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Towards a Net Zero Luanda: Carbon Neutral Solutions for Sustainable Coastal Regeneration in Ramiros

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Abstract

This research paper aims to propose sustainable infrastructure solutions for regenerating and redeveloping the Ramiros community in Luanda, Angola. The rapid urbanisation of Luanda has led to the proliferation of Ramiros, informal settlements lacking adequate infrastructure and basic services like housing, clean water access, reliable energy sources, and waste management systems. Employing a quantitative methodology involving resident surveys and field studies, the research will collect data on the daily challenges faced by Ramiros residents, their priorities, and existing infrastructure conditions to identify potential intervention areas. The data will then be analysed to develop and evaluate innovative engineering solutions integrating sustainable practices, advanced technologies, and net-zero carbon principles. The key objectives are to enhance living conditions in Ramiros while minimising environmental impact, preserving cultural traditions, and promoting community engagement through capacity-building initiatives. Potential solutions may include locally sourced and recycled construction materials, solar microgrids, rainwater harvesting, greywater recycling, and efficient waste segregation systems. By focusing on sustainable development principles, the research aims to propose contextually and culturally appropriate infrastructure interventions for Ramiros. The solutions will integrate innovative engineering approaches and green technologies to create a model that is environmentally responsible for the improvement of informal settlement.

Keywords: Sustainable Infrastructure, Carbon Neutral, Net-zero Principles, Redevelopment, Community Engagement, Renewable Energy

1. Introduction

This paper has the goal of showcasing the potential of this region of Angola due to its privileged location, as well as its social and economic potential. Angola is a country composed of 18 provinces where several have a coastal area with a great fauna and flora species important to the environment. The Ramiro's region, located in the capital Luanda, is an emerging region full of cultural values and a huge potential that can bring a substantial contribution to Angola. According to Saraiva, 21 "The Ramiro's area is located in the province of Luanda in the municipality of Belas". This region is located about 35 km South center of its capital Luanda. Surrounded by the Mussulo Bay, it is reachable by interprovincial road no. 100 that connects the province of Luanda to the province of Kwanza Sul. The geographical location is referenced by the coordinate point, Latitudes 9° 5'26.07"S and Longitudes 13° 4' 8.21"E.

The area has a territorial expansion of 14 km2, with a measurable population of 12,000 inhabitants and is divided in 6 locations: Zone A, Zone BI, Zone C, Cateba, Buraco and Tanque II. Its geographical positions allows the population the ability to participate in services such as artisanal fishing and rural farming. Those became the most prominent activities carried out in this commune. Today with the help of local township administration, the population has become more aware of the region privilege and importance.

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Ramiros is defined by a tropical dry to semi-arid climate with two climatic seasons per year (Saraiva 21). For its vegetation cover, the region is formed essentially by rain-fed herbaceous vegetation, shrubs and medium to large trees such as Muchacheiros and coconut palms that colonise the sandy areas and mangroves and other slinking species that occupy the shores of the bay, as shown in the vegetation map shown on the page.

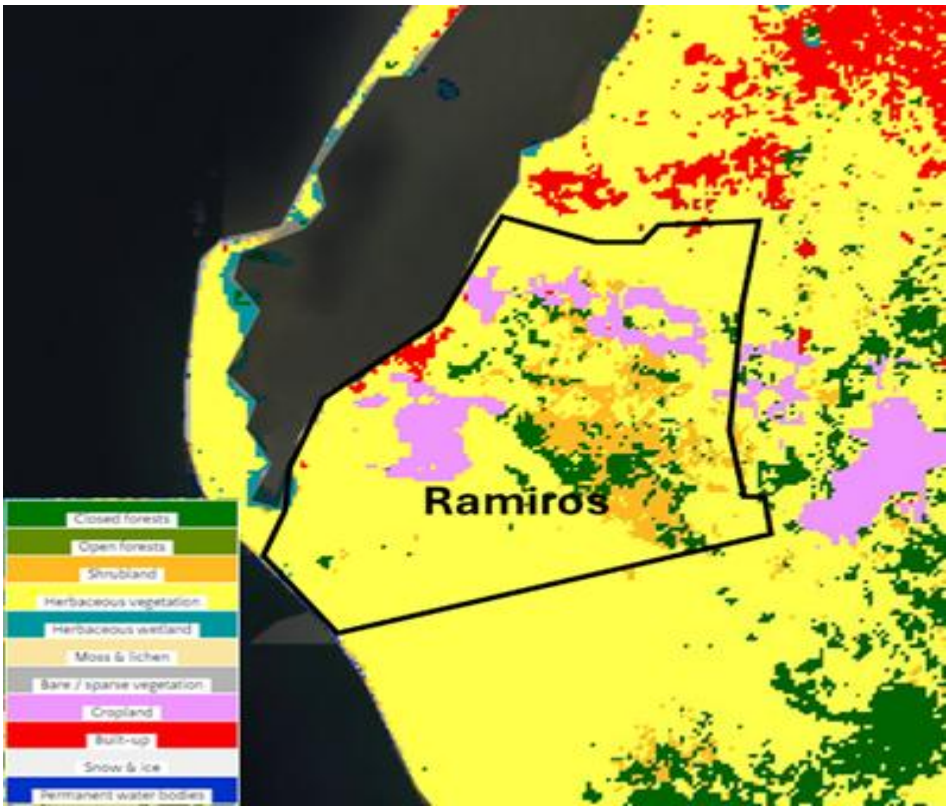


Figure 1: *2019 vegetation cover map of the study area*

The inhabited vegetation area is formed of herbaceous communities that best illustrates the area of acknowledgement, which is understandable given by the climatic conditions of the territory.

Ramiro's has a peculiar animal and vegetation life, which serve as study subjects of ecological initiatives such as the Otchiva Association. This research has catalogued more than a hundred species of fauna and flora from the Mussulo commune, where it is located, contributing to the knowledge of local ecosystems. It is imperative to note that the region faces challenges in terms of environmental preservation and protection. A little over one hundred species of local plantation have been studied in the municipality of Talatona, including the municipality as of January of 2024, by the NGO Otchiva, and there are mangrove planting projects at Ramiros Beach, with approximately 20,000 mangroves already planted through 2022.

From a geological point of reference, according to Andosufu 2024, it is a zone of merged action of erosive phenomena on the lithologies, where the natural process happens through the lithologies that are close to the sea and their modelling is directly linked to the action of the ebb and flow of sea water. However, the lithologies are influenced by the drainage network that formulae incisions or ravines that cut through the urban district. The district is mostly covered by Quaternary red sands, but it is possible to find outcrops of clays, sands and carbonates belonging to the Luanda Formation along the coast. The Ramiros urban district is a coastal area with atypical geological features, mainly because of its proximity to the Mussulo peninsula.

In the Ramiros area, the Upper Miocene to Quaternary formations represented by the Cacuaco, Luanda and Quelo formations and recent deposits made up of well-selected sands of marine and fluvial origin can be seen from the base to the top. The recent deposits make up the sandy body of the Musulu peninsula and

occupy the top of this stratigraphic sequence. The study area has also been affected by faults of predominantly NNW - SSE and secondary N - S direction.

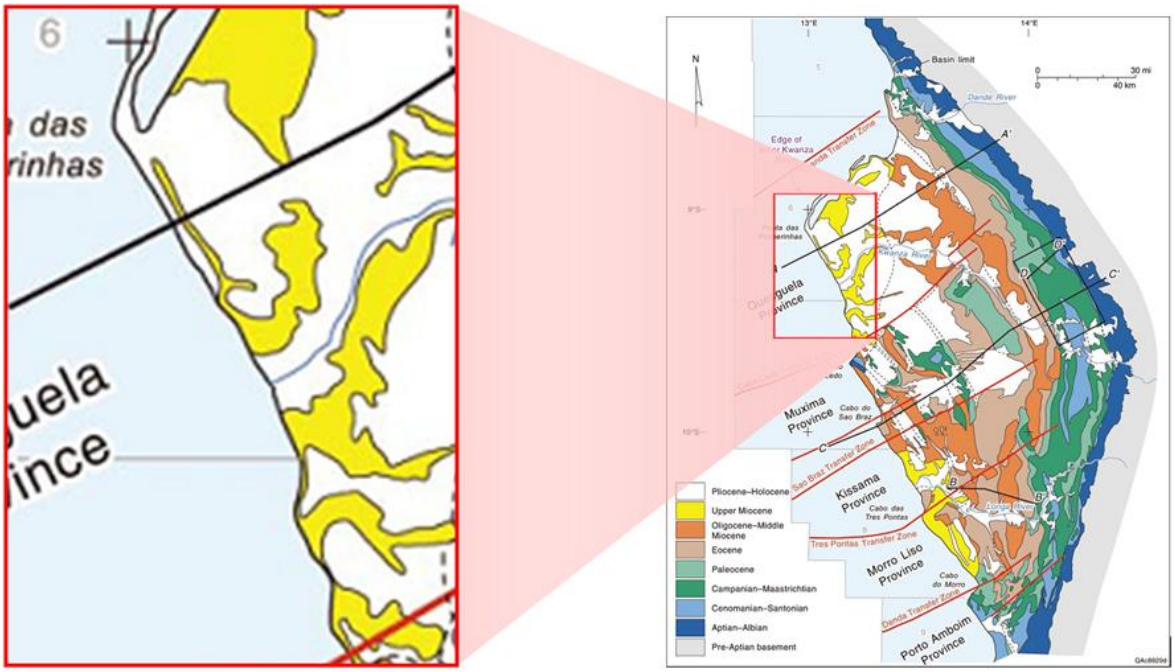


Figure 2: *Simplified surface geological map of the Kwanza Interior Basin, The red rectangle shows the location of the Ramiros area (source: Total-Sonangol 1987)*

The goal of this study is to put in evidence the great quality of the area from a geographical standpoint. This gives a potential reason to answer to the region's principal infrastructural necessities that with the right attention can help an economic growth, and also a potential sustainable environmental preservation.

2. Research Methodology and Techniques

This chapter outlines the comprehensive methodological approach and techniques employed to investigate and propose sustainable infrastructure solutions for regenerating and redeveloping the Ramiros community in Luanda, Angola. The complex nature of informal settlements and the urgent need for sustainable urban development necessitate a multifaceted research strategy that can capture both quantifiable data and in-depth community insights.

To achieve this, we have adopted a mixed-methods research design, combining quantitative and qualitative approaches.

This methodology allows us to leverage the strengths of both paradigms, providing a holistic understanding of the challenges faced by Ramiros residents and the potential for sustainable interventions. Consequently, the research methodology will be structured in accordance with Leong et al., (2016) and Creswell (2018). The illustration below shows the summary of the structure to be used for the appropriate research.

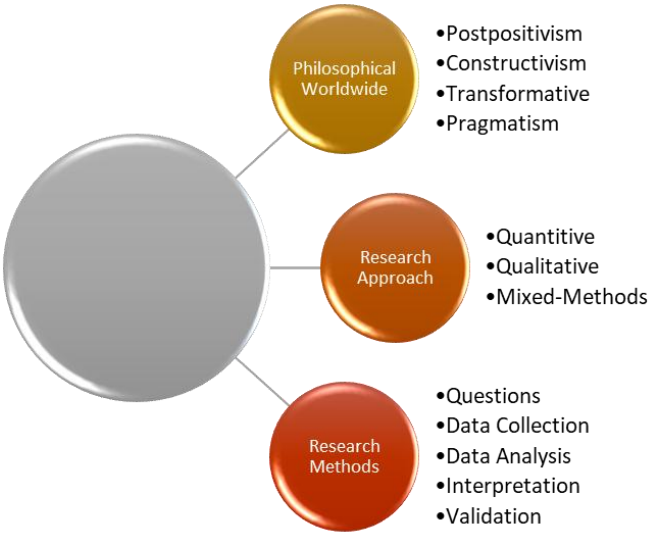


Figure 33 *Framework for the research*
Source: *Adopted by Creswell (2018)*

The research adopts a mixed-methods design, integrating both quantitative and qualitative data to provide a nuanced understanding of the challenges and opportunities within the community (Creswell, 2018, p.14). This methodological triangulation facilitates the identification of feasible, culturally congruent, and environmentally sustainable infrastructure solutions. As stated by Creswell (20218), the study employs an exploratory sequential design, where initial quantitative data informs subsequent qualitative inquiry, allowing for a deeper exploration of emergent themes.

2.1. Research Philosophy

This study adopts a Pragmatic Philosophical Worldview as its foundational research philosophy. Pragmatism, as described by Creswell (2018), is not committed to any one system of philosophy and reality. Instead, it focuses on the research problem and uses all available approaches to understand and address it. According to Creswell (2018), there are four main philosophical worldviews, which are Postpositivism, Constructivism, Transformative and Pragmatism. As described on the table below the possible assumptions:

Table 1: Assumption of philosophical worldview

Philosophical Assumptions	**Postpositivism**	**Constructivism**	**Transformative**	**Pragmatism**
Ontology (Nature of reality)	Singular reality	Multiple realities	Political reality	Singular and multiple realities
Epistemology (How we know what we know)	Objective	Subjective	Participatory	Both objective and subjective
Axiology (Role of values)	Unbiased	Value-laden	Value-laden	Multiple stances
Methodology (Research process)	Deductive	Inductive	Participatory	Combining approaches
Rhetoric (Research language)	Formal style	Literary, informal style	Advocacy, change-oriented	Formal or informal

Source: Adopted by Creswell (2018)

The adoption of pragmatism as the philosophical foundation for this research is rooted in several key considerations that align with the study's objectives and context. Pragmatism offers a problem-centred approach that resonates with the study's focus on addressing real-world issues in the Ramiros community, as emphasised by Creswell (2018), who notes that pragmatists are primarily concerned with practical applications and solutions. This philosophical stance enables a pluralistic perspective, which Shan (2022) highlights as allowing researchers to draw from both quantitative and qualitative assumptions. Such an approach is crucial for understanding the multifaceted nature of infrastructure needs in Ramiros, encompassing both measurable aspects and subjective experiences of community members.

The flexibility in methods afforded by pragmatism, as described by Creswell (2018), is essential for the study's mixed-methods approach, facilitating the integration of questionnaires, interviews, and field studies. Moreover, pragmatism's emphasis on context-specificity, as noted by Shan (2022), aligns with the need to develop tailored solutions for Ramiros' unique social, cultural, and environmental landscape. The action-oriented nature of pragmatism, highlighted (Creswell, 2018), supports the study's aim of not only understanding the current situation but also proposing actionable sustainable development solutions.

The purpose of employing Pragmatism in this research is multifaceted. It serves to bridge the gap between theoretical knowledge and practical, context-specific solutions for the Ramiros community. As Shan (2022) suggests, pragmatism provides a philosophical basis for integrating multiple data sources, allowing the research to combine quantitative data from questionnaires with qualitative insights from interviews and field observations. This approach is particularly suited to addressing the complexity inherent in studying informal settlements and sustainable development, offering the flexibility to adapt to emerging insights and challenges.

Furthermore, pragmatism's focus on outcomes, as noted by Creswell (2018), aligns with the study's goal of proposing viable, sustainable infrastructure solutions. Importantly, pragmatism acknowledges the value-laden nature of research, encouraging researchers to be reflective about their biases and interpretations. This aspect is crucial for a study dealing with sensitive social and cultural issues in the Ramiros community. By adopting pragmatism, this research aims to produce knowledge that is both theoretically grounded and practically applicable, navigating the complex interplay of factors characterising the Ramiros community while remaining focused on proposing effective sustainable infrastructure solutions.

2.2. Research Approach - Deductive vs Inductive

In research methodology, there are two primary approaches to reasoning and analysis: inductive and deductive. Understanding these approaches is crucial for determining the most appropriate method for a given study.

Inductive Approach (Qualitative)

The inductive approach moves from specific observations to broader generalisations and theories (Proudfoot, 2023). It's often described as a "bottom-up" approach. Researchers using this method start with specific observations, look for patterns, and then develop broader conclusions or theories (Proudfoot, 2023).

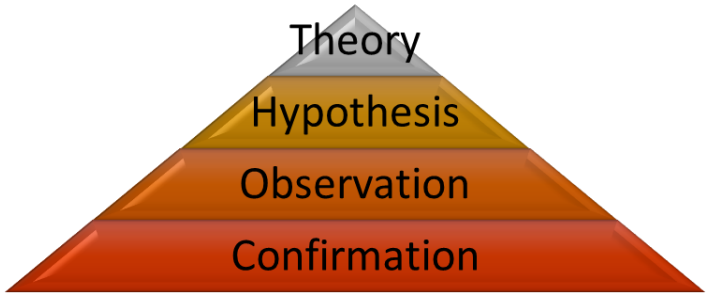


Figure 4: *Inductive Approach*

Deductive Approach (Quantitative)

The deductive approach works from the more general to the more specific, often referred to as a "top-down" approach. It starts with a theory or hypothesis, which is then tested through specific observations, ultimately leading to confirmation (or rejection) of the original theory (Proudfoot, 2023).

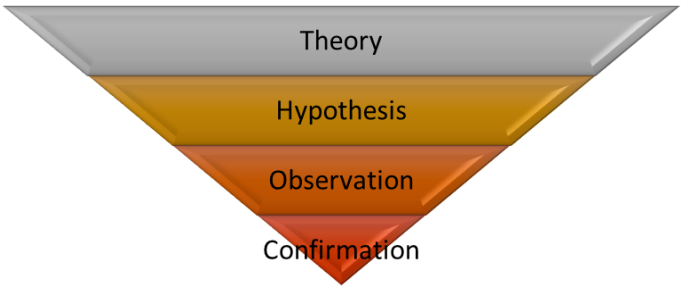


Figure 5: *Deductive Approach*

For this research on sustainable solutions for Ramiros Community Zone A, an inductive approach:

- **Exploratory Nature**: The study aims to understand the unique challenges and needs of the Ramiros community without preconceived hypotheses, which aligns with the inductive approach.
- **Context Specificity**: Inductive reasoning allows for a deeper understanding of the local context, essential for developing tailored solutions.
- **Flexibility**: The inductive approach provides the flexibility to adapt the research focus based on emerging data, crucial when studying complex social systems.

However, as Proudfoot (2023) suggests, a purely inductive or deductive approach may not always be sufficient for mixed methods research. Instead, a hybrid approach can be beneficial. Proudfoot proposes an inductive/deductive hybrid thematic analysis that can be particularly useful for our mixed method research.

Table 2 *Hybrid Approach*

Steps	Description
Data Collection	Gather data through questionnaires, interviews, and field studies.
Initial Inductive Coding	Analyse the data without preconceived codes, allowing themes to emerge naturally from the participants' responses and observations.
Deductive Framework Application	Apply existing theoretical frameworks on sustainable development and urban planning to the initial findings.
Integration of Inductive and Deductive Themes	Combine the inductively derived themes with the deductive framework, creating a comprehensive thematic structure.
Iterative Analysis	Continuously revisit the data, refining themes and identifying relationships between them.
Quantitative Data Integration	Incorporate quantitative data from questionnaires to support or challenge qualitative findings.
Theme Finalisation	Develop a final set of themes that represent both the unique aspects of the Ramiros community and align with broader theoretical concepts.
Theory Development	Develop context-specific theories or models for sustainable infrastructure development in Ramiros.

Source: Proudfoot (2023)

This hybrid approach allows the research to benefit from both the openness of inductive reasoning and the structure of deductive analysis. It enables the study to remain grounded in the specific context of Ramiros while also connecting findings to broader theoretical frameworks in sustainable urban development. As

Proudfoot (2023) argues, this method is particularly well-suited for mixed methods research, providing a robust framework for integrating diverse data types and perspectives.

2.3 Research Choice

This study will collect and evaluate data using quantitative and qualitative methodologies to determine sustainable infrastructure solutions for the Ramiros community in Luanda, Angola. A mixed-method research approach will accomplish this purpose, as it collects both qualitative and quantitative data, enabling a more comprehensive examination of the community's infrastructure needs and potential solutions (Creswell, 2018). This method aims to explore the current state of infrastructure, identify key challenges, and propose sustainable solutions tailored to the Ramiros context.

Qualitative Method

Qualitative research focuses on exploring and understanding the meanings individuals or groups ascribe to social or human problems (Creswell, 2018). This approach typically involves collecting data through interviews, observations, or document analysis. Qualitative methods are particularly useful for exploring complex phenomena, uncovering new insights, and providing rich, detailed descriptions of experiences or processes.

The qualitative method will be implemented through recorded interviews with technical and administrative professionals. Semi-structured interviews will be conducted and audio-recorded, allowing for in-depth exploration of topics while ensuring accurate data capture. An interview guide with open-ended questions will be used, providing flexibility in probing and follow-up questions. Purposive sampling will be used to select professionals with relevant expertise and roles in infrastructure development. Recorded interviews will be transcribed, and thematic analysis will be conducted, involving coding of transcripts, identification of themes, and interpretation of patterns in the data. This method will provide rich, detailed insights into the technical aspects of infrastructure challenges and potential solutions, allowing for exploration of complex issues and uncovering of new perspectives that may not be captured in the quantitative survey.

The integration of these methods aligns with the exploratory sequential mixed methods design. The professional interviews will be conducted first in the initial qualitative phase. Insights gained from these interviews will inform the refinement of the community survey, ensuring that relevant issues identified by professionals are included in the quantitative instrument. In the subsequent quantitative phase, the community survey will be conducted, allowing for measurement of the prevalence of issues and preferences identified in the qualitative phase across a larger sample. Findings from both methods will be integrated during the analysis phase. For example, themes identified in the qualitative data may be quantified and tested in the survey data. Conversely, statistical findings from the survey may be explained and contextualised using the rich qualitative data from interviews.

Quantitative Method

Quantitative research involves the collection and analysis of numerical data. This method typically employs structured data collection techniques, such as surveys or experiments, and uses statistical analysis to test hypotheses and identify patterns (Creswell, 2018). Quantitative research is particularly useful for measuring variables, testing relationships, and generalising findings to larger populations (Creswell, 2018).

The quantitative method in this study will be employed through in-person surveys conducted with members of the Ramiros community. Researchers will distribute paper questionnaires to community members with administration, a method that ensures a higher response rate and allows for clarification of questions, if needed. The questionnaire will include multiple-choice and rating scale questions, providing numerical data for statistical analysis.

Data from the surveys will be tabulated and organised by graphs and charts, which will provide easy interpretation and description of the survey. The graphs and charts will be particularly valuable in identifying priority areas for infrastructure development, understanding the distribution of opinions within

the community, and highlighting any significant disparities in infrastructure needs or satisfaction levels across different demographic groups.

Mixed Method

Mixed methods research involves collecting, analysing, and integrating both quantitative and qualitative data within a single study (Creswell, 2018). This approach allows researchers to leverage the strengths of both quantitative and qualitative methods, providing a more comprehensive understanding of research problems than either approach alone (Creswell, 2018).

For this study, on sustainable infrastructure solutions for the Ramiros community, a mixed methods approach has been selected. According to Creswell (2018), mixed methods research is particularly valuable when:

- A single data source is insufficient to address the research problem;
- There is a need to explain initial results;
- Exploratory findings need to be generalised;
- A theoretical stance needs to be employed;
- An overall research objective can be best addressed with multiple phases.

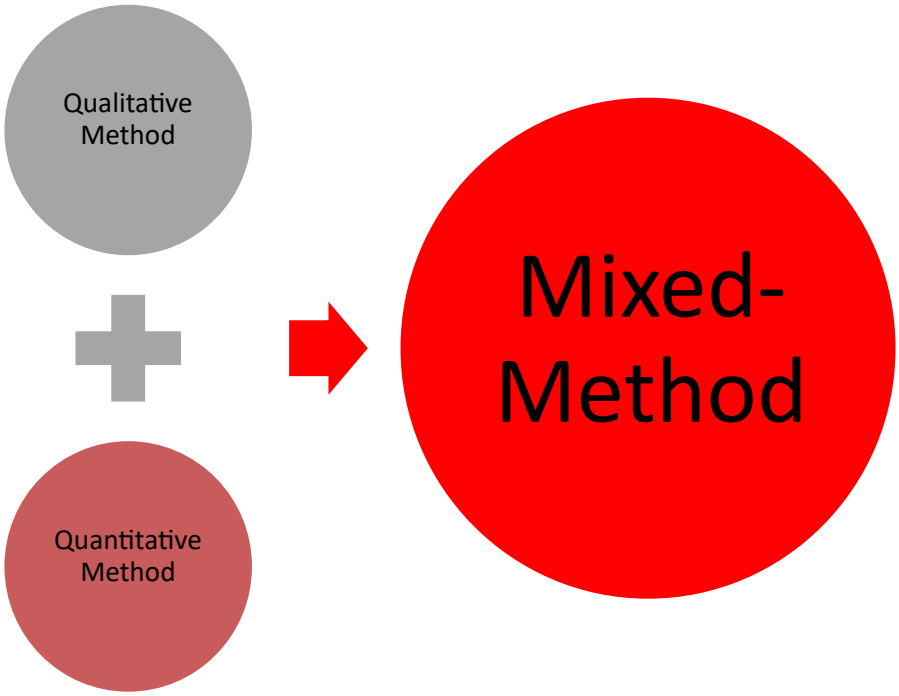


Figure 6:4 *Mixed Method Design*

A Mixed Method approach leverages the strengths of both methods. The qualitative interviews, provide depth, context, and flexibility to explore complex issues, while the quantitative survey, provides breadth, allowing for generalisation and statistical analysis of patterns across the community. By combining these methods, the research will gain a comprehensive understanding of the infrastructure challenges and potential sustainable solutions in the Ramiros community, incorporating both expert knowledge and community perspectives. This mixed-methods approach ensures a robust and nuanced exploration of the research questions, providing a solid foundation for developing effective and contextually appropriate sustainable infrastructure solutions for the Ramiros community.

Study designs can take several forms within the mixed-methods research paradigm. Six distinct mixed-methods strategies were found by Morse (2016): Exploratory, Explanatory, Triangulation, Embedded, Multiphase and Synthesis, as showing on table below:

Table 3 *Mixed method design*

Design	Description	Application
Exploratory	Qualitative study conducted first, followed by a quantitative component. The quantitative phase is used to extend or test the qualitative findings.	Used when exploring a phenomenon about which little is known, or to develop and test a new instrument based on qualitative findings.
Explanatory	Quantitative study conducted first, followed by a qualitative component. The qualitative phase is used to explain or elaborate on the quantitative results.	Used when unexpected results arise from a quantitative study and further explanation is needed.
Triangulation	Qualitative and quantitative methods are used concurrently but independently. Results are integrated during interpretation.	Used when seeking convergence of findings from different methods to enhance validity.
Embedded	One method (usually qualitative) is embedded within a larger study of the other method	Used when different questions require different types of data within a predominantly qualitative or quantitative study
Multiphase	A series of studies conducted sequentially, with each phase informing the next	Used in program development and evaluation, where each phase builds on the previous one.
Synthesis	A core qualitative project with a quantitative component, followed by a smaller qualitative component.	Used to develop theory and then test and refine it

Exploratory Design

For this research on sustainable infrastructure solutions in the Ramiros Community, the Exploratory Design, as described by Morse (2016), has been selected as the most appropriate mixed method approach. This design is particularly well-suited to the study's objectives and context for several reasons. Firstly, the research begins with qualitative interviews of professionals, allowing for an in-depth exploration of the current infrastructure situation and potential sustainable solutions.

This initial qualitative phase provides a rich, nuanced understanding of the complex issues at play. Secondly, the insights gained from these interviews will directly inform the development of the quantitative survey for community members, ensuring that the survey questions are relevant, comprehensive, and grounded in the realities of the local context. Thirdly, the subsequent quantitative phase, through the community survey, will help to extend and potentially generalise the findings from the qualitative phase, providing a broader perspective on the prevalence and distribution of identified issues and preferences across the community.

Finally, this design aligns seamlessly with the research goal of first gaining an in-depth understanding of the infrastructure challenges and then measuring the extent and nature of these issues across the broader community. By employing this Sequential Exploratory design, the study can leverage the strengths of both qualitative and quantitative approaches, resulting in a comprehensive and nuanced understanding of the infrastructure needs and potential sustainable solutions in the Ramiros community.

2.4. Research Techniques

A research method is defined as a questionnaire, data collection, data analysis, interpretation and validation of the study (Creswell, 2018).

2.4.1. Data Analyses

This study employs a mixed-methods approach, aligning with an exploratory sequential design. The data collection and analysis process is divided into qualitative and quantitative phases, with manual processing techniques used throughout.

2.4.2 Content Analysis (Qualitative)

For the qualitative data collected through semi-structured interviews, a simplified manual content analysis will be conducted, as showing on table below:

Phase	**Description**
Familiarisation	Researchers will thoroughly read all interview transcripts to gain an overall understanding of the content.
Creating a Coding Framework	Based on the research questions and initial reading, researchers will develop a preliminary list of codes or categories. This list will be flexible and can be expanded as analysis progresses.
Manual Coding	Using coloured pens or highlighters, researchers will mark relevant sections of the transcripts, assigning codes to specific text segments. Each code will be represented by a unique colour or symbol.
Tallying	For each code, researchers will manually count its frequency across all interviews, creating a simple tally sheet.
Identifying Themes	By reviewing the coded segments and frequency tallies, researchers will identify overarching themes that emerge from the data.
Extracting Quotes	Relevant quotes that best illustrate each theme will be manually extracted and organised.
Peer Review	A second researcher will review the coding and themes to ensure reliability and discuss any discrepancies.

2.4.3. Data Collection (Quantitative)

Surveys will be administered in person by trained local enumerators, who will obtain informed consent from all participants prior to survey administration. To accommodate varying literacy levels, enumerators will read the questions aloud and record the responses. Data collection will take place over a two-week period, with visits scheduled in the morning, as the authors only have time on Saturday mornings due to their work commitments.

Survey Structure

The quantitative phase will utilise a structured survey instrument developed based on insights from the qualitative interviews. The survey will consist of:

- Demographic questions (e.g., age, gender, occupation)
- Closed-ended questions using Likert scales (1-5) to assess community perceptions of infrastructure needs and priorities
- Multiple-choice questions to gauge preferences for specific infrastructure solutions
- Ranking questions to prioritise different infrastructure projects
- A few open-ended questions for additional comments.

The survey will be designed to be completed in approximately 15-20 minutes to encourage participation and minimise respondent fatigue.

Risk to Collection - Low Responses

A significant risk to this research is the potential for low response rates, particularly in the quantitative phase involving community surveys. Low response rates could compromise the representativeness of the sample and, consequently, the validity of the findings. Several factors might contribute to this risk in the Ramiros community context, including potential distrust of outsiders, survey fatigue, time constraints of residents, or lack of interest in infrastructure issues. To mitigate this risk, several strategies will be employed. Firstly, the researchers will leverage the support of the Ramiros administration to enhance the legitimacy of the study in the eyes of community members. Secondly, the survey will be designed to be concise and easy to understand, minimising the time burden on participants. Thirdly, researchers will be flexible in their data collection approach, offering to conduct surveys at times and locations convenient for community members. Additionally, the importance of the study and its potential benefits to the community will be clearly communicated to all potential participants. If, despite these measures, response rates remain low, the research team will extend the data collection period and intensify outreach efforts. In the event of persistently low response rates, the limitations this poses to the generalizability of findings will be explicitly acknowledged in the study's results and discussion sections. The research team will also consider supplementing the quantitative data with additional qualitative methods, such as focus groups, to ensure a comprehensive understanding of community perspectives is achieved.

2.4.4 Ethical Considerations

This research adheres to stringent ethical standards to ensure the protection and respect of all participants. To maintain data security and confidentiality, all collected information will be stored in a dedicated Google Drive created specifically for this project. This secure, cloud-based storage solution ensures that only authorised researchers have access to the data, while simultaneously allowing all authors to collaborate effectively. Importantly, the surveys administered to community members will be anonymous, with no names or directly identifying information collected, thus preserving participant confidentiality. Prior to commencing the study, the research team engaged with the administration of Ramiros. This engagement served a dual purpose: firstly, to secure the participation of technical personnel crucial for the qualitative phase of the study, and secondly, to establish trust and legitimacy within the community. This administrative backing is expected to make community members more comfortable in participating and answering questions honestly. Furthermore, all participants will be provided with clear information about the study's purpose, their rights as participants, and the voluntary nature of their participation. They will be informed

that they can withdraw from the study at any time without consequence. By implementing these ethical safeguards, the research aims to protect participants' rights and welfare while ensuring the integrity and credibility of the study's findings.

3. Results

The following section presents the primary findings of the surveys conducted in the Ramiros Zone A neighbourhood. The complete questions are listed in the APPENDIX A and C. Fig. 7, Fig. 8 and Fig. 9 display the demographics such as gender, age, monthly income and education level to understand the population views on the importance of infrastructures. The majority of residents who answered were between the ages of 34-40, mainly women. Furthermore the key metrics selected were the commute time to and from the nearest public services such as schools and health centres, and the presence of public transportation, road conditions and visibility and infrastructures for cyclists. These questions laid the groundwork for subsequent analysis and recommendations.

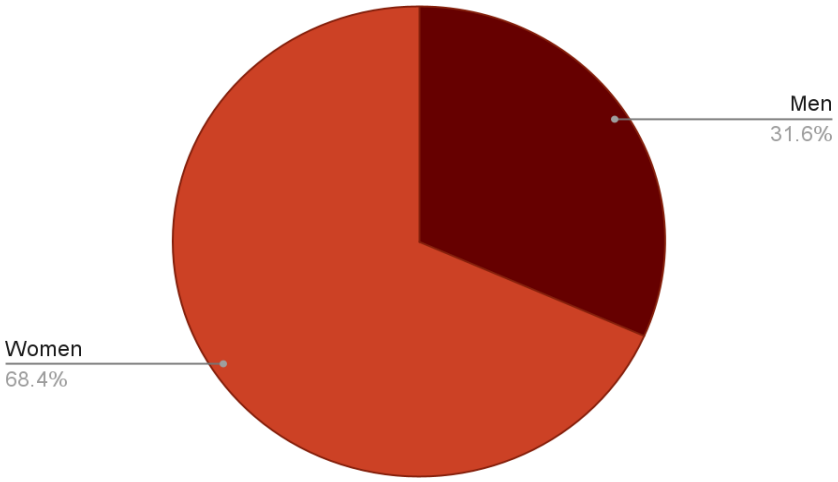


Figure 5 *Sample Distribution by Gender*

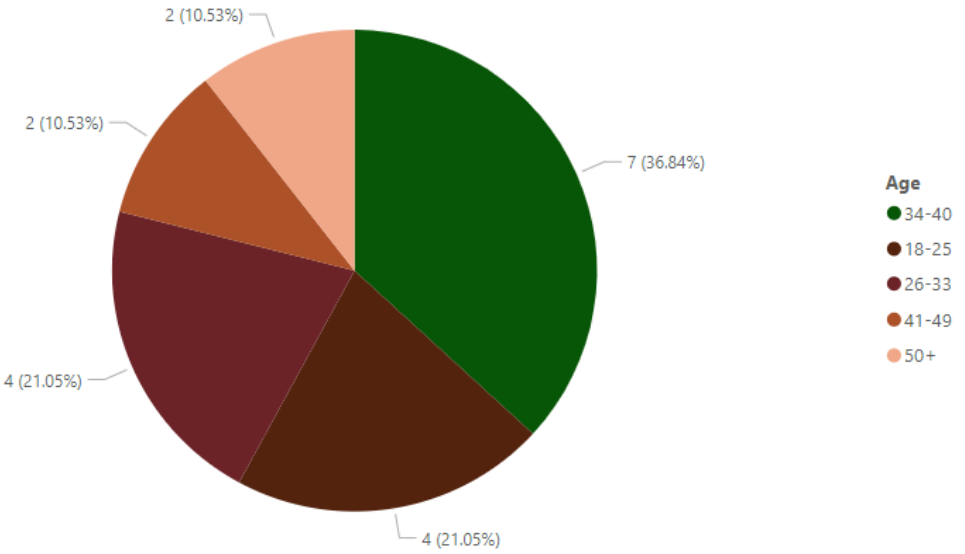


Figure 6 Age Distribution of Population

The sample of the residents working or living in Zone A had concluded at least the primary education, with the majority having started secondary education as displayed in Fig 9 while Fig. 10 showcases the type of public services most important to the sample population.

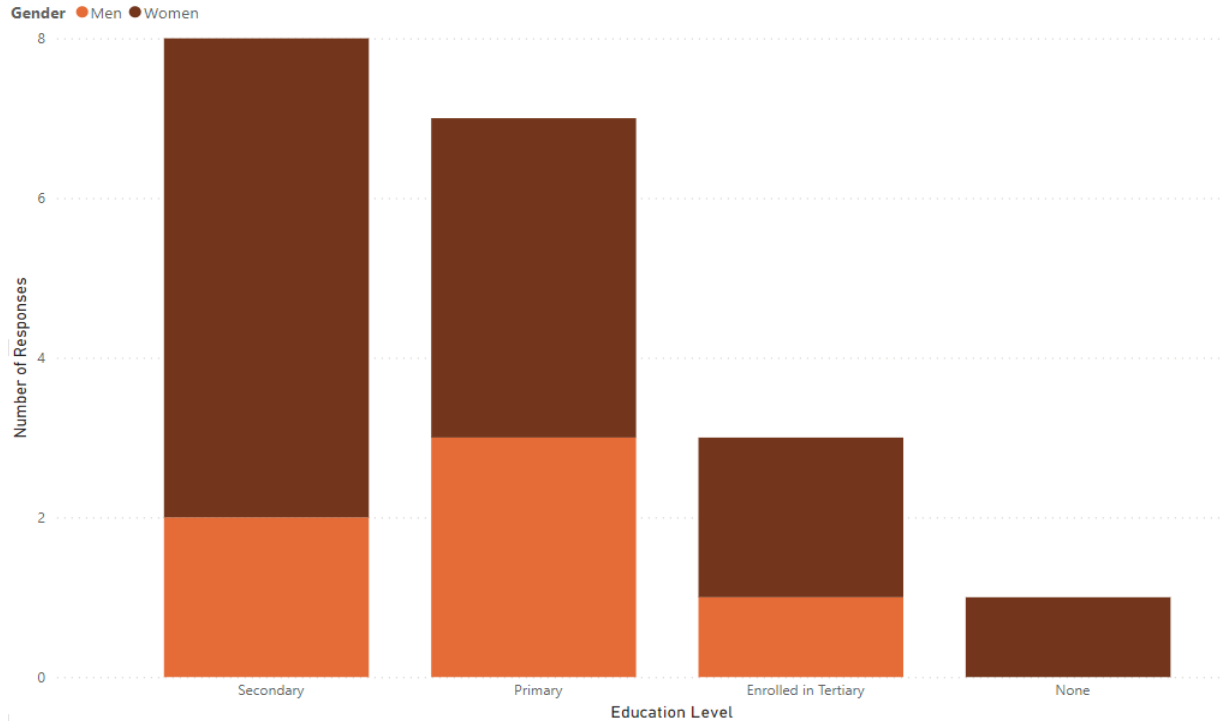


Figure 7 Education level distribution

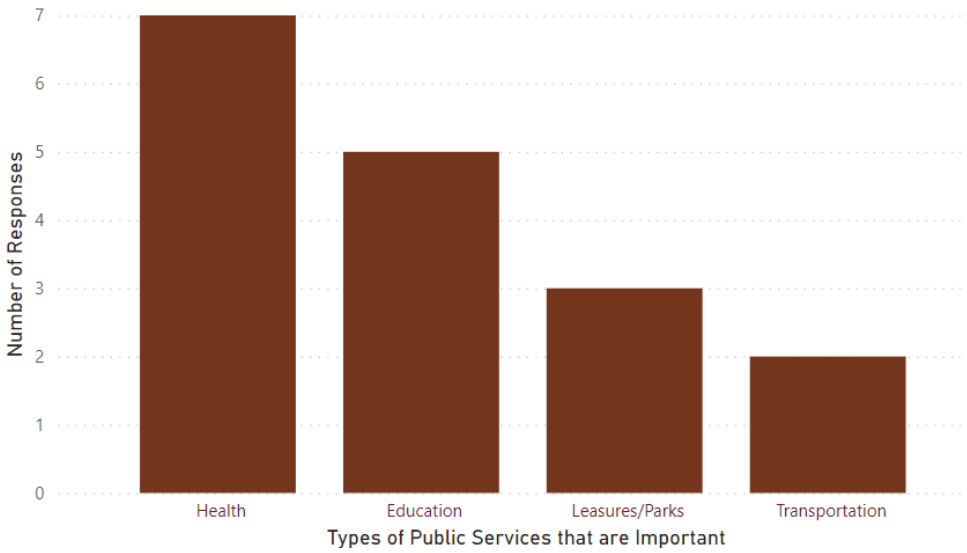


Figure 8 *Types of Public Services and/or infrastructures that are important to residents*

Figure 11 is an illustration of the monthly income of the sample population.

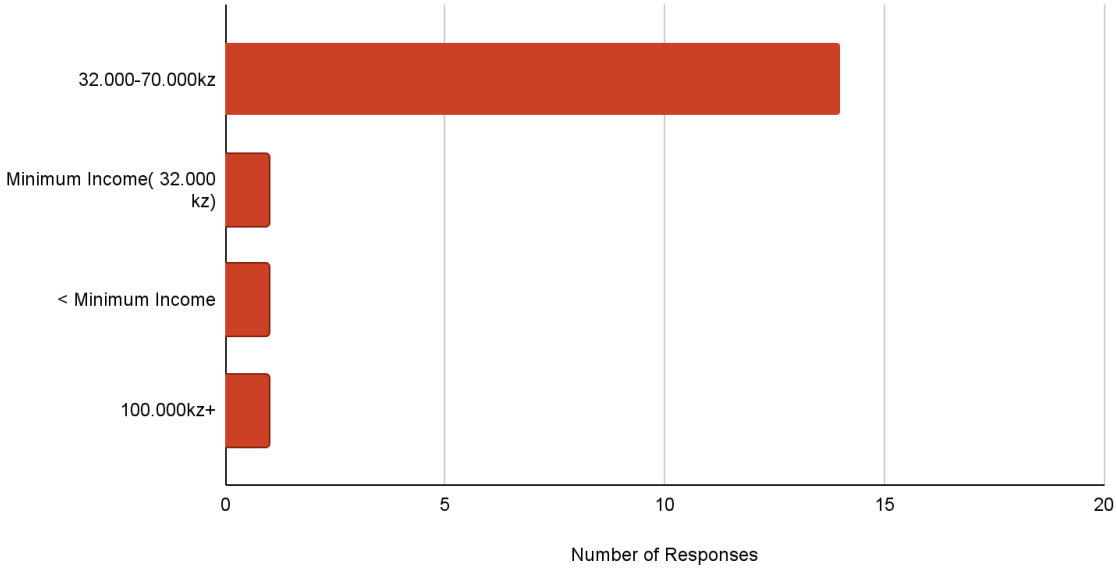


Figure 9 *Graph of household monthly income. Minimum monthly income adjusted to 70.000Kz June 26th (Jornal de Angola, 2024).*

Figures 12 illustrates the types of public services the population find the most important while Fig. 13 is an illustration of the commute time that residents take from their residence to reach the nearest bus stop, health center or school.

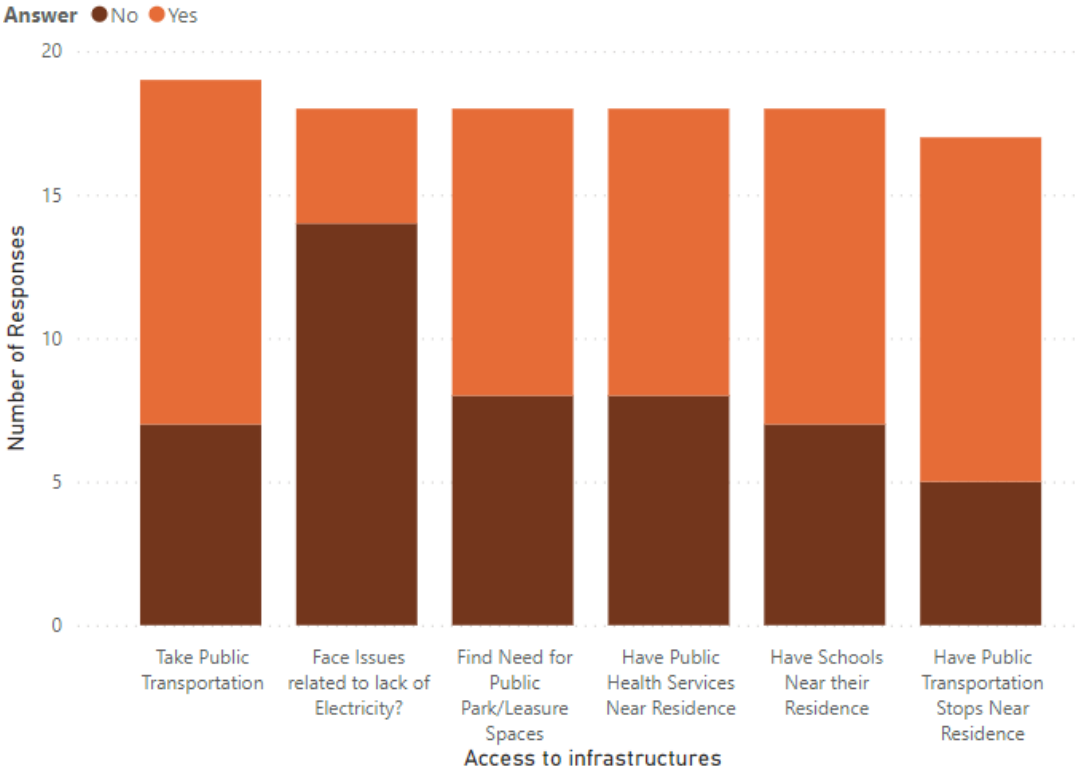


Figure 10 *Most important Public Services*

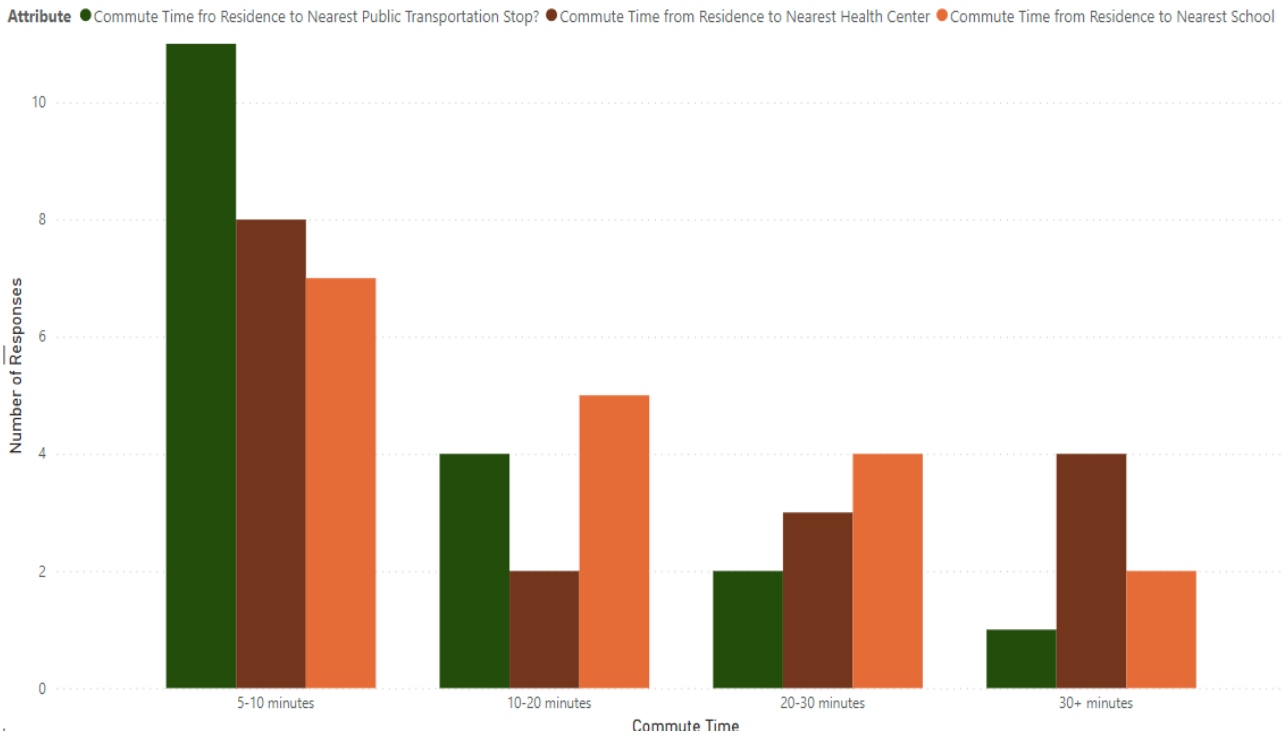


Figure 11 *Commute Time to Public Services*

Understanding that Ramiros is located in the outskirts of Luanda city center, it was important to understand the impact of the road conditions for people that could potentially transit in this area for tourism, recreation and sport purposes. Another survey was conducted to cyclists and runners that use the road Luanda - Ramiros (APPENDIX C). The sample included answers from 10 cyclists. Fig. 14 lists the frequency they cycle or run in the area while F ig. 15 indicates that bike lanes are the primary improvement needed in the road EN100, followed by better road maintenance, improved visibility and lastly the addition to road signals.

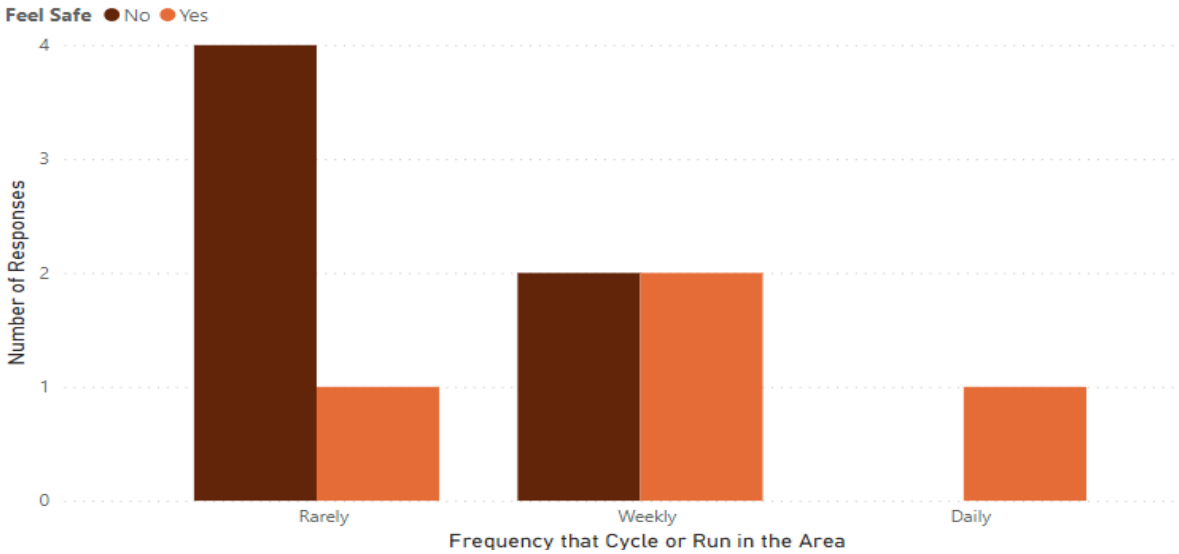


Figure 12 *Frequency that athletes cycle or run in Ramiros Area*

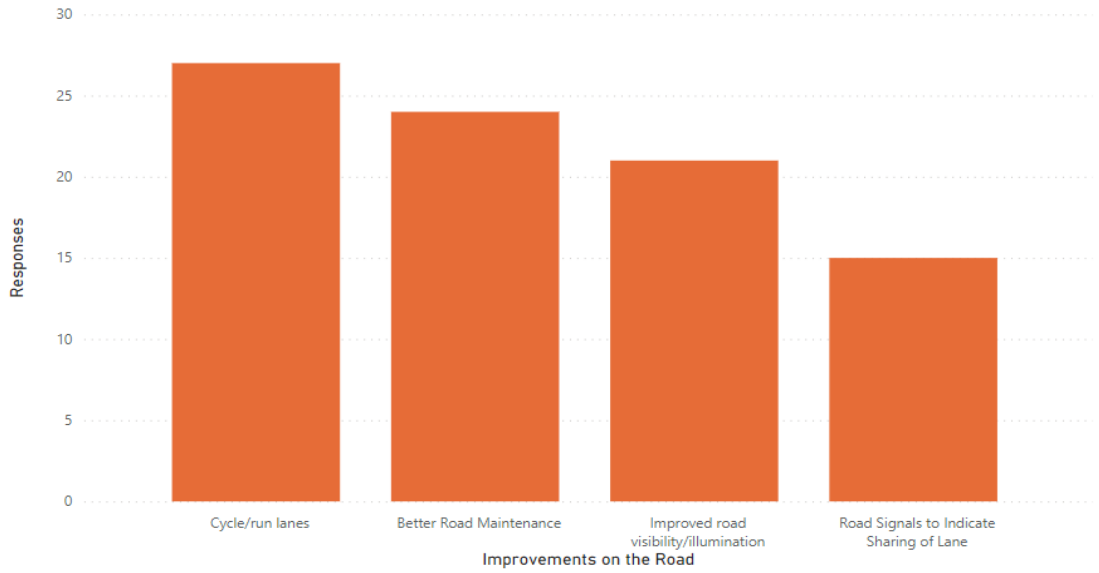


Figure 13 *Suggested Improvements to the National Road EN100 Luanda – Ramiros*

Figure 16 highlights main infrastructures that might impact the overall experience of cyclist and runners that use the main Luanda – Ramiros road. Highlighted key points were the need for bike stations, car parking, public restrooms. Other suggestions included bike rack, shelters. This visualization allows for a clearer comparison of priorities, helping to identify which infrastructure developments could have the greatest impact on the safety and enjoyment of road users in the community.

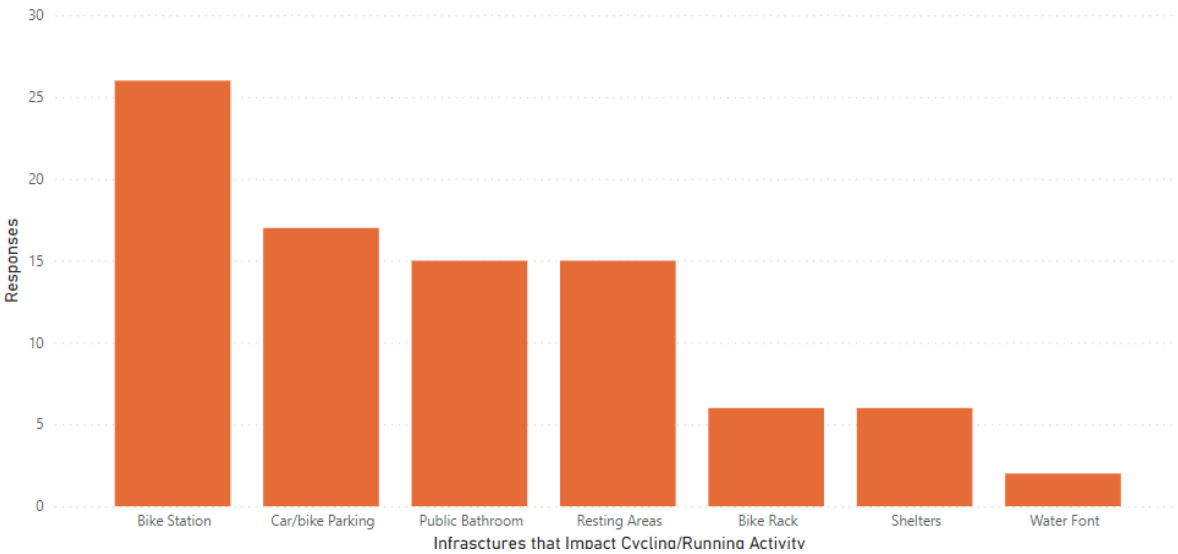


Figure 14 *Infrastructures that Impact Cycling Activity*

4. Discussion

During an interview with a technician from the local administration of the Ramiros urban district, we learned that the current state of infrastructure in Ramiros is concerning:

- There is no running water;
- There is no solid waste management plan, resulting in inappropriate waste disposal by the population;

- The public electricity supply does not yet cover the entire length of the district, and private energy costs are high.

The local administration faces several challenges, one of the biggest being the illegal occupation of land, which hinders the implementation of new services and infrastructure. However, it has done a good job of raising awareness among the population about the importance of mangroves, PAL (Luanda Afforestation Plan) activities and public cleaning initiatives.

Thinking about sustainable projects, such as solar energy, is complicated because the district still lacks basic necessities. The lack of infrastructure has an extremely negative impact on the lives of the population, who often complain about the absence of essential services.

As part of the PIIM, three new schools have been built and are already in operation, and a project is underway to supply water to the area. In addition, projects are underway to implement district markets and leisure areas in some parts of the district.

The population feels that they are not being heard, as their concerns have not been addressed. One of the biggest concerns raised by the population was urban mobility, which is strongly affected by the size and current condition of the district's roads. A solution to this problem would be to rehabilitate roads in a way that minimizes environmental impacts and promotes economic and social efficiency of the process. Such a process would involve using techniques and materials that reduce the carbon footprint, conserve natural resources and improve the durability of roads.

For public lighting along these routes, LED luminaires can be installed, which will have an impact on energy consumption and operating costs in the long term.

In terms of the use of ecological materials, we can highlight the use of recycled rubber from tires and recycled plastic from bottles that can be incorporated into asphalt, improving the durability and resistance of roads. This use of recycled materials would also have an impact on the district's waste management.

As part of the redevelopment, it could also be planned to widen the roads to include specific lanes for motorcycles, and to implement transport stops spaced between 500 - 800 m apart.

5. Conclusion

This research underscores the potential for sustainable development in Ramiros, a coastal area within Luanda, Angola, through the application of carbon-neutral and innovative engineering solutions. By integrating advanced technologies with sustainable practices, we have outlined a roadmap that not only addresses the infrastructural deficits in the region but also promotes environmental stewardship and community resilience.

The findings of this study reveal that the Ramiros community, while rich in cultural heritage and natural resources, faces significant challenges due to rapid urbanisation and inadequate infrastructure. The proposed interventions—ranging from the use of locally sourced and recycled construction materials to the implementation of solar microgrids and efficient waste management systems—demonstrate the feasibility of achieving net-zero carbon emissions in the redevelopment of informal settlements. These solutions, tailored to the specific needs and context of Ramiros, offer a blueprint for sustainable urban regeneration that can be replicated in similar settings across Angola and beyond.

A key aspect of the proposed development strategy is the expansion of transportation routes, which is anticipated to have a significant impact on tourism and local mobility. The improvement of road infrastructure will facilitate easier access to Ramiros, attracting tourists and fostering economic opportunities. Additionally, enhanced mobility will benefit local residents, enabling those who leave Ramiros to seek services elsewhere and those who come to Ramiros in search of livelihood opportunities. This increased connectivity is expected to stimulate economic growth and contribute to the region’s overall development.

Moreover, the research highlights the importance of community engagement and capacity-building initiatives in ensuring the success and sustainability of such projects. By involving local residents in the

planning and implementation phases, the proposed solutions not only enhance living conditions but also foster a sense of ownership and responsibility towards the environment.

In conclusion, this study provides a compelling case for adopting a holistic approach to urban redevelopment, one that balances ecological sustainability with socio-economic development. As Angola continues to urbanise, the lessons learned from Ramiros can serve as a model for other regions, contributing to the broader goal of achieving a net-zero future. Future research should focus on the long-term impacts of these interventions and explore additional strategies to enhance the resilience of coastal communities in the face of climate change.

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