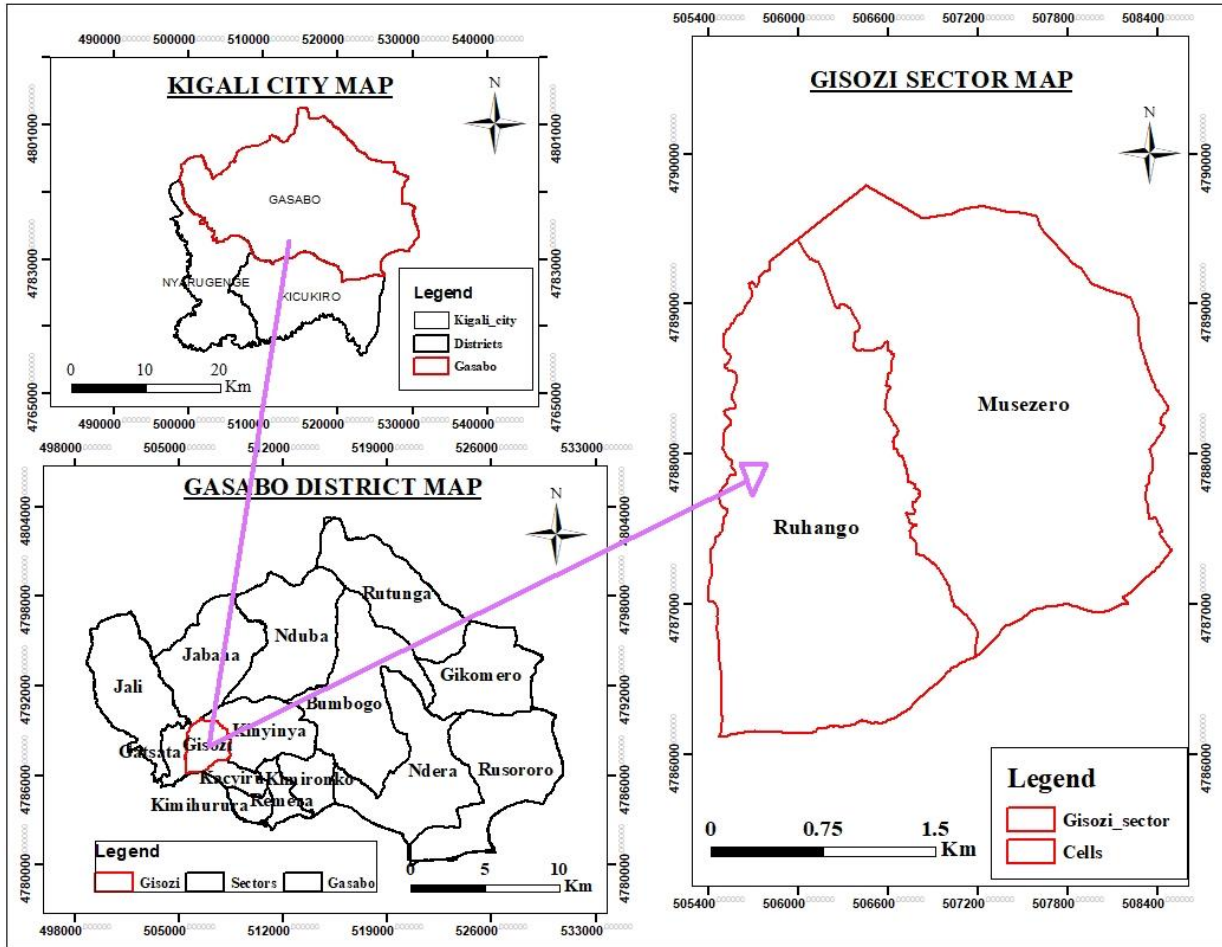


Figure 3. 2. Map of the study area (Arch Map)

### 3.3. Research Design

For this study on the assessment of urban densification in the Gisozi sector of Kigali, Rwanda, a **descriptive survey design** has been chosen. This design is particularly appropriate because it allows for the systematic collection and analysis of data from a representative sample of the population in Gisozi, providing insights into the patterns, causes, and effects of urban densification in the area. The study has utilized **both quantitative and qualitative approaches**, with questionnaires being the primary tool for gathering quantitative data from residents, urban planners, and local authorities. The descriptive survey design is justified as it facilitates the identification of trends and correlations in the data, offering a comprehensive understanding of urban densification's impact on the community. This design is well-suited to the study's objectives, enabling the researcher to capture a broad range of perspectives and draw meaningful conclusions from the findings.

### **3.4. Research population**

The research population for this study consists of the residents, urban planners, and local authorities within the Gisozi sector of Kigali, Rwanda. This population is critical to the study as it directly experiences the impacts of urban densification, making it highly relevant for gathering insights and understanding the phenomenon. The target population from which the sample has drawn includes all individuals living in Gisozi, along with professionals involved in urban planning and local governance. This diverse group provides a comprehensive view of how urban densification affects different segments of the community. The study focused on individuals who have lived or worked in Gisozi for a significant period, ensuring that respondents have substantial experience and understanding of the local context. Inclusion criteria focused on age, residence, and professional involvement in urban planning, while exclusion criteria ruled out those with less than one year of residency or involvement in the area. This careful selection process ensured that the findings are both representative of and generalizable to the broader population of the Gisozi sector.

### **3.5. Sample Size**

To ensure that the sample size accurately represents the accessible population of the Gisozi sector, a sample of 128 respondents were selected. This sample size has been determined using Cochran's Formula, which considers the total population size and desired confidence level. Given that the population of Gisozi sector is estimated to be 9,600, this sample size is sufficient to provide reliable and generalizable results. According to Cochran's Formula, a sample size of 128 is adequate for a population of this magnitude, ensuring that the study's findings had to be statistically significant and reflective of the broader population. This approach guarantees that the sample is both manageable and representative, facilitating the accurate assessment of urban densification's impact in Gisozi sector.

#### **3.5.1. Sampling Procedure**

The sampling procedure for this study employed a stratified random sampling technique to ensure that the selected sample accurately represents the diverse characteristics of the Gisozi sector's population. The population was divided into strata based on key characteristics such as age, gender, length of residence, and professional involvement in urban planning. From each stratum, a random sample has been drawn, ensuring that all relevant segments of the population are proportionately

represented in the final sample. This method is chosen to account for the potential variability in how different groups experience urban densification, thereby enhancing the reliability and generalizability of the study's findings. By stratifying the population and then randomly selecting participants, the procedure minimizes bias and ensures that the sample reflects the broader population's composition, making it a robust and effective strategy for this research

### **3.6. Research Instrument**

#### **3.6.1. Choice of the research instrument**

During this research the utilization of ArcGIS 10.8 enabled to conduct all the spatial analysis and mapping. The software made it accurately classify all necessary maps, as well as analyze spatial relationships between various geographic features in the study area. Using ArcGIS 10.8, made it possible to process and analyze large datasets, this tool was instrumental in ensuring precise data visualization and supporting the overall findings of the research.

#### **3.6.2 Validity and Reliability of the Instrument**

To ensure the validity and reliability of the researcher-devised questionnaire used in this study, several steps have been taken. Validity had to be established through content validation, where the questionnaire had to be reviewed by experts in urban planning and research methodology to ensure that the questions are relevant, clear, and adequately cover the key aspects of urban densification discussed in the literature review. Their feedback has been used to refine the questions, ensuring they accurately capture the intended information. The responses were analyzed to determine the consistency of the results, and any ambiguities or inconsistencies will be addressed by revising the questions. Additionally, the use of a Likert scale for closed-ended questions enhances reliability by providing a standardized method for respondents to express their views. The combination of expert validation and pilot testing ensured that the questionnaire is both a valid and reliable tool for data collection in this study.

### **3.7. Data representation**

Tables and graphs are used in this study to illustrate the data, and they provided the conclusions a clear and succinct visual. Descriptive statistics were used to assess quantitative data, which are then shown in tables with mean scores, frequencies, and percentages to facilitate comparisons across various variables. A visual representation of trends and correlations found by correlation

analysis is provided by graphs, such as bar charts and line graphs, which provide an intuitive understanding of the links between factors like urban densification and citizens' quality of life. Schematic analysis of qualitative data produces themes that are presented in tables that emphasize significant patterns and insights. These graphics are crucial for clearly conveying the study's conclusions, and increasing the data's accessibility, and clarity.

### **3.8. Ethical consideration**

Ethical considerations for this study were meticulously addressed to ensure the safety, social, and psychological well-being of all participants and the community involved. Prior to data collection, ethical clearance was considered, ensuring that the study adhered to established ethical guidelines. Informed consent was sought from all respondents, who were thoroughly briefed on the study's purpose, procedures, and their rights, including the right to withdraw at any time without penalty. Confidentiality of the participants' information was strictly maintained, with all data being anonymized and securely stored. Additionally, the study was designed to minimize any potential psychological or social risks to the participants by framing questions in a non-intrusive manner and ensuring that the research process was respectful and non-disruptive to the community. These measures ensured that the study was conducted with the highest ethical standards, protecting the dignity and well-being of all involved.

### **3.9. Limitations of the study**

The study on urban densification in the Gisozi sector faced several limitations that could impact the validity of the findings. One key limitation was the reliance on self-reported data through questionnaires, which may introduce **response bias** as participants might have provided socially desirable answers rather than accurate reflections of their experiences. Additionally, the geographical focus on a single sector of Kigali limits the generalizability of the findings to other areas, as the unique characteristics of Gisozi may not represent other sectors with different urban dynamics. Another limitation was the potential for non-response bias, as some selected respondents might have chosen not to participate, which could skew the results if non-respondents differ significantly from those who completed the survey. To minimize these limitations, efforts were made to ensure a representative sample through stratified random sampling, and respondents were assured of confidentiality to encourage honest and accurate responses. Despite these

challenges, the study provides valuable insights into the effects of urban densification, though the findings should be interpreted with caution, considering these potential biases.

## CHAPTER FOUR: RESULTS AND DISCUSSION

### 4. 0. Introduction

This chapter provides a detailed examination of the data collected throughout the study. This section aims to present the findings systematically, utilizing tables, charts, and other visual aids to clarify the results. Furthermore, the analysis offers critical insights by interpreting the data with the research objectives, drawing comparisons, identifying trends, and highlighting any significant relationships. This chapter reports on the observed outcomes and contextualizes them within the broader scope of existing literature, ultimately contributing to a deeper understanding of the subject matter.

### 4.1. Identification of the Number of People Living in Gisozi Sector

In the case of evaluating the population of Gisozi, we will refer to the Rwanda census that has been done by 2022. This consensus has shown that the population increase was up to 5.6% rate. The table below shows the distribution of people by cell. (City Population, 2023)

The table below describes the population distribution as per Rwanda census 2022 (National Institute of Statistics of Rwanda, 2022)

Table 4. 1. Distribution of people living in Gisozi sector

Cell name	Number of people per cell
Ruhango	37,452
Musezero	46,971
<b>Total</b>	<b>84,423</b>

Such a high population density underscores the need for careful urban planning and efficient land-use strategies to accommodate the growing population. Implementing densification techniques like vertical building and reducing plot sizes can help manage this pressure while maintaining a balance between infrastructure needs, housing, and public spaces. (City Population, 2023)

### 4.2. Evaluate the Area of Gisozi sector

Gisozi, one of the rapidly growing sectors in Gasabo district, presents both opportunities and challenges for urban densification. **While its 8.304 km<sup>2</sup>** (City Population, 2023) expanse offers

ample space for development, the terrain, characterized by valleys and hills, could influence construction costs and urban planning. The presence of existing infrastructure, such as roads, utilities, and public facilities, can either facilitate or hinder densification efforts. Careful consideration of these factors will be crucial in determining the most effective and sustainable ways to develop Gisozi while preserving its unique character and addressing the needs of its growing population.

### **4.3. Densification rate of Gisozi Area**

To know the densification rate in Gisozi we will need to use the formula to find it out.

Here is the formula:

$$\text{Densification Rate} = \frac{\text{Population number}}{\text{Area (Sq. Km)}}$$

$$\text{Densification Rate} = \frac{84,423 \text{ population}}{8.304 \text{ Km}^2} = 10,166 \text{ population / km}^2$$

From the calculations above it is seen that we have 10,166 people per square kilometer. This is still low in comparison to Addis Ketema in the city of Addis Ababa (Ethiopia). In the Addis Ketema is found to have a densification rate of 34,000 people per square kilometer. (Worldometer, 2023). This is so obvious as Kigali isn't of the same size as Adis Ababa, but necessary measures need to be taken with regard to the size of Gisozi and its respective people and what to be managed.

There will be discussion about the ways of putting a hand on densification and having proper ways to help people to live in these conditions.

### **4.4. Suggestive ways to increase population density**

Increasing population density in urban areas requires strategic planning that optimizes land use while ensuring sustainable growth. Methods to achieve higher density include vertical development, reducing plot sizes, and promoting mixed-use developments. By constructing taller

buildings, cities can house more people in the same footprint, allowing for efficient use of limited land resources. Smaller plot sizes encourage compact neighborhoods, facilitating closer proximity between homes and essential services. Additionally, mixed-use zoning integrates residential, commercial, and recreational spaces, reducing the need for urban sprawl and enhancing accessibility. These approaches foster livable, vibrant communities while managing population growth in a sustainable manner.

#### **4.4.1. Increase the number of House Holds in a Plot**

Increasing the number of households per plot is an effective way to control densification while optimizing land use in urban areas. By encouraging multi-family housing units, such as duplexes, townhouses, or apartment complexes, cities can accommodate more residents within a single plot without expanding the urban footprint. This strategy not only maximizes land efficiency but also reduces infrastructure costs per household, as utilities and services are shared among more people in a concentrated area. Additionally, having multiple households on a single plot can foster a sense of community and provide more affordable housing options, making urban living more accessible. This approach balances population growth with the preservation of green spaces and public areas, promoting a sustainable urban environment.



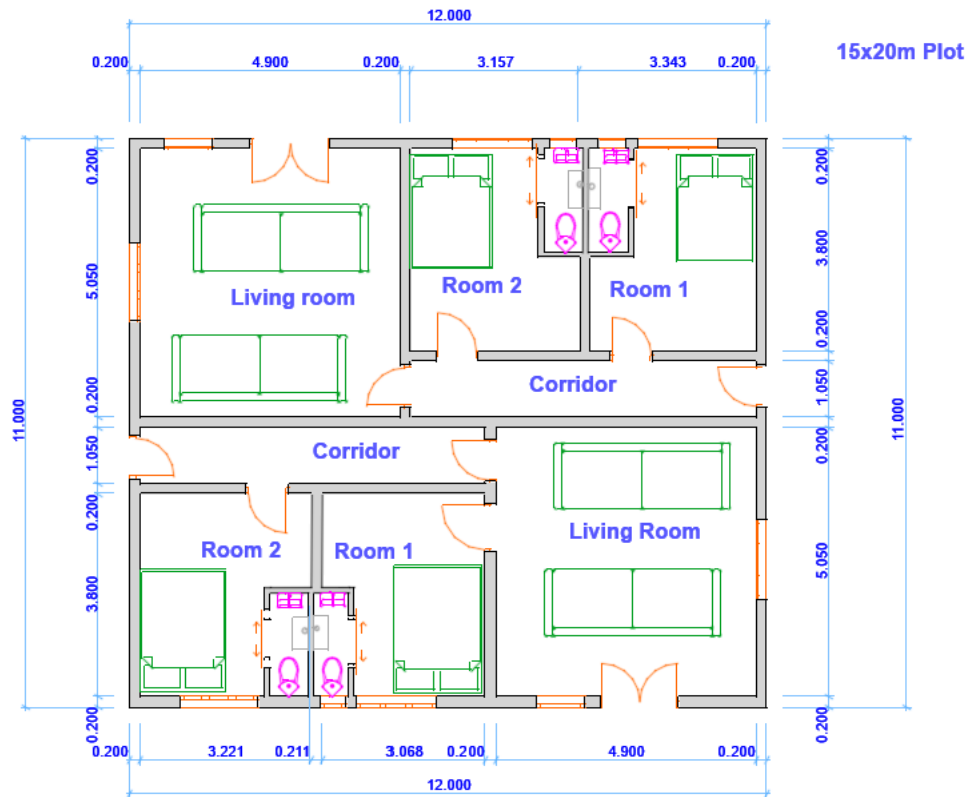


Figure 4. 1. A proposed duplex residential house

#### 4.4.2. To encourage people to construct buildings going up

The upward building technique has been key in managing urban densification in Ethiopia and the United States. In Addis Ababa, vertical construction has helped curb urban sprawl and accommodate a growing population. Building upwards maximizes land use efficiency, reduces infrastructure costs, and promotes vibrant, economically diverse urban neighborhoods through mixed-use buildings.

In the U.S., cities like New York and Chicago use tall buildings to optimize space and concentrate economic activity in business districts, reducing the need for long commutes. In Gasabo District, Rwanda, adopting vertical construction in the Gisozi sector can support densification while preserving green spaces and public infrastructure for long-term livability.

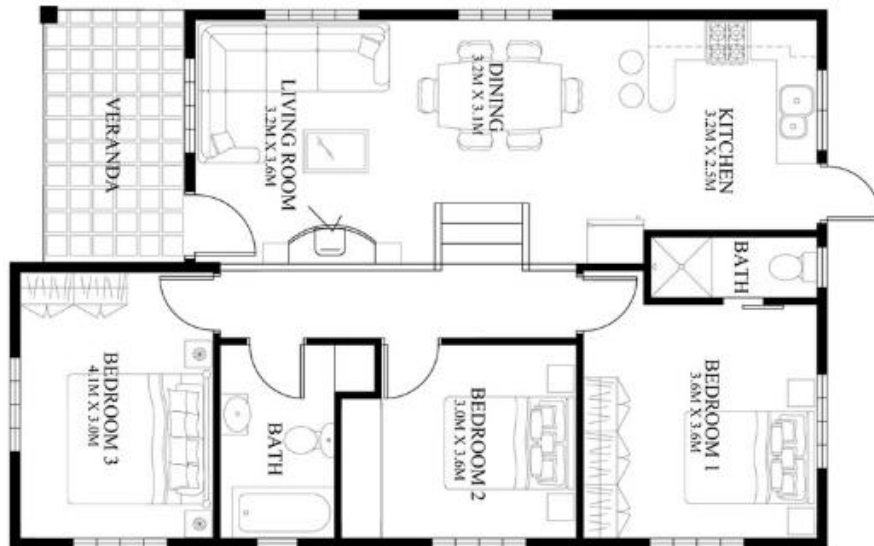


Figure 4. 2. A sample of G+3 residential house (floor plan & elevation)

#### 4.4.3. To Reduce parcel size

Reducing plot sizes, such as shifting from 15 m x 20 m to 7.5 m x 15 m, can be an effective strategy to control densification while optimizing land use. Smaller plots allow for more housing units or commercial buildings to be built within a given area, thereby increasing population density without requiring urban sprawl. This approach helps in creating compact communities that make better use of infrastructure, such as roads, water, and electricity, while reducing the per-unit cost of services. Smaller plots also encourage more efficient building designs and can lead to the development of more affordable housing options, making urban living accessible to a broader demographic. By controlling plot sizes, cities can foster sustainable growth, optimize land use, and manage population pressures more effectively.

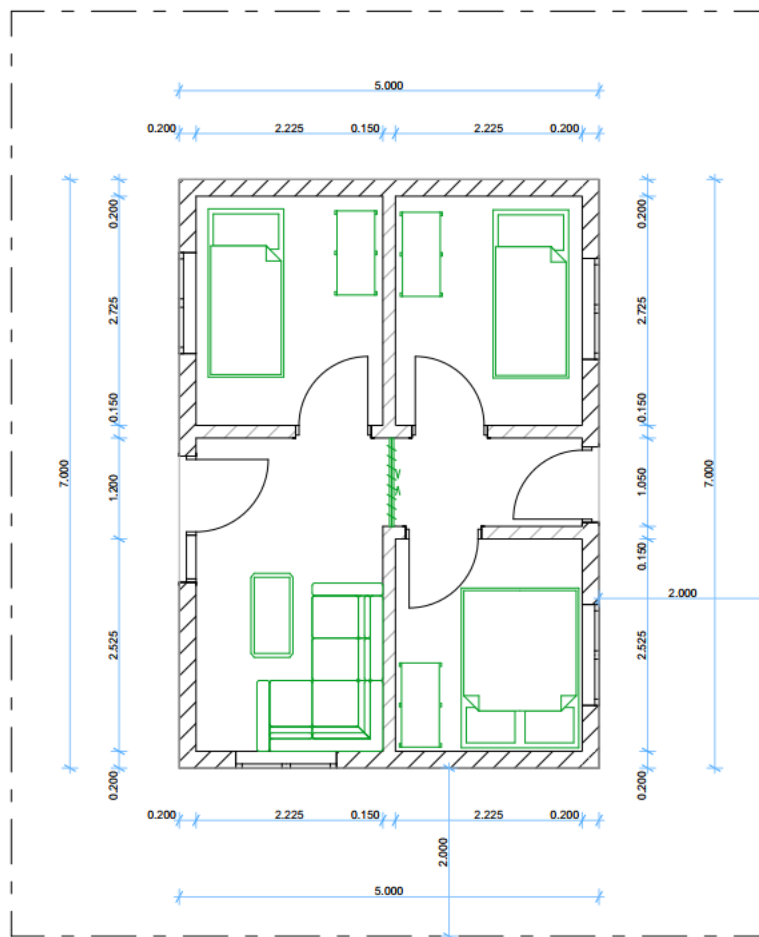


Figure 4. 3. Proposed house floor plan in a plot/parcel of 7.5x20m

## **CHAPTER FIVE: CONCLUSION AND RECOMMENDATION**

### **5.1. Summary of the findings**

As in this research the population density was examined to evaluate if there might be possible alternatives that can help to mitigate any challenge that may have raised due to urbanization pressure. As in the conductance of this study some critical point from this study were made into a conclusion. The findings indicate that there is an increase on urban densification in Gisozi sector. There are various factors influencing this densification increase which include population increase and rural urban migration which is mostly viable from people coming from rural areas surrounding Kigali. It is also speculated among people that Gisozi sector and it surrounding have an affordable life which attracts other people to live in Gisozi.

The population increase at 5.6% as the statistics show. This increase pressure to the existing infrastructural facilities. It is also obvious that if a proper monitoring is not done a disruption in residential construction.

### **5.2. Conclusion**

By the grace of Rwanda Institute of statistics another considerable resource were used. This is to say that people in charge, institutions, and property owners can have an insight on the management of land vis a vis the population density at hand. This also gives an insight to the government on the degree at which the current infrastructure is the burden of adapting to a growing population.

In conclusion, this research indicates that the urban densification in the study area will continue to increase with reference to the current data. This implies that there is positive impact and negative impact in the given area. This is for the local communities to embrace and the property developers to benefit from the population densification. This study found out that the level of densification has an impact on the price of land which mostly benefits land owners.

Moreover, it is obvious that both pros and cons of densification can be gotten from densification, hence all related bodies can play a significant role to judge what best choices to make. It is necessary to keep in mind the management of the available resources play a big role in development and urban densification adaptation.

### **5.3. Recommendations**

The study highly recommends that the Ministry of Infrastructure, Rwanda Housing Authority, Rwanda Land Use and Management Authority, and Rwanda Environmental Management Authority promote and mobilize vertical residential construction, reduce the size of the plot for efficient land use, and promote the construction of duplex buildings in residential zones.

The urbanization policy in Rwanda is essential as it assembles people and facilitates the provision and distribution of access to services to the entire community. Policymakers are urged to consider the management of population densification for general benefits. Preparation for sustainable urban planning implies the growth of a healthy society, and economy, and the protection of the economy. There is hope that education on urbanization and population densification shall improve effectiveness in land and property uses.

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