PROJECT ID: ...

"ASSESSING COMMUTERS' PERCEPTION OF BUS SERVICE QUALITY ALONG MAIN BUS CORRIDORS IN KIGALI CITY, RWANDA".

A DISSERTATION

Submitted by

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Under the Guidance of

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DECLARATION

I, NIYIGENA Ernest, with Reg. No 220017039, from University of Rwanda College of Science and Technology, School of Engineering; Department of Civil, Environmental and Geomatics Engineering, following studies of Master of Science in Highway Engineering and Management Programme, hereby declare that this work is of my original and has never been submitted for any academic award in any other University or Institution or anyone else where he/she had the same purpose.

Student Names:

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CERTIFICATION

This research proposal has been submitted with approval from the University supervisor (Main supervisor).

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Signature: Date: July 25th, 2025

Dedicated to

To my beautiful Wife Alphonsine, My Children Ian, Norah and Ariela

To my parents

To my family and my Family in Law.

ABSTRACT

Urban public transport is crucial for mobility and economic development especially in rapid growing Cities like Kigali, Rwanda, where the effort of modernizing the public transport by bus have been made. However, to align this development with the commuter satisfaction has remained not understood as it would be. This thesis assesses the commuter perceptions of Kigali bus service quality along Kigali's main corridors by employing a multi-disciplinary approach that combines participatory data collection with statistical analysis.

The data of this study were collected through structured questionnaires from 387 commuters across Kigali City, these questionnaires have the socio-demographic, travel pattern information and their satisfaction levels on bus service quality on different factors that influence the bus service quality. after collecting those data, the Two step-cluster analysis was employed to have distinct clusters based on their travel behavior factors, a methodological approach that allows for more targeted service interventions. The two clusters were identified: Cluster one and Cluster two, the commuters of cluster one are called The Long Haul frequent and those of the cluster two are time efficient occasional commuters due to their difference in critical factors such as average waiting and average traveling time, and also their frequency of commuting with bus on a weekly basis.

After the identification of two distinct group, an Importance-Performance Analysis (IPA) was employed to reveal the specific bus service quality for each commuter's cluster in Kigali City; while both groups prioritize operational efficiency, their satisfaction levels diverge. After analysis, it was found that for The Long-Haul frequent commuters, shelter quality including seating at bus stop, access to information, luggage accommodation and air cooling are most needed as they show the high importance, but their satisfaction is poor, there is a need of improvement for those bus service quality attributes. Addressing these deficiencies should be a priority as they are highly valued by this group of commuters but are currently underperforming. In contrast, the cluster two commuters valued more the bus service reliability, bus frequency, bus stop infrastructure, access to information, bus accessibility and onboard experience, especially bus entering and access to bus of people with disability in wheel chair,

luggage assistance and accommodation, air cooling, and route alignment with commuter destination, but their satisfaction is poor, thus these should be improved to meet the satisfaction level of Kigali City commuters.

This research bridges a methodological gap by combining a two-cluster analysis with Importance-Performance Analysis to provide a nuanced, commuter centered framework. The findings offer an evidence-based model for Kigali City and other African cities to develop more inclusive, data driven, and user oriented public transport systems.

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LIST OF ACRONYMS

AFDB: African Development Bank

BRT: Bus Rapid Transit

MININFRA: Ministry of Infrastructure

PCA: Principal Component Analysis

RURA: Rwanda Utilities Regulatory Authorities

SDGs: Sustainable Development Goal

SUMPs: Sustainable Urban Mobility Plans

UN: United Nations

UR: University of Rwanda

UR-CBE: University of Rwanda- College of Business and Economics

SPSS: Statistical Package for the Social Sciences

CBD: Central Business District

NISR: National Institute of Statistics of Rwanda

SPSS: Statistical Package for Social Studies

IPA: Importance-Performance-Analysis

RPHC-5: Rwanda Population and Housing Census fifth edition

CHAPTTER ONE: INTRODUCTION

This chapter introduces the background and the context of the study by tracing the evolution of public transport in Rwanda, generally and in Kigali specifically. It shows the historical development of Public transport sector; it highlights the main public transport reforms, policy shifts, and service provision strategies that have shaped the current state of public transport in Kigali City. The chapter also presents the major development paradigms influencing Kigali City's transport planning which includes the government's efforts to modernize urban mobility systems. Furthermore, it describes the various modes of public transportation, the distribution of roles among stakeholders and the institutional framework responsible for regulation and policy implementation. By setting this foundation, the chapter one establishes the rationale for assessing commuters' perceptions of bus service quality in Kigali City.

1.1. STUDY BACKGROUND

Urban Transportation plays a crucial role in driving economic development, promoting social inclusion, and supporting environmental sustainability (Litman., 2020). Efficient transport systems facilitate access to essential services such as employment, education and healthcare, thereby improving the quality of life and enhancing urban productivity (Litman, 2020)

However, as cities continue to grow, they face increasing challenges including traffic congestion, environmental degradation, and inadequate infrastructure. The United Nations projects state that by 2050, nearly 68% of the global population will live in cities, further intensifying the demand for sustainable and inclusive urban mobility solutions (UN, 2018)

In response, many developed countries have adopted integrated, technology-based transport systems such as metro-rail networks, Bus Rapid Transit (BRT), and real-time passenger information services to enhance efficiency and reduce environmental impact (World Bank, 2021). The implementation of such technologies is frequently embedded within sustainable Urban Mobility Plans (SUMPs), Which are strategic frameworks that promote multi modal, user-oriented, and low carbon transport solutions.

In cities of sub-Saharan Africa, Including Kigali city, Rwanda, continue to face distinct transportation challenges. These include rapid Urbanization, limited infrastructure investment, urban sprawl, and weak regulatory enforcement (Porter, 2014). Informal transport modes, particularly motorcycle taxis have become prevalent due their convenience, but they also have safety concerns. In fact, motorcycle taxis account for approximately 22.5% of road accident fatalities across the continent (African Development Bank, 2022).

In Kigali City, there are ongoing efforts by the Rwandan government, particularly through the Ministry of Infrastructure aim to modernize the public transport system. These reforms have included the consolidation of public operators, digitization of fare payment systems, and route restructuring (Mininfra, 2021). Despite these efforts, public transport services in Kigali city still face persistence issues such as irregular schedules, overcrowding, inadequate coverage, and passenger safety concerns (Baganizi, 2013, Nkurunziza et al., 2012)

Given Kigali's annual population growth rate of approximately 4% (Kigali City website, 2025), the efficiency and inclusiveness of its public transport services are becoming increasingly vital. This aligns with sustainable Development Goal 11, which calls for inclusive, safe, resilient and sustainable urban transport systems by 2030 (UN, 2015)

While previous research has focused on operational and infrastructural aspects of Kigali's transport system, there is a limited understanding of how commuters perceive service quality across different routes and corridors. Studies by Eboli and Mazzula (2007; 2011) highlight the importance of commuter perception in evaluating transport services focusing on dimensions such as reliability, affordability, comfort, frequency, and safety.

This study addresses that gap by assessing commuters' perceptions of bus service quality along Kigali's main bus corridors using Cluster analysis and Impact Performance Analysis methods, first to group commuters in distinct clusters, then analyses what are the important factors compared to their satisfaction level; so to find the attributes that need urgent improvement.

The aim is to classify commuters into distinct clusters and to support evidence-based improvements for urban mobility in Kigali City and similar rapidly growing African Cities.

1.2 Statement of the Problem

Urbanization and rapid population growth in the context of Kigali City, Rwanda, has increased demand of public transport. Bus transport remains the dominant mode of urban mobility, essential for accessing employment, education, healthcare, commercial and other daily services and activities. Despite on-going reforms and infrastructure investments aimed to modernize Kigali City's transport network (MININFRA, 2021), challenges such as long bus waiting times, long travel times, insufficient bus stop infrastructure, unreliable bus schedules, and limited access to real-time information continue to diminish commuter satisfaction and system effectiveness (Baganizi, 2013).

Importantly, these bus service quality challenges are not experienced evenly across all Kigali bus corridors and across different categories of commuters, they vary based on their travel behavior and their socio-demographic behaviors of commuters as stated by Mihigo (2022). Even if in Rwanda, exists the studies that focus on transport supply and policy level efficiency, the failure to explore the different commuter's behavior varied experiences, Nkubiyaho (2024). This lack of commuter-centered insights has resulted in a generalized transport recommendation that inadequately serve Kigali City's commuters.

Furthermore, bus public transport affordability and safety remain poorly understood from the user's perspective. As Andres (2021) notes, affordability is often treated in overlay broad terms without considering its variability across user profiles. Similarly, Hirwa (2021) emphasizes that safety concerns, especially for women and vulnerable people, this remains undervalued in the transport planning.

This study addresses these gaps by assessing commuter perceptions of bus service quality along Kigali City's main corridors using a data-driven, mixed-methods approach. Through the two-step cluster analysis, the study reveals the two major commuter groups:

Cluster 1. Long Haul-Frequent commuters: for this cluster group, bus stop infrastructure, access to information, luggage assistance and comfort during travel are most needed, but their satisfaction is poor

Cluster 2. Time-Efficient Occasional Commuters, for this cluster, they valued more the bus service reliability, bus frequency, bus stop infrastructure, access to information, onboard experience, especially bus entering and access to bus by people with disability in wheel chair, luggage assistance and accommodation, air cooling and route alignment with commuter destination, but their satisfaction is low.

This segmentation aligns with Friman and Fellesson's (2009) "quality paradox," which describes the disconnection between the service provision and customer's satisfaction. It also reinforces the view that user-centered planning must consider differences in needs and expectations (Eboli & Mazzula, 2007).

The findings further highlight structural gaps in inclusivity, particularly in bus stop infrastructure, access for persons with disability, and the availability of the user-friendly features such as luggage space and ventilation areas in the bus, where service improvement could drastically impact the commuter's experience (Friman & Fellesson, 2009)

This study aims to:

- Classify the commuters in clusters based on their travel behavior using the 2-step cluster analysis
- Identify priority service attributes using the Importance-Performance-Analysis
- Provide the policy and recommendations based on the evidence-based results especially the bus stop infrastructure and bus operations. \

By integrating commuters' perceptions into urban transport policy and design, this research contributes to a more inclusive, efficient, and sustainable mobility framework for Kigali City and other fast-growing African cities (Nkubiyaho, 2024)

1.3 Objectives of the study

1.3.1. General Objective

The main objective is to evaluate commuter perceptions of bus service quality along the main bus corridors in Kigali City, Rwanda, by assessing behavioral clusters such as accessibility, reliability, frequency, comfort, and overall user experience; identifying bus service quality attributes that require urgent improvement, and providing policy and recommendations based on data to improve the public transport in Kigali City.

1.3.2. Specific Objectives

The specific objectives of this study are as follows

(1) To assess clusters of commuters based on travel behavior and analyzing their commuting patterns. This Include analyzing frequency, travel purpose, route usage, and satisfaction levels and group them into distinct segments based on shared characteristics across selected bus corridors in Kigali.

(2) To evaluate the perceived quality of bus services among distinct commuter clusters in Kigali City, by analyzing the relative importance and the satisfaction levels of the key bus service quality attributes.

(3) To propose data-driven recommendations

For Improving Kigali City bus service system based on identified clusters and identify bus service quality aspects that require urgent improvement.

1.3.3. Research questions

To effectively guide the investigation and address the study's specific objectives, the following research questions have been formulated. These questions are designed to generate meaningful insights into current performance of Kigali's bus transport system, with a particular focus on commuter behavior, spatial perceptions of service quality, and the identification of targeted areas for improvement. The answers to these questions will support evidence-based recommendations aimed at enhancing service effectiveness and commuter satisfaction across Kigali city.

s/n	Research Objectives	Research Questions
1	Assess clusters of commuters based on travel behavior and analyzing their commuting patterns.	What are the distinct clusters of commuters in Kigali City based on their travel patterns and behavior?
2	To evaluate the perceived quality of bus services among distinct commuter clusters in Kigali city, by analyzing the relative importance and satisfaction levels of key service quality attributes.	How do distinct commuter clusters perceive the bus service quality in terms of relative importance and satisfaction with key service quality attributes?
3	To propose data-driven recommendations	What are the evidence-based policy recommendations that can be developed to improve bus service quality, based on Importance-performance analysis of commuter clusters in Kigali City?

1.3.4. Significance of the study

This study holds both practical and academic significance in the context of urban mobility planning in Kigali City and beyond. As the city continues to experience rapid urbanization and population growth, the demand for efficient, reliable, and inclusive public transport becomes increasingly urgent. Understanding Commuters' perceptions of bus service quality is essential for improving service delivery and aligning transport systems with user needs and expectations.

From a policy and planning perspective, the study provides valuable insights that can guide the city of Kigali, The Rwanda Utilities Regulatory Authority (RURA), and the Ministry of Infrastructure (MININFRA) in refining urban transport strategies. By identifying areas with low commuter satisfaction and spatial disparities in service quality, this research supports evidence-based based decision making and resource allocation to enhance mobility and accessibility.

From operational perspective, Transport operators and service providers can benefit from the findings to adjust routes, improve reliability, upgrade facilities, and enhance customer service. The results may also contribute to ongoing reforms aimed at digitizing public transport in Kigali City.

Furthermore, the study aligns with global development frameworks such as sustainable Development Goal 11, which emphasizes the importance of inclusive, safe, and sustainable urban transport. By highlighting the voices and experiences of bus users, this research promotes a participatory and equity focused approach to transport planning in Kigali City.

1.4 Scope of the Study

This study focuses on assessing commuter perceptions of public bus service quality within boundaries of Kigali City, Rwanda. Specifically, it concentrates on the main bus corridors, which represent the primary arteries of the city's formal transport system and carry the majority of daily mobility network, making them critical for understanding city-wide transport service performance. The analysis is spatially constrained to the limits of Kigali City and does not include secondary urban routes due to time and financial resource limitations. The study employed structured questionnaires distributed via Google Forms, targeting regular bus users along selected main corridors. While this method allowed for cost-effective data collection, it may have excluded populations with limited internet access or those who use informal transport modes. Due to Financial and logistical constraints, the study did not include field-based service audits, comparative analysis with informal transport operators. The focus was therefore on gathering self-reported commuter experiences, which were then analyzed using SPSS

software to identify commuters' clusters, then Importance performance Analysis (IPA) to evaluate service quality aspects that need urgent improvement.

This scope aligns with approaches taken in comparable urban mobility studies, such as Nkurunziza et al., (2012) in Dar es Salam and Niyonsenga (2012) in Kigali, which also limited their assessment to Major corridors or formal systems due to similar resource and access considerations. These prior works have demonstrated that targeting key routes yields representative insights into system-wide challenges and opportunities, particularly in rapidly growing urban centers with uneven transport infrastructure.

1.5 Structure of the Thesis

This thesis is organized into five chapters; Chapter one provides a general introduction and overview of the public transport sector in Rwanda, tracing its evolution and highlighting key development paradigms that have shaped service provision. It further outlines the problem statement, objectives of the study, the significance and the scope of the research. Focusing on the need to evaluate commuter satisfaction in Kigali City.

Chapter two presents a review of relevant literature related to Public transport service delivery and commuter satisfaction, with particular emphasizes on bus users. The chapter explores the socio-demographic factors, travel pattern factors and bus service quality factors that measure satisfaction of commuters such as: bus headway, punctuality, seating, cleanliness, air cooling, wheelchair access, assistance with luggage, bus stop shelters and seating, information access and driver behaviors.

The literature review also identifies existing gaps, culminating in the specific problem addressed by this study namely, the needed bus service quality aspects to be improved.

Chapter three details the methodology used to conduct the study. It explains the research design, sampling approach, data collection tools and analytical techniques, SPSS analysis, Importance-performance Analysis which were employed to distinguish clusters among commuters, and interpret the need for improvement in bus service quality.

Chapter four presents the results of the study. It presents the descriptive statistics of collected including table of socio-demographic factors and table of travel pattern

factors; it presents the results from a 2-step cluster analysis by using SPSS software; it also shows the results from Importance-Performance Analysis (IPA) from the distinct clusters found in a 2-step cluster analysis.

Chapter five provides the data discussion of results presented in chapter four, first it analyzes the results from a 2-step cluster analysis that reveal the distinct clusters among Kigali City bus commuters; then analysis of Importance-Performance Analysis results to reveal Kigali city bus service quality aspects that need urgent improvement.by providing visualization of IPA quadrants.

Chapter six presents conclusion and recommendations drawn from the study and offers practical recommendations aimed at improving bus service delivery and enhancing bus service commuter satisfaction.

CHAPTER TWO: LITTERATURE REVIEW

2.1 Introduction

The literature review begins by defining the concept of public transport service quality, emphasizing its multidimensional nature and relevance to urban mobility. It then explores commuter satisfaction, focusing on socio-demographic and travel patters behavioral dimensions, commuter's segmentation. Finally, it evaluates existing transport studies and policy frameworks in Kigali City to identify knowledge gaps that the current study aims to fill.

This comprehensive review enables a contextualized and methodologically sound approach to analyzing public transport service delivery in Kigali City, providing insights into the application of integrated analytical tools such as behavioral clustering by employing a 2-step cluster analysis, and then with the use Importance-Performance Analysis tool, the bus service quality attributes that need the urgent improvement are identified.

2.2 The concept of public transport service Quality

The concept of public transport service quality has received a considerable attention in the literature, particularly in relation to how it influences user satisfaction, ridership levels, and the overall efficiency of transport systems. Public transport service quality refers to the extent to which the services offered by transit systems meet the expectations, preferences, and needs of users (Eboli & Mazzula, 2007). It is a multidimensional construct encompassing several performance indicators, including operational efficiency, travel time, reliability, vehicle cleanliness, staff behavior, safety, affordability, accessibility, and comfort (Tyrinopoulos & Antoniou, 2008).

Eboli and Mazzula (2007) developed a service quality model that emphasizes both objective indicators (such as punctuality and frequency) and subjective indicators (such as component in evaluating service quality. Tyrinopoulos and Antoniou (2008) further argue that the perception of service quality varies significantly based on user characteristics such as travel frequency, age, income level, and purpose of travel, underscoring the need for targeted service improvements.

High-quality public transport services are essential for promoting a modal shift from private vehicles to collective modes, especially in rapidly urbanizing cities. Litman (2013) stresses that service quality is a major determinant of travel behavior, and improving it can lead to increased ridership, reduced congestion, and improved environmental outcomes. Similarly, Dell'Olio et al. (2011) note that satisfaction with service quality is directly linked to user loyalty, which is crucial for the long-term viability of public transport systems.

In developing countries, including Rwanda, challenges such as inadequate infrastructure, overcrowding and irregular schedules often hinder service quality (Awuor et al., 2021). Moreover, the lack of user-oriented planning and feedback mechanisms further exacerbates commuter dissatisfaction. As argued by Beirao and Sarsfield Cabral (2007), successful public transport systems are those that continuously monitor user perceptions and integrate them into policy and operational decisions. Therefore, assessing and improving service quality in public transport systems is not only a technical challenge but also a strategic imperative to promote inclusive and sustainable urban mobility.

The literature clearly indicates that understanding commuter perceptions of service quality is vital for enhancing the performance of public transportation systems. As such, a research that explores how users experience public transport services, particularly in contexts like Kigali City, where transport systems are evolving, is crucial for informing data driven improvements and achieving mobility equity.

2.2.1 Theoretical Models of service Quality

A foundational model for evaluating service quality is the SERVQUAL framework introduced by Parasuraman et al., (1988), it outlines five following dimensions: tangibles, reliability, responsiveness, assurance, and empathy. Although, even if they were initially designed for general services, the model has been widely adapted in transport studies (Eboli & Mazzula). Scholars such as Dell'Olio et al., (2011) have emphasized that user perceptions of quality in public transport often differ from technical performance metrics and they should be integrated into planning.

2.2.2 Dimensions of Service Quality in Public Transport

- **Reliability:** Refers to adherence to scheduled arrival and departure times. Delays and unpredictable services significantly affect user satisfaction and willingness to use public transport (Eboli & Mazzulla, 2011; Hensher et al., 2003)
- **Accessibility:** Encompasses the proximity of stops, network coverage, and the ease with which individuals, including persons with disabilities, can use the system (Lattman et al., 2016; Delbosc &Currie, 2011).
- **Comfort:** Includes factors such as seating availability, cleanliness, noise levels, temperature, and vehicle condition. These affects both short-term satisfaction and long-term modal choice (Beirao & Sarsfield Cabral, 2007).
- **Safety and security:** safety refers to protection from accidents, while security involves the prevention of crime and harassment. Both are significant predicators of perceived quality, especially among vulnerable groups (Vuchic, 2005; et al., 2021).
- **Affordability:** Concerns the financial burden of commuting, particularly for low-income groups. Transport costs can influence decisions regarding employment, education, and healthcare access (Litman, 2013; Lucas, 2012).
- **Information Availability:** Real-Time and accessible information reduces uncertainty and improves decision-making. Lack of reliable information leads to frustration and reduces trust in the system (Dell'Olio et al., 2011).

Improvements in these dimensions have been shown to increase public transport use, particularly when combined with strategies that discourage private vehicle reliance (Paulley et al., 2006; Redman et al., 2013).

2.2.3 Contextual Considerations in Kigali

Kigali has made substantial investments in upgrading its bus fleet, digitizing fare collection, and expanding routes. However, service quality remains inconsistent due to infrastructure gaps, congestion, and regulatory fragmentation (Baganizi, 2013; Mihigo & John, 2022). A user-centered understanding of quality is essential for aligning services with public needs.

2.3 Commuter Satisfaction and Perception

Commuter satisfaction is an outcome of how individuals experience public transport services. It reflects subjective evaluations that often go beyond technical performance to include emotional and behavioral responses (Friman & Fellerson, 2009; Eboli & Mazzula, 2012). Satisfaction is shaped by daily travel experiences and is crucial for assessing service effectiveness.

2.3.1 Factors affecting Satisfaction

Factors influencing satisfaction vary across user groups:

- **Students** often prioritize affordability and frequency.
- **Working professionals** value punctuality and speed.
- **Elderly users** focus on accessibility and comfort.
- **Women and vulnerable populations** emphasize safety and harassment-free environments (Delbosc & Currie, 2012; Yavuz & Welch, 2010)

2.3.2 Behavioral Segmentation

Behavioral segmentation groups users by travel habits, demographics, and satisfaction profiles. Beirao & Sarsfield Cabral (2007) and politis et al., (2012) found that this approach allows for more targeted interventions. Cluster analysis is commonly used to group users into meaningful categories.

2.3.3 Equity and Inclusion

Public transport systems that neglect commuter diversity risk exacerbating inequality. Lucas (2012) and Pereira et al., (2017) argue for transport justice, ensuring access for marginalized populations. In cities like Kigali, where income disparities are significant, inclusive planning is essential.

2.5 Review of relevant Studies on urban Transport in Kigali City.

Urban transport research in Kigali city has grown, with studies focusing on fleet management, digitization, and environmental sustainability (Baganizi, 2013; Martin et

al., 2023). However, limited attention has been paid to commuter satisfaction and spatial inequality.

The Rwanda Ministry of infrastructure's National Transport policy (2021) stresses equitable access, environment protection, and financial viability. Nevertheless, operational studies often fail to incorporate studies often fail to incorporate the voices of commuters.

Recent regional studies offer methodological insights. Mendiate et al. (2024) applied behavioral clustering in Maputo, Mozambique, revealing divergent satisfaction patterns. Sturgess et al., (2024) emphasized the importance of integrated, clean, and inclusive mobility frameworks. Such approaches remain rare in Kigali City.

2.6 Importance-Performance Analysis in Public Transport Research

Importance-Performance Analysis (IPA) is widely used tool in service quality research to assess customer satisfaction by comparing perceived importance and actual performance of service attributes. Originally introduced by Martilla and James (1977), IPA has been applied extensively in transport studies to identify priority areas for service improvement by classifying attributes into four quadrants. Keep up the good work", "Concentrate here", "low priority", "possible overkill". This method provides clear visual insights for decision makers and transport planners seeking to optimize service delivery based on user feedback.

In the context of public transportation, IPA has proven effective for evaluating commuter perceptions across multiple service dimensions, including reliability, comfort, safety, punctuality, and accessibility. For instance, Yu et al., (2014) applied IPA to analyze satisfaction with bus services in China, demonstrating how the approach helps align operational focus with user expectations. Similarly, studies in Sub-Saharan Africa, such as Adebola (2020) in Nigeria and Byamugisha et al.,(2021) in Uganda, have used IPA to highlight mismatches between perceived importance and service delivery, thereby guiding targeted interventions in urban transport systems.

Locally, the utility of IPA has begun to gain attention in Rwanda's academic and policy research. A study by Bizigira (2021) emphasized the mismatch between service

frequency and user satisfaction in Kigali's public transport system and recommended IPA as a suitable framework to identify attributes needing urgent improvement. The IPA framework is particularly valuable in low-income urban settings like Kigali, where transport resources are limited and must be allocated strategically to the most impactful service areas.

2.7 Knowledge Gaps and Research Contribution

2.7.1 Knowledge Gaps

Neglect of user perceptions: Most studies focus on infrastructure and technical performance and technical performance, with limited analysis of commuter experiences.

Homogenization of users: There is a tendency to treat commuters as a monolithic group, ignoring socio-economic, gendered, and behavioral differences.

Absence of Integrated Methods: Little use of combined tools like cluster analysis

2.7.2 Research Contribution

- **User centered**

Unlike many transport studies that prioritize operational efficiency and supply-side indicators, this research adopts a user-centered approach by placing commuter perceptions at the core of service evaluation. Structured survey instruments were developed to collect primary data on rider satisfaction across critical service dimensions such as reliability, affordability, accessibility, safety and comfort. This perspective aligns with the growing recognition in the literature that Subjective user experiences are essential for assessing the actual performance and societal value of transport systems (Beirao &Sarsfield Cabral, 2007; Eboli & Mazzula, 2011). The framework enables the identification of latent issues such as perceived insecurity or Unfair fare structures which may be overlooked by purely technical metrics. By integrating user voices into service evaluation, the study aims to enhance the relevance and responsiveness of transport planning to the needs of urban commuters.

- **Behavioral Clustering**

To transcend the limitations of aggregate averaged in transport research, the study uses behavioral and demographic clustering techniques. Drawing on variables such as travel frequency, preferred routes, income levels, age, and satisfaction ratings, the research applies unsupervised machine learning methods such as Kaiser Means clustering to segment the commuter population into distinct user profiles. This methodology captures the heterogeneity of transport experiences and facilitates the identification of which user groups are more satisfied or underserved. (Anable, 2005; Pauley et al.,2006). The resulting commuter typologies support more targeted and inclusive interventions by providing evidence to inform differentiated strategies based on cluster-specific needs.

- **Policy Relevance**

By Integrating user feedback, behavioral segmentation, and spatial analytics, the study offers evidence-based insights to inform transport policy and urban planning, It aligns with Kigali's broader agenda of inclusive and sustainable urban mobility by highlighting service gaps, population specific barriers and spatial inequalities in the public transport network. The framework promotes data informed, equity-driven decision making which is the key priority in urban mobility strategies across rapidly urbanizing Africa cities (Lucas, 2011; Salon & Gulyani, 2010). Furthermore, the methodology is adaptable and can serve as a replicable model for other cities in the Global south facing similar transport accessibility and equity challenges

CHAPTER THREE: RESEARCH METHODOLOGY

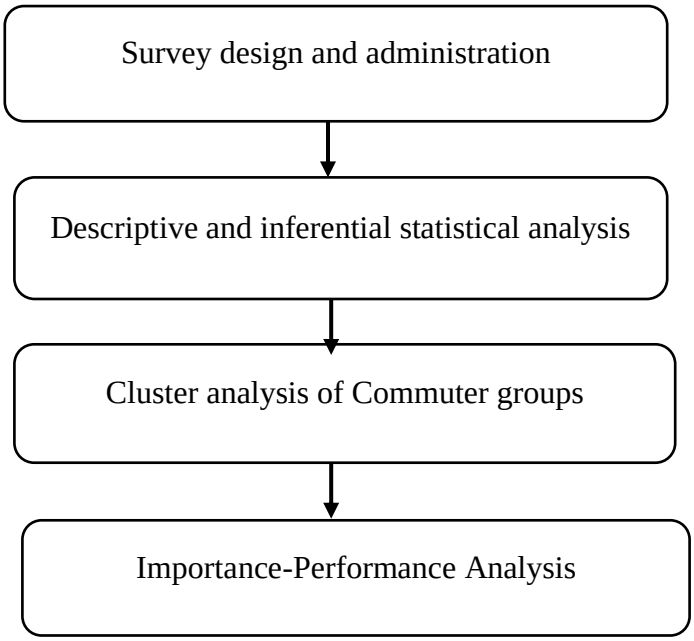
3.1 Introduction

This chapter outlines the methodological framework used to achieve the objectives of the study on commuter perceptions of bus service quality in Kigali City. It presents the research design, study area, data collection techniques, sampling methods, and analytical tools, with an emphasis on the integration of behavioral clustering.

3.2 Research design

A mixed-methods approach was adopted, combining both quantitative and spatial analysis techniques. This approach allowed for a detailed understanding of commuter behavior, satisfaction levels, and geographic disparities in service quality. The study used structured questionnaires to collect data from bus commuters and applied a 2-step cluster analysis to analyze perceptions.

The overall methodological flow involved the following diagram



3.3. Study Area

The study was conducted in Kigali City, the capital of Rwanda, which comprises three administrative Districts: Gasabo, Kicukiro and Nyarugenge. The city serves as the political, economic, and transport hub of Rwanda. With a population exceeding 1.5 million, according to 2022 Population and Housing Census (RPHC-5) and a high annual growth rate approximately 4%, public transport plays a central role in facilitating mobility and access to services. Kigali city is almost in the centre of the country, and its geographical position is on latitude 1^0 57' South and on longitude 30^0 04' East. It started in 1907 by Dr. Richard Kandt. In 1962, Kigali city's population was 5000 to 6000 people and the urban area of Kigali was approximately 3 km^2, from 1962 to 1984 the population grew at around 16% from around 6,000 to 160,000 people, and the built area expanded also to 15 km^2 (Kigali city, 2011a, OZ Architecture, EDAW, Tetra Tech, ERA, and Engineers without borders, 2007)

Map 1: Administrative map of Kigali City (http:/www/kigalicity.gov.rw/Download scientific

The city's topography is characterized by rolling hills, ridges, and valleys, with elevation ranging from approximately 1,300 meters to over 2,100 meters above sea level. This varied terrain influences urban planning, public transport routing, infrastructure development, and settlement patterns. The presence of steep slopes in certain areas also presents challenges for accessibility and road construction, especially in informal and densely populated neighborhoods.

The city's bus transport network is organized along main corridors radiating from central terminals such as

- Nyabugogo
- Kimironko
- Remera
- Giporoso
- Downtown/Main CBD

These corridors were selected based on ridership volume, route coverage, and strategic relevance to daily commuter flows.

3.4. Population and Sampling

3.4.1 Target Population

The target population included commuters using public buses in Kigali City, specifically those traveling along the main bus corridors during weekdays.

3.4.2 Sampling Technique

A stratified random sampling method was used to ensure representation across different bus corridors and socio-demographic groups. The city was divided into strata based on major bus corridors, and commuters were randomly selected from terminals and high traffic bus stops.

It may be important in those cases where there are relatively small groups in the population as they may lack representation in a simple random sample. The stratification

can also be performed with respect to several variables thus creating an n-dimensional matrix of stratification cells.

3.4.3 Sample size

The sample size was determined using Cochran's formula for large populations

The formula is:

$$n_0=\frac{Z^2\ p(1-p)}{e^2}$$

where

- Z is the Z-score (Confidence level)
- p: is the estimated proportion of the population
- e is the margin of error which is the maximum amount allowed by sample results to differ from actual population value.

  for this research:
- Z=1.96 at 95% confidence level
- P=0.5
- E=0.05 (margin of error) .

Why Choose those values?

1. The reason to choose 5% as error margin is the following:

- It is widely accepted in social sciences and public health studies
- It balances precision with cost-effectiveness
- Smaller margins example 0.01 require much larger samples which implicates more time and cost.

2. Z-score, Z=1.96: it corresponds to the level of confidence the results will have which is 95% confidence level, the most commonly used standard in surveys

It corresponds to a **95% confidence level**, the most commonly used standard in surveys to mean that there is only 5% chance that the sample results differ from the population due to random chance.

$n_0=\frac{1.96^2\ 0.5(1-0.5)}{0.05^2}=384.16$

n=385

To account for people who will not respond, the final sample size used during the data collection increased to 387 respondents.

3.5 Data Collection Methods

3.5.1 Primary data sources

These include original data collected specifically for the purpose of this study:

- **Structured Questionnaires** distributed to commuters along main bus corridors in Kigali City to capture perceptions on service quality indicators such as punctuality, accessibility and comfort. This questionnaire was in google forms and included Likert questions covering socio-demographic information, travel pattern behaviors, and bus service quality satisfaction information

3.5.2 Secondary data sources

These comprise existing data and literature used to support analysis, provide context, or inform the theoretical framework:

- **Government policies and regulatory documents,** including
- Rwanda Utilities Regulatory Authority (RURA) reports and service standards.
- Ministry of Infrastructure (MININFRA) strategic transport development plans and urban mobility policy documents.
- **Academic literature** from journals, theses, and research papers related to public transport, bus service quality, and urban mobility.
- **Books and Technical publications** covering public transport planning, satisfaction modelling, and evaluation tools such as Importance-Performance Analysis.
- **Online databases and institutional websites,** such as the RURA portal, MININFRA publications, University of Rwanda digital repository, and International Transport research portals.

3.6. Data Analysis Techniques

3.6.1 Descriptive and inferential Analysis

The collected data were first cleaned, coded, and analyzed using **SPSS (Statistical Package for social sciences) and Microsoft Excel** to ensure accuracy and consistency. The analysis involved both descriptive and inferential techniques, outlined as follows

- Descriptive statistics that include the following:
- ✓ Frequency distributions that were generated to understand the demographic profile of respondents like age, gender, and income.
- ✓ Mean satisfaction scores that were calculated for each service quality indicator to gauge overall perceptions
- ✓ Cross-tabulations that were conducted to explore variations in satisfaction levels by demographic groups and travel behavior

3.6.2 Inferential and Multivariate Analysis

To enter deeper into the data and identify underlying patterns, inferential and multivariate analysis techniques were utilized. Including

- Two step Cluster analysis: This was a key analytical technique employed to identify distinct groups of public transport users. Nine input variables were used for this analysis such as area of destination, weekly frequency, departure time, return time, average travel time, average waiting time, number of bus lines taken to reach the destination, type of bus used either diesel or electric, and the corridor used. The analysis successfully identified two distinct clusters: Cluster one named as Long-haul frequent commuters and Cluster two named as Time efficient occasional commuters. The quality of the clustering solution, as assessed by the silhouette measure, was “Fair”, indicating a meaningful, through not particularly strong, separation between groups. Predictor importance analysis revealed that average waiting time and average travel time were the most crucial variables in differentiating commuter clusters, highlighting the significance of time-related behaviors. Destination neighborhood and bus type also showed a strong influence.

3.6.3 Importance-Performance Analysis (IPA)

This analysis was conducted across the identified commuter clusters (cluster one and cluster two) to understand the perception of public bus service quality in Kigali City. IPA Charts, as shown in figures 7 and 8 in the discussion, helped in identifying attributes that are perceived as high in importance but low in performance in the top left quadrant named “Concentrate here”. This analysis revealed specific performance gaps, such as route coverage, bus entering, and seating for cluster 2, and highlighted concerns with driver behavior.

3.7 Validity and Reliability

To ensure **Validity**, the questionnaire was pre-tested with 30 commuters and revised accordingly, the expert consultations were conducted with transport planners and academic advisors to refine indicator selection and weighting. For reliability, internal consistency of Likert-scale responses was tested using Cronbach’s Alpha with values above 0.7 considered acceptable

3.8 Ethical Considerations

Ethical clearance was obtained from The University of Rwanda’s Institutional Review Board, all respondents were informed about the purpose of the study, and Informed consent was obtained prior to participation was voluntary, and anonymity and confidentiality of responses were ensured.

3.9 Limitations of the study

- The study relied on Self-reported perceptions, which may be influenced by mood or recent experiences
- Data collection was limited to Peak travel hours, excluding part-time and off-peak users
- Some informal routes or non-standardized operations may not have been fully captured in spatial datasets.

Despite these limitations, the study provides a comprehensive analysis of commuter satisfaction and bus service quality in Kigali City.

CHAPTER FOUR: RESULTS

4.1 Social Demographic characteristics of respondents

The survey captured responses from a diverse group of 387 individuals across various socio-demographic categories, including gender, employment status, age, education level, and monthly income. It includes both absolute counts and percentages, with a distinction between frequent and non-frequent public transport users. This breakdown provides context for analyzing variations in commuter satisfaction across different socio-economic groups in Kigali City. The following table summarizes the socio-demographic characteristics of respondents.

Table 1: Socio-Demographic Characteristics of respondent

Demographic Factor	%	Frequent	%	Non-Frequent	%
Gender					
Females	46.8	100	25.8	81	20.9
Males	53.2	102	26.4	104	26.9
Employment status					
Employed by private sector	32.8	57	14.7	70	18.1
Employed by public sector	26.1	64	16.5	37	9.6
Unemployed	1.6	0	0	6	1.6
Self-employed	35.1	71	18.3	65	16.8
Student	4.4	10	2.6	7	1.8
Age group					
18-20	3.9	13	3.4	2	0.5
20-30	46.3	91	23.5	88	22.7
30-40	35.1	73	18.9	63	16.3
40-50	10.9	20	5.2	22	5.7
50-60	2.8	3	0.8	8	2.1
60-70	0.3	0	0	1	0.3
70	0.8	2	0.5	1	0.3
Education level					
Primary	5.4	8	2.1	13	3.4
Secondary	19.6	42	10.9	34	8.8
University	66.7	138	35.7	120	31
No Education	0.3	1	0.3	0	0

other level	8	13	3.4	18	4.7
Income					
10,000-250,000	43.4	93	24	75	19.4
250,000-500,000	38.5	72	18.6	77	19.9
500,000-750,000	15	33	8.5	25	6.5
750,000-1,000,000	2.8	4	1	7	1.8
Above 1,000,000	0.3	0	0	1	0.3
Residence location					
Urban area	54	115	29.7	94	24.3
Peripheral area	46	87	22.5	91	23.5

4.2 Travel behavior characteristics of respondents

To gain deeper insights into commuter behavior, the study analyzed travel pattern characteristics of both frequent and non-frequent bus users along main corridors in Kigali City. The analysis focused on factors such as origin-destination patterns, average travel and waiting times, departure and return times, number of bus lines used, and the type of bus typically used. These dimensions provide a clear picture of how different categories of users interact with the public transport system on a daily basis. The following table gives details about the findings on main corridors of Kigali City.

Table 2: Travel pattern behavior of respondents

Travel pattern Factor	%	Frequent	%	Non-Frequent	%
Origin and destination factor					
Travel within inner city	36.4	85	22	55	14.2
Travel between inner city and the peripheral areas	17.8	33	8.5	38	9.8
Travel between peripheral zones	6.2	6	1.6	16	4.1
Travel between peripheral zone to the city	39.5	78	20.2	76	19.6
Travel average time					
0-30 min	29.5	61	15.8	53	13.7
30-60 min	44.4	82	21.2	90	23.3
1h-1h30 min	20.4	49	12.7	30	7.8
1h30-2h	5.7	10	2.6	12	3.1
Average waiting Time					
0-20min	69.5	154	39.8	115	29.7
20-40min	25.8	39	10.1	61	15.8
40min-60min	2.6	6	1.6	4	1
60min and above	2.1	3	0.8	5	1.3
Departure Time					
Morning peak hours	86	189	48.8	144	37.2
off-peak hours	12.4	13	3.4	35	9
Evening Peak hours	1.6	0	0	6	1.6
Back home Time					
Morning peak hours	3.9	10	2.6	5	1.3
off-peak hours	47.3	90	23.3	93	24
Evening Peak hours	48.8	102	26.4	87	22.5
Number of bus lines					
1 bus line	83.7	160	41.3	164	42.4
2 bus lines	15	39	10.1	19	4.9
more than 2 lines	1.3	3	0.8	2	0.5
Type of bus					
Diesel bus	23	48	12.4	41	10.6

Electric bus	17.3	31	8	36	9.3
Electric and or diesel bus	59.7	123	31.8	108	27.9

4.3 Two step cluster analysis

The two step Cluster analysis is conducted to identify meaningful groupings among public transport users in Kigali City, based on their travel behaviors. This is a statistical technique that is suitable for large datasets which contains both continuous and categorical variables. This Technique determines the optimal number of clusters using statistical criteria which is called "Schwarz's Bayesian Information Criterion (BIC), that enhances the objectivity and reliability of the results. The following are the variables considered during a 2-step cluster analysis.

Table 3:The travel behaviors considered during a 2-step cluster analysis

No	Name
1	Area of destination
2	Frequency of public transport
3	Time to start the trip
4	Time to start back home
5	Average travel time
6	Average waiting time
7	number of bus lines to reach the destination
8	Type of bus used
9	Corridor

4.3.1 Presentation of results from SPSS 2 Step cluster analysis

The results from the 2-step cluster analysis show different figures and demonstrations that helps to understand better the distinct cluster, among those there are: (1) Model summary and Cluster quality, (2) Predictor Importance evaluation, (3) cluster sizes, (4) Cluster comparison

(1) Model summary and cluster quality

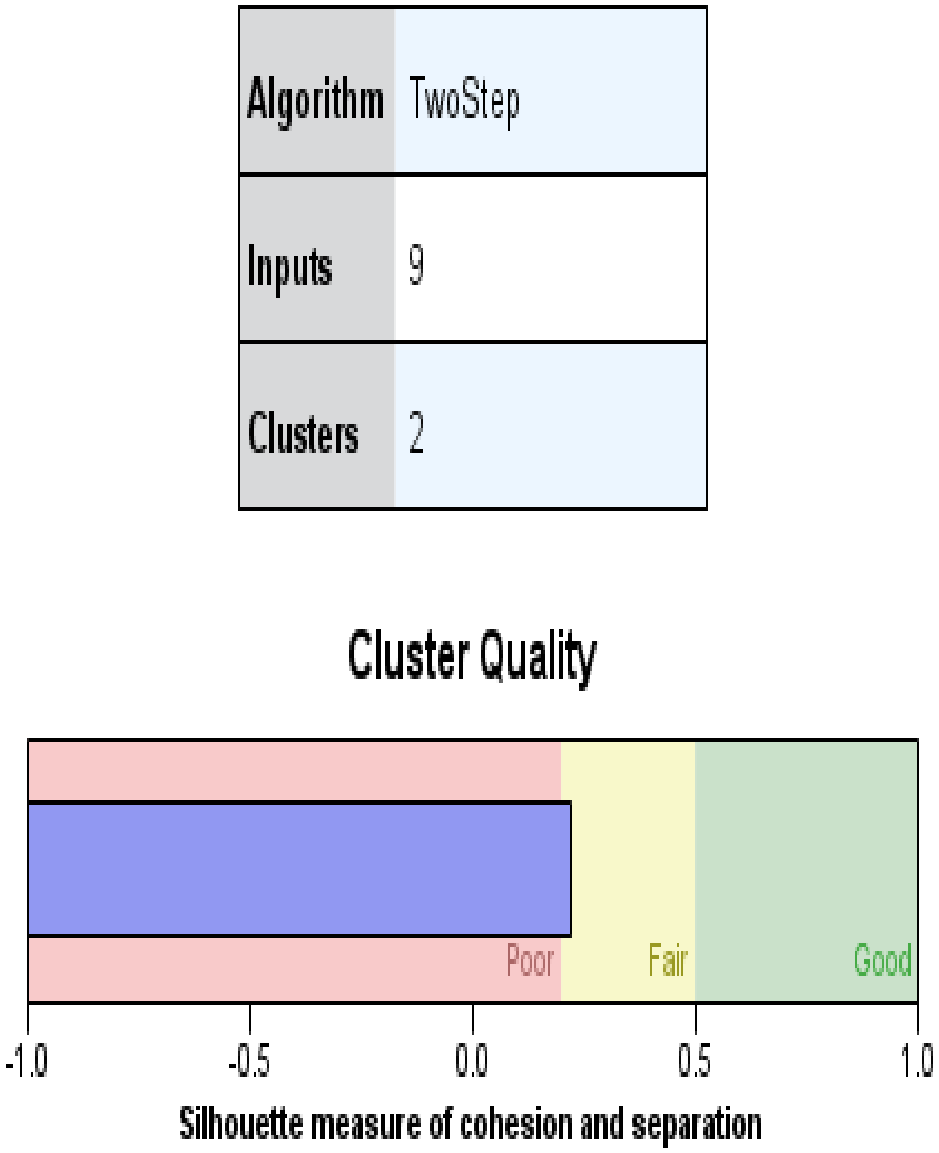


Figure 1: Two step cluster analysis Model summary

(2) **Predictor Importance**

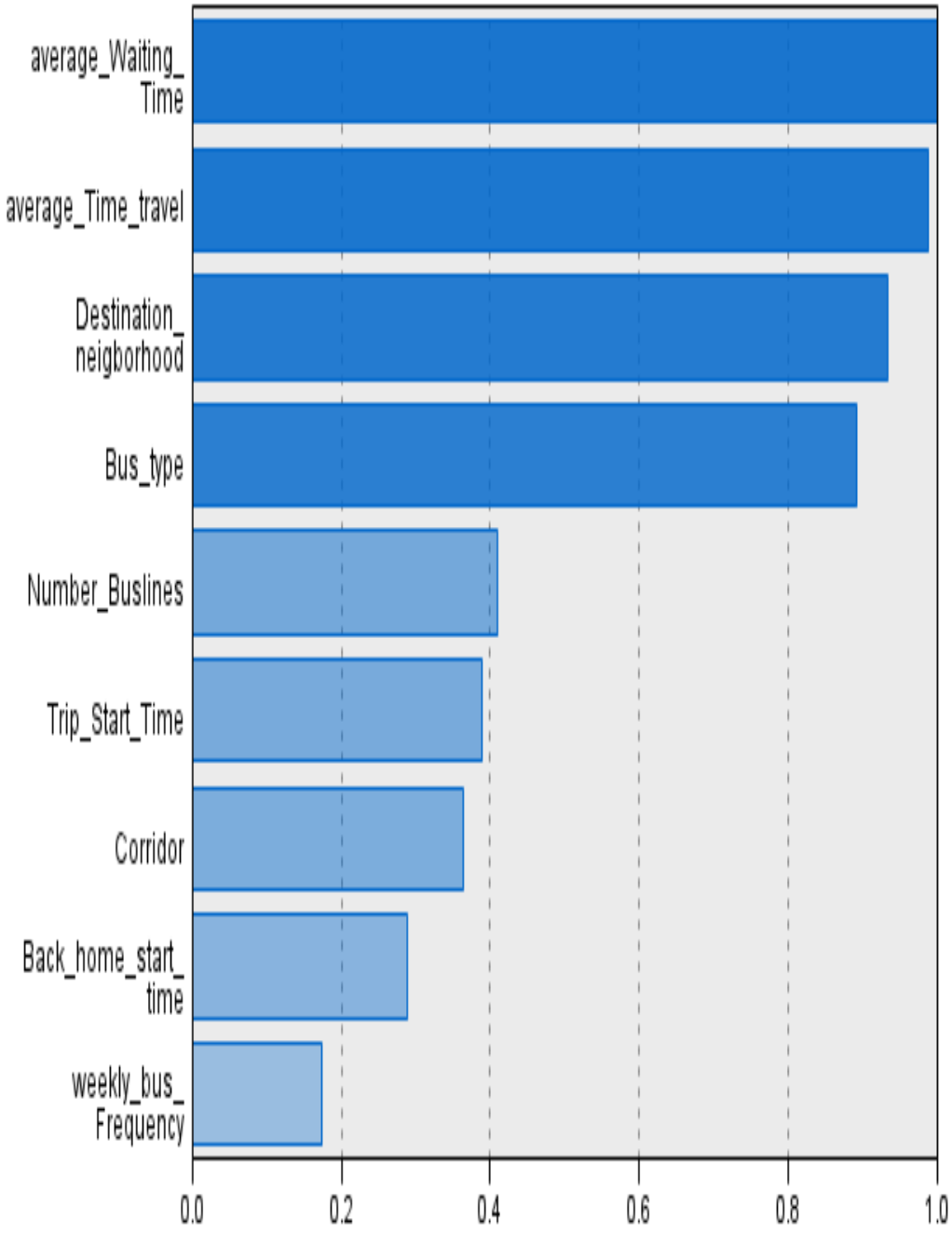
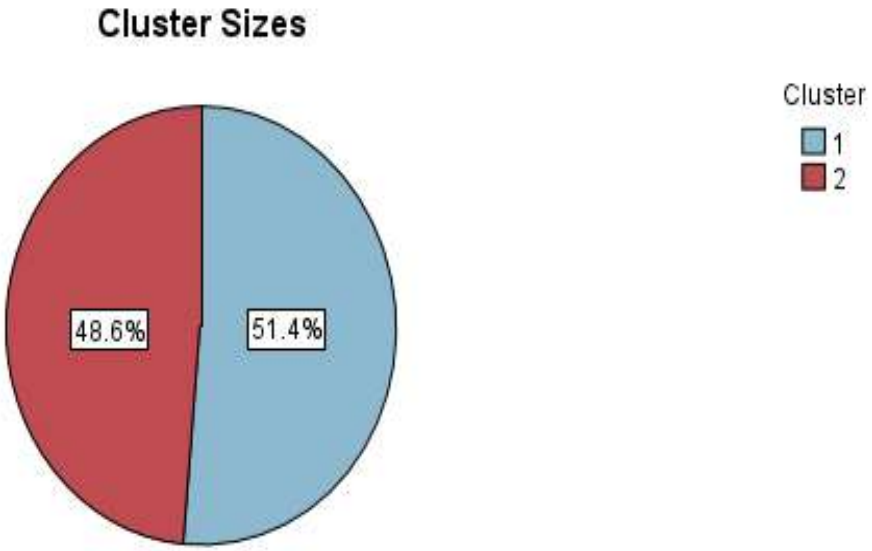


Figure 2: Two step cluster analysis predictor importance

(3) Cluster sizes



Size of Smallest Cluster	188 (48.6%)
Size of Largest Cluster	199 (51.4%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.06

Figure 3: Commuters' cluster

(4) Cluster comparison

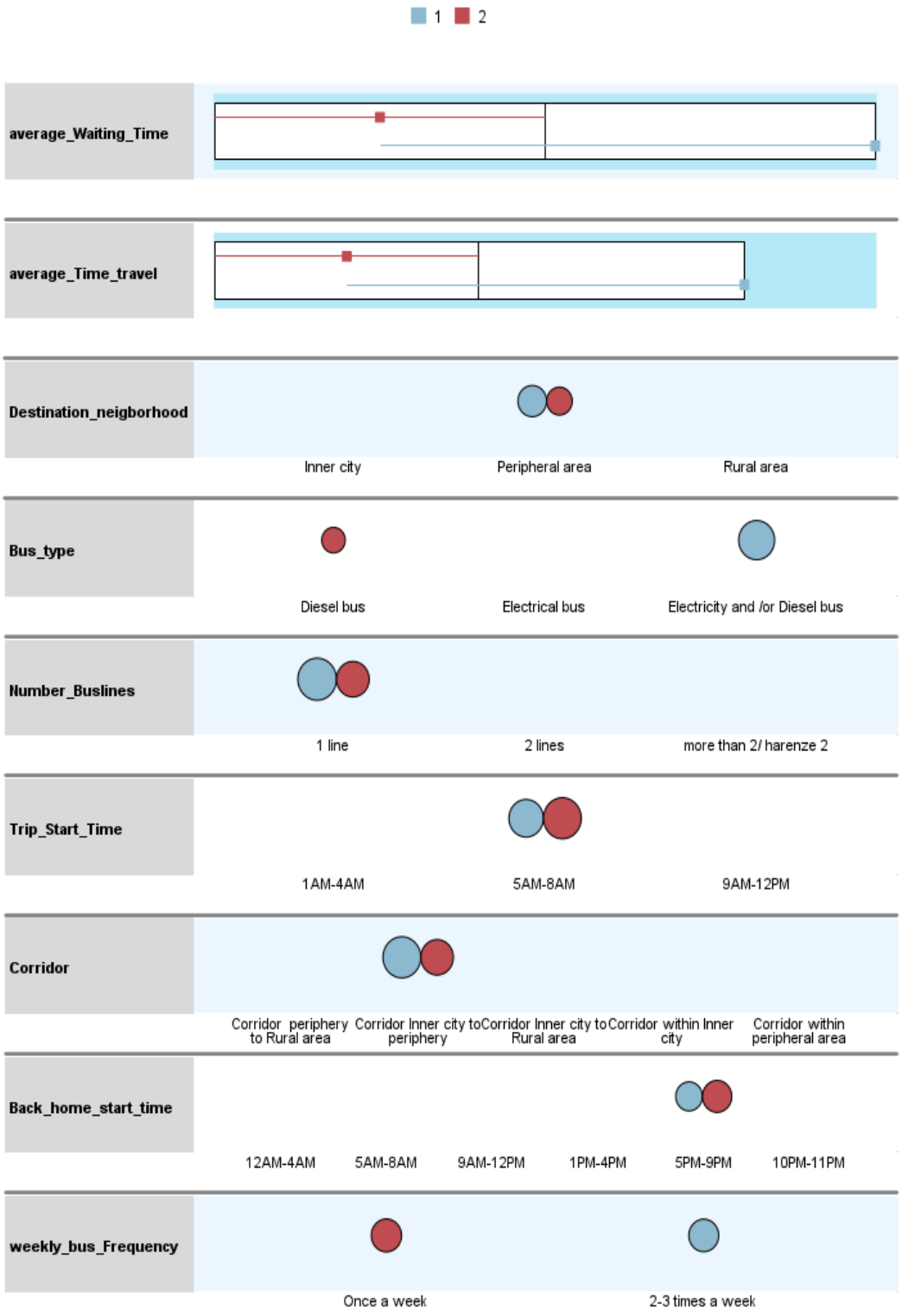


Figure 4: Cluster Comparison

4.3.2 Importance score of Each variable in the cluster distribution

The results from 2 step cluster analysis are from the importance of each variable from travel pattern factor expressed in values between 0 to 1, to have a harmonized distribution of results. They differ from the importance they play in commuters' perception. The following table shows details of the importance of each variable from travel behavior.

Table 4: Importance of variable on clusters

No	Latent variables	Cluster's Importance
1	Average waiting time	1
2	Average travel time	0.99
3	Destination neighborhood	0.93
4	Bus type	0.89
5	Number of bus line	0.41
6	Departure time start	0.39
7	Corridor	0.36
8	Back home start time	0.29
9	Weekly frequency	0.17

All the variables play role in the cluster analysis, in this study nine variables were evaluated as shown in the above table, each variable has cell distribution in each cluster as shown in the following charts.

Each chart shows the contribution of the variable in the set of the other (shade graph) and the level of contribution

1. **Graphs showing contribution of travel pattern variable for cluster 1.**

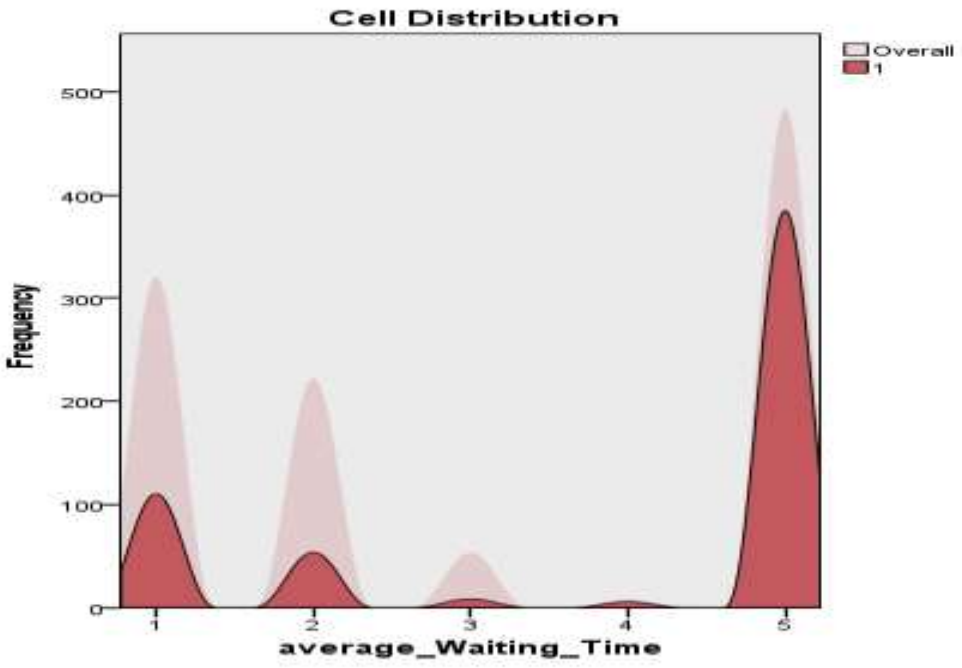


Figure 5: Average waiting Time

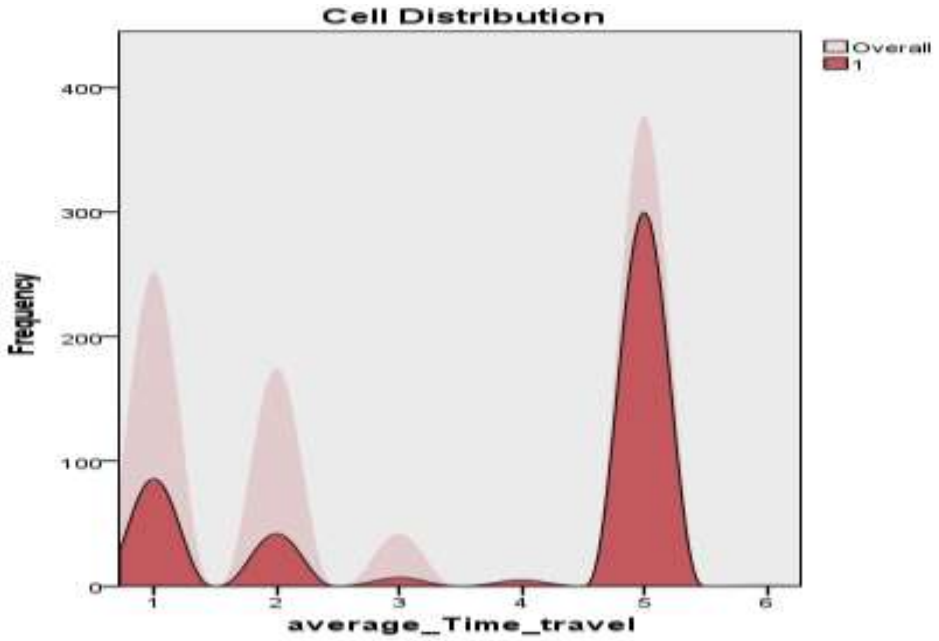


Figure 6: Average Travel time

4.4 The Importance-Performance Analysis

This section visualizes the commuters located in cluster one (long haul frequent commuters) and in cluster 2 (Time efficient occasional commuters) of Kigali city using a four-quadrant matrix. The analysis draws on multiple satisfaction variables related to bus service quality performance across Kigali City; including headway, punctuality, seating, cleanliness, air cooling, wheelchair access, assistance with luggage, bus stop shelters and seating, information access and driver behavior; which are assigned importance factor and satisfaction score of each for commuters of cluster one and two.

4.4.1 Importance factor and satisfaction score for commuters in cluster one

The table 5, presents the relationship between perceived importance and satisfaction scores for 14 key service quality variables as evaluated by respondents in the study. The data reflects commuter perspectives on service aspects such as headways, cleanliness, accessibility, comfort, and information availability, and provides insight into which variables are performing well versus those needing targeted improvement.

Table 5: Importance factor and Satisfaction score for commuters of cluster one.

No	Satisfaction variable	Importance factor	Satisfaction score
1	Headway	0.58	3.63
2	Cleanliness	0.32	3.59
3	Seating	0.58	3.5
4	Route	0.66	3.48
5	Bus Entering	0.6	3.57
6	Easy access by wheelchair	0.45	3.5
7	Luggage assistance	0.49	3.37
8	Information access	0.53	3.33
9	Fare price	0.21	4.06
10	Air cooling	0.48	2.86
11	Shelter at bus stop	0.53	3.15
12	Shelter seat	0.52	3.14
13	Drivers behavior	0.43	3.4
14	Bus punctuality	0.55	3.62

4.4.2 visualization of the Results from IPA for the cluster one.

The following figure presents an Importance-performance Analysis (IPA) visualization of service quality indicators as perceived by respondents in cluster one, derived from a two-step cluster analysis. This group represents commuters who rated service attributes as important but reported varying levels of satisfaction. The chart maps attributes across two dimensions: the x-axis (Importance) and the y-axis (performance/satisfaction), this chart has four quadrants each representing a role in commuters' perception.

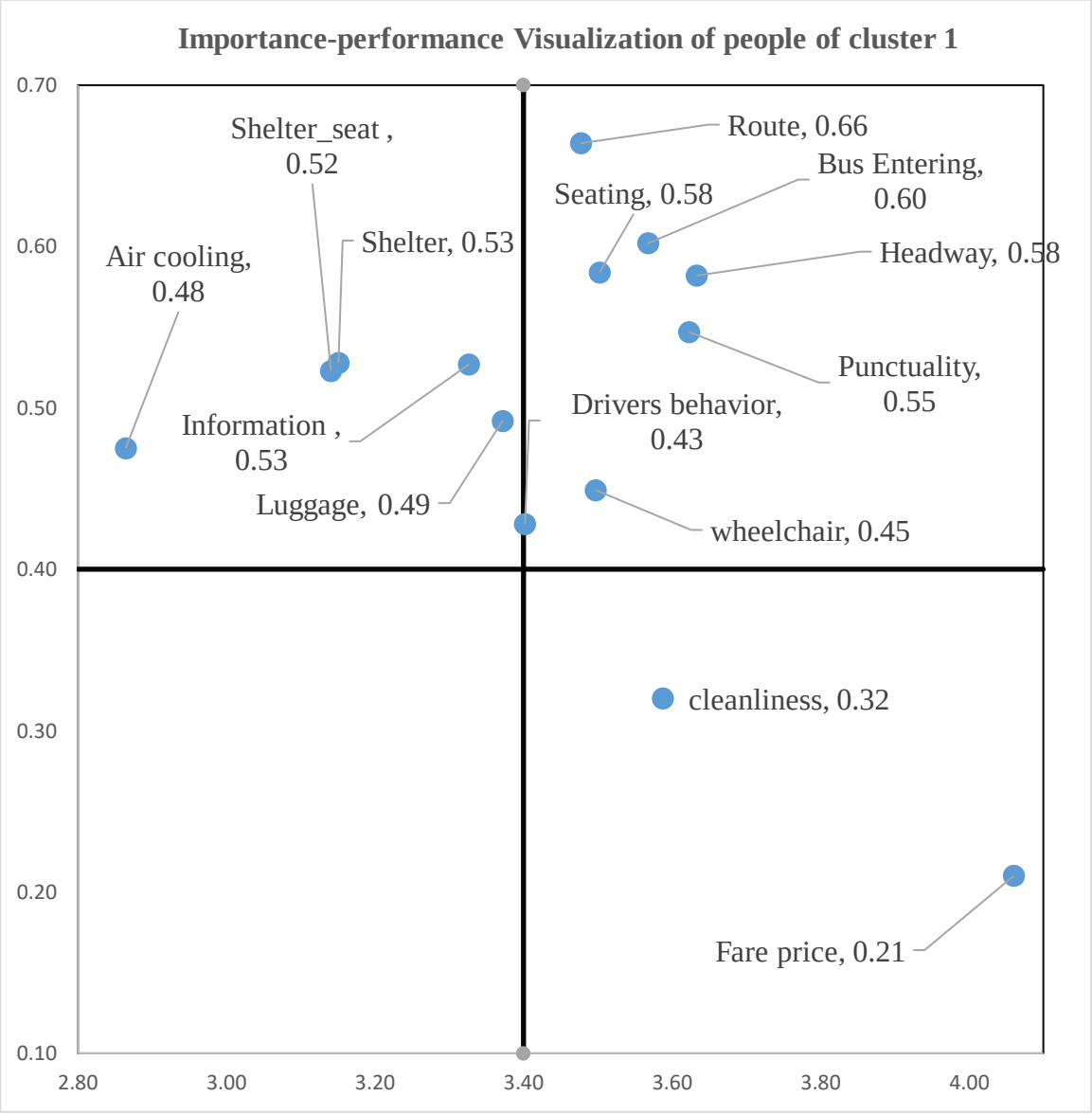


Figure 7: Visualization of IPA results for cluster one

4.4 3 Importance factor and satisfaction score for commuters of cluster two.

The table 6. Presents the descriptive summary of commuter perceptions regarding 14 key dimensions of bus service quality along the main corridors of Kigali City. For each variable, the average satisfaction score on Likert scale is compared with its corresponding Importance factor, derived from the two-step cluster analysis and Importance performance framework. This comparison provides insight into both how users experience various service attributes and how much they value them

The following table shows the Importance factor and satisfaction score for commuters in cluster two.

No	**Satisfaction variable**	**Satisfaction score**	**Importance factor**
1	Headway	3.16	0.58
2	cleanliness	3.68	0.32
3	Seating	3.26	0.58
4	Route	3.35	0.66
5	Bus Entering	3.38	0.6
6	Wheelchair access	3.36	0.45
7	Luggage	3.12	0.49
8	Information	3.06	0.53
9	Fare price	3.88	0.21
10	Air cooling	2.97	0.48
11	Shelter at bus stop	3.21	0.53
12	Shelter seat	3.21	0.52
13	Drivers behavior	3.51	0.43
14	punctuality	3.17	0.55

Table 6: Importance-Satisfaction score table

4.4.4 visualization of the Results from IPA for the cluster two

The figure 8 presents the Importance-Performance Analysis (IPA) visualization for commuters categorized in cluster two. This matrix helps to identify the key service quality dimensions by plotting average satisfaction scores against their corresponding importance factors, as rated by respondents in this specific cluster.

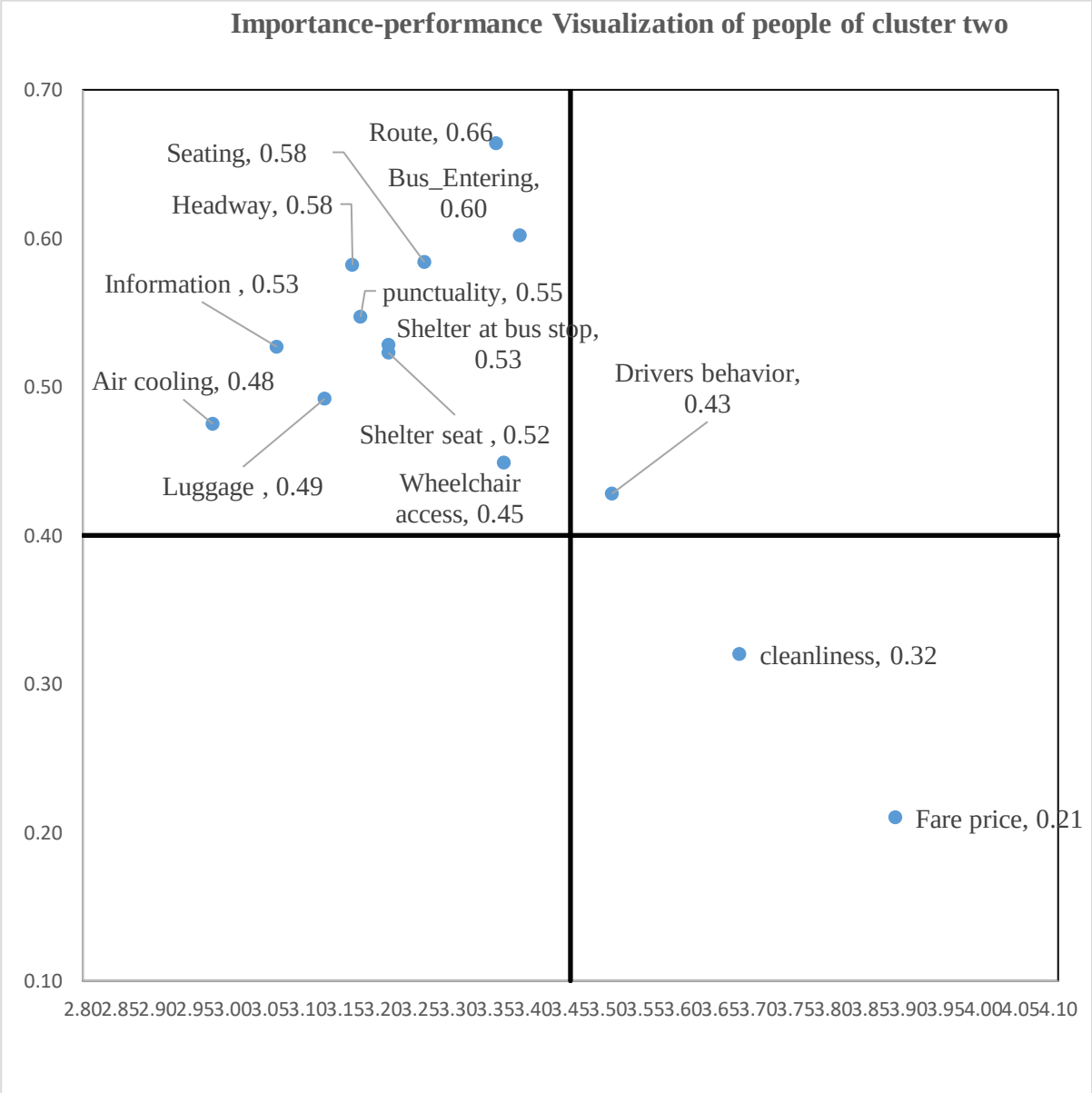


Figure 8: Visualization of IPA results for cluster one

CHAPTER FIVE: DISCUSSION OF RESULTS

5.1 Introduction

The discussion of results synthetizes the key findings from the analysis of commuters' perceptions data in Kigali City, contextualizing them within the broader academic and policy regulations on urban Transport in Kigali City. The research is an additional literature, which has historically focused on infrastructure rather than commuter experiences and has often treated users as a monolithic group. By adopting a user centered approach and employing behavioral segmentation, this study provides a more understanding of bus service quality in Kigali City.

The main findings of this research are the identification of two distinct commuter groups: Cluster 1 (long haul frequent commuters) and cluster 2 (Time efficient occasional commuters) found from

the travel behavior characteristics such as destination area, average travel and waiting time, departure time, number of bus lines to reach the destination, the type of bus used frequently and the bus corridor. This use of behavioral segmentation aligns with methodologies proposed by Beirao & Sarsfield Cabral (2007) allowing for more targeted service interventions.

5.2 The Two step cluster analysis

5.2.1 Model summary and cluster quality

The two-step cluster analysis was performed using nine inputs variables which are: area of destination, weekly frequency to use public bus, departure time, return back time, average travel time, average waiting time, number of bus lines taken to reach the destination, type of bus used, be it diesel or electric, and the corridor used. The results show the identification of two distinct clusters, the quality of the clustering solution is assessed during the silhouette measure of cohesion and separation, which ranges from the interval of -1 to +1, in this case, the silhouette value falls slightly above zero, placing it in the "Fair" quality range, through just marginally above the "poor" threshold, as shown in the figure 1. This suggests that while the clustering does identify some degree of meaningful separation between groups, the distinction between the two clusters is not particularly strong. There is a moderate internal cohesion within each cluster and limited

separation between them, which may indicate overlapping characteristics among respondents.

5.2.2 Predictor Importance

The predictor importance graph as shown on the figure 2, presents the relative of various variables in a two-step cluster analysis model, which is used to identify distinct groups within a data set. In this context the variables such as average waiting time and average travel time emerge as the most important predictors, indicating that the behaviors that are related to time are key to differentiate clusters of commuters. Destination neighborhood and bus type also show the strong influence of spatial and vehicle type preferences. On the other hand, the variables such as weekly bus frequency, the time to start going back home, and the corridor used they show the low importance during differentiating clusters. These insights help in understanding the definition of different user segments, guiding targeted service improvement and transit planning.

5.2.3. Cluster comparison

The two-step cluster analysis identified two distinct groups of public transport users, labeled Cluster one indicated in blue color and the cluster two group indicated in red color, this was established based on the travel pattern behavior. the commuters in cluster experience longer waiting and travel times compared to those of commuter two as shown on the figure 4. The weekly bus frequency differentiates the clusters as the commuters of cluster one, are more frequent than the people of cluster one, this shows the difference in dependence to public transit.

The differentiation between Long haul frequent and time efficient occasional commuters aligns with findings in East African corridors (Nkurunziza et al., 2012) and recent large-scale segmentation studies in Maputo (Mendiate et al.,2024), which show that frequency of travel, travel time, and residential location are reliable discriminators of commuter satisfaction and service quality perception.

5.3 Evaluating Perceived quality of bus services among commuter clusters in Kigali City.

To understand the perception of public bus service quality among different commuters' group is the essential part to design equitable and user centered transport system. The heterogeneity of user needs and expectations necessitates a disaggregated approach to service quality evaluation. According to Dell'Olio et al., (2010), the user perceptions of public transit quality vary significantly across population segments, and addressing these differences is essential for improving satisfaction and promoting transit use. In line with the objective of this study, commuter was analyzed using Importance-Performance Analysis. This analysis was conducted across commuter clusters derived from travel pattern factors.

5.3.1 cluster one: Operational Efficiency Appreciated, inclusivity undervalued

from Table 5, The importance factors and satisfaction scores for each satisfaction variable of commuter cluster one is given, the evaluation of service quality attributes reveals a gap between what commuters consider important and how satisfied they are, with the current provision. the variable may be of high importance but showing less satisfaction such as route which has 0.66 of importance, and have the satisfaction score of 3.48. these results reveal that while operational reliability such as frequency and punctuality are critical to this cluster, current services do not fully meet expectations. This supports findings by Nkurunziza et al., (2022), who noted that Kigali's peripheral routes suffer from poor frequency, limited connectivity, and insufficient real time information systems.

5.3.2 cluster two: Performance Gaps in Human Interaction

cluster two presents a similar prioritization of operational efficiency, with route coverage (0.66), bus entering (0.60), seating (0.58) again dominating the high importance and high-performance quadrant. This reflects the continued emphasis among Kigali City commuters on reliable and timely service, a trend also noted in urban mobility studies by Litman (2013) and Tyrinopoulus & Antoniou (2008)

However, a key difference in cluster 2 lies in the identification of driver behavior (0.43) as a high-importance but low-performance attribute. These findings suggest dissatisfaction with interpersonal interactions between staff and passengers, which can significantly impact perceptions of safety, respect and trust. Prior literature emphasizes the role of driver behavior in shaping service satisfaction, particularly among women, elderly passengers, and those who are unfamiliar with the system (Dell'Olio et al., 2011).

CHAPTER SIX. CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

This study assessed commuters' perceptions of bus service quality along main bus corridors in Kigali City, Based on travel behavior of commuters analyzed, this study, through SPSS software, demonstrated that Kigali city commuters is divided into two distinct clusters, the Long-Haul frequent commuters and the Time efficient occasional commuter, the main behaviors that differentiate the two clusters are average waiting time, average travel time, and destination location, consistent with segmentation approaches proposed by Beirao & Sarsfield Cabral (2007) and validated in East African contexts by Nkurunziza et al. (2012) and Mendiate et al., (2024).

Based on the Importance-Performance Analysis (IPA) charts as shown on figures 7 &8 for cluster one, and cluster two, the second quadrant (top left) represents attributes that are perceived as high in importance but low in performance; namely: Bus stop shelter infrastructure, information access, luggage handling, accessibility for persons with disabilities (PWDs), onboard air cooling, punctuality, and general service quality.

Overall, the results highlight that service quality perceptions in Kigali City are not homogeneous, and improving commuter satisfaction requires targeted interventions for each segment. Enhancing route reliability, reducing waiting times and travel times are critical strategies, in Line with Dell'Olio et al., (2010), acknowledging and addressing the heterogeneity of user needs is essential to designing equitable, user centered transport systems that can both sustain and increase public transport use.

6.2 Recommendations

1. **Upgrade Bus stop Infrastructure:** Investment in durable, weather-protected bus shelters with adequate seating is essential. As shown by Eboli and Mazzula (2007), such infrastructure improvements significantly impact perceived bus service quality.
2. **Enhance Real Time passenger information:** Implementation of digital boards or mobile platforms offering accurate schedules and delay alerts can bridge communication gaps and improve commuter satisfaction (Dell'Olio et al., 2011)
3. **Improve Thermal Comfort:** for long trips, lack of ventilation or cooling can lead to discomfort. Equipping buses with buses with basic air circulation or cooling systems is therefore recommended.
4. **Introduce Luggage-Friendly Bus designs:** Given their travel distance, frequent commuters often carry bags. Designated luggage space would enhance convenience and safety.

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APPENDICES

QUESTIONNAIRE

The questionnaires comprise the three parts : (1) Socio-demographic Information, (2) Travel Pattern behavior and Satisfaction level of respondents

1. When did you born? / wavutse ryari?

2. Gender/ Igitsina

3. In which area do you live?/ Utuye he?

4. What is your monthly income level/ winjiza angahe ku kwezi?

5. what is your Employment status?/ ukora akahe kazi?

6. What is your Educational level/ Amashuri wize?

7. which is the bus corridor do you use?/ ukoresha uwuhe muhanda?

8. What is the area of your Destination?/ Nihe uba ugiye iyo uteze bus?

9. How many times do you often use public transport on this corridor?/ uyu muhanda uwugendamo inshuro zingahe ugenda muri buryo bwa Rusange?

10. What time do you start your bus trip?/ utangira ryari urugendo?
AM: Mu gitondo
PM: Nyuma ya saa sita

11. What time you start the trip back to home?/ utangira ryari urugendo rusubira mu rugo?
AM: Mbere ya saa sita
PM: Nyuma ya saa sita

12. what is your average travel time by bus ?/ ukoresha igihe kingana gute muri bus?
Min: Iminota

13. What is your average waiting time at the bus stop?/ utegereza igihe kingana iki kugirango ufate bus?
Min: Iminota

14. How many bus lines do you take to reach the destination?/ Utega kangahe kugirango ugere aho ugiye?

15. What is the type of the bus do you often use? / Ni ubuhe bwoko bw'Imodoka ugendamo ?

16. How are you satisfied with the bus frequency on this corridor (headway)? ku ruhe rugero wishimira uburyo bus zikurikirana kuri uyu muhanda?
1: very dissatisfied/ nta kunyurwa cyane
2: dissatisfied/ Nta kunyurwa
3: Neutral/ ndifashe
4: satisfied/ Ndanyuzwe
5: Very Satisfied/ ndanyuzwe cyane

18. How are you satisfied with the cleanliness of the buses?/ ku ruhe rugero wishimira isuku muri bus?
1: very dissatisfied/ nta kunyurwa cyane
2: dissatisfied/ Nta kunyurwa
3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

19. How are you satisfied with the comfort of buses in terms of seating and space?/ ku ruhe rugero wishimira kugenda muri bus ugendeye ku buryo bwo kwicara n'umwanya ?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

20. How satisfied are you when using public transport on this route? / Ku ruhe rugero wishimira kugenda mu buryo bwa Rusange?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

21. How satisfied are you with the entering into the bus ?/ ku ruhe rugero wishimira kwinjira muri bus?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

22. How satisfied are you with the access on the bus in a wheel chair ? Ni ku ruhe rugero wishimira uburyo igare ry'abamugaye ryinjira muri bus?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

23. How satisfied are you with getting assistance in carrying packages on the bus?/byoroshye gute ku kwinjirana n'imizigo mu modoka ya rusange?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

24. How are you satisfied about how to get access to the information of cancelling or delaying of bus ?/ Ni ku ruhe rugero wishimiye kuubona amakuru yerekeranye no gukererwa cg kuvanaho bus ?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta ku

25. What is your level of satisfaction with the fare price on this route?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

26. What is the level of satisfaction with the air cooling in a bus ?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

27. What is your level of satisfaction in terms of sherter at the bus stop?/ Wishimira gute ubwugamo aho utegera Imodoka?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

28. What is the level of satisfaction in terms of seats at the shelters while waiting for the bus?/ Wishimira gute imyanya y'aho kwicara mu gihe utegereje Imodoka?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

29. How are you satisfied with the Drivers behavior?/ ku ruhe rugero wishimira imyitwarire y'ababatwara muri bus?

1: very dissatisfied/ nta kunyurwa cyane

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

17. How are you satisfied with the arrival on time of the bus on this corridor? / ku ruhe rugero wishimira kugendera ku gihe kwa bus kuri uyu muhanda?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane

30. How are you satisfied with the overall quality of public transport services along the Corridor?/ ku ruhe rugero wishimira muri rusange uburyo bwo gutwara abantu bwa rusange?

1: very dissatisfied/ nta kunyurwa cyane

2: dissatisfied/ Nta kunyurwa

3: Neutral/ ndifashe

4: satisfied/ Ndanyuzwe

5: Very Satisfied/ ndanyuzwe cyane