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FACULTY OF BUILT ENVIRONMENT & DESIGN
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MASTER OF URBAN MANAGEMENT

PERFORMANCE OF PARK-AND-RIDE STATIONS IN NAIROBI METROPOLIS: (A CASE STUDY OF ATHI RIVER AND SYOKIMAU RAILWAY STATIONS)

Submitted By

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A Research Project Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Urban Management of the University of Nairobi.

July 2023

DECLARATION

I hereby declare that this Research Paper is my original work and has not been presented for examination in any university.

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DEDICATION

I dedicate this research work to my dear parents, my dad Mutua Muange and my mum Anna Syokau Mutua, in sheer honor to the virtues of hard work, discipline and sustained efforts in any endeavor that you inculcated in me right from childhood. These, together with your words of wisdom and inspiration have been instrumental to my progression in education and professional career life. I am forever grateful to your dedicated parenting (Proverbs 6:20; 23:25).

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ABSTRACT

Park and Ride facilities have the potential to promote use of mass transit systems and help in relieving traffic congestion and air pollution, which are all associated with excessive automobile usage. However, some factors can impede their successful performance. This study is a focus on performance of Park and Ride stations in Nairobi Metropolis with a view to giving recommendations on performance improvement. The theories underpinning the study were the Systems theory, Actor Network theory and Rhizomes theory. The researcher also devised an empirical framework guide the study and a conceptual framework with performance criteria to gauge performance. A situational analysis was carried out on the existing legal and institutional framework governing transport sector in Kenya. The urban land use planning and development in the study area were also examined to determine challenges that may need to be resolved in the operating environment for the study stations. The study employed a quantitative and qualitative research methodology with data collected via questionnaires administered to 165 respondents in the two stations and 3 interviews held with Kenya Railways officers. The findings indicated that the land use character in the station influence area, operating trains schedules and speed and availability of other socio-economic facilities like convenience stores and recreational facilities have a direct bearing on performance of park and ride stations. The study recommended some short-term measures to improve performance like introduction of differentiated affordable fares for train trips at peak and off-peak hours, awareness creation and obtaining constant feedback. The medium to long term measures and strategies recommended include introducing faster trains with condensed schedules, more connector transport services in the suburbs railway stations, review of the planning concept for the stations and reconfiguration of the station land area to create station plazas with other facilities like convenience stores, restaurants, and recreational facilities. Collaboration between the railway operator, the host County Government, and the adjacent landowners was also recommended towards re-planning the stations surrounding area. The study provided insights into other areas of further study like impacts of major land use and transport development undertakings on existing Park and Ride facilities and economic appraisal of Park and Ride stations in Nairobi Metropolitan Area, among others.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACRS – Athi River Commuter Railway Station

ANT – Actor Network Theory

BRT – Bus Rapid Transport

CBD – Central Business District

CG – County Government

CoK – Constitution of Kenya

CVI – Content Validity Index

DMU – Diesel Multiple Units

e.g. – For Example

EPZ – Export Processing Zone

Expy – Expressway

GoK – Government of Kenya

HOV – High Occupancy Vehicle

Hr – Hour

INTP – Integrated National Transport Policy

ISUDP – Integrated Strategic Urban Development Plan

ITF – Intermodal Transfer Facility

JICA – Japanese International Cooperation Agency

JKIA – Jomo Kenyatta International Airport

KeNHA – Kenya National Highways Authority

KeRRA – Kenya Rural Roads Authority

KIHBT – Kenya Institute of Highways and Building Technology

KRTI – Kenya Railway Training Institute

KURA – Kenya Urban Roads Authority

KNBS – Kenya National Bureau of Statistics

KRC – Kenya Railways Corporation

KSh – Kenya Shilling

MCA – Member of County Assembly

MDA – Ministries, Departments and Agencies

MGR	– Metre Gauge Railway
Min	– Minutes
MoRT	– Ministry of Roads and Transport
MoTIHUD	– Ministry of Transport, Infrastructure, Housing and Urban Development
MRTS	– Mass Rapid Transit Systems
MTRD	– Materials Testing and Research Division
NaMATA	– Nairobi Metropolitan Area Transport Authority
NG	– National Government
NIUPlan	– Nairobi Integrated Urban development master Plan
NMA	– Nairobi Metropolitan Area
No.	– Number
NPV	– Net Present Value
Nrb	– Nairobi
NTSA	– National Transport and Safety Authority
P&R	– Park-and-Ride
PWD	– Persons With Disability
SCRS	– Syokimau Commuter Railway Station
SDR	– State Department for Roads
SDT	– State Department for Transport
TOD	– Transit Oriented Development
UK	– United Kingdom
USA	– United States of America

CHAPTER ONE: INTRODUCTION

1.1 Background Information

A nation's economy according to Meyer (2016) is greatly dependent on a well-functioning transportation system. The key functions of an effective transport system are mainly mobility and accessibility. These functions also influence land use patterns and affect the lives of many people. A successful modern community in an urban set up requires moving people, goods and services from one point to another which are critical components for its survival in an economic set up.

The urban managers in an urban set up should anticipate the challenges and opportunities that are related to the existing transportation system. Performance aspects are critical to the transportation system effectiveness which impacts on economic and social well-being of the dependent communities. An evaluation of performance of a transportation system begins with review of available data to identify where problems shall originate in the present time or in the future. Developing analysis tools or models to manipulate data and predict future behaviour of a system is therefore crucial (Banister, 1999).

Nairobi City is the capital of Kenya and is the centre of the Nairobi Metropolitan Area (NMA). Due to its significance in administrative activities as well as commercial and industrial growth, the city generates many employment opportunities for people from all over the country and more specifically the metropolitan region. The NMA consists of five Counties, which are autonomous administrative governments, namely, Nairobi, Machakos, Kajiado, Kiambu and Murang'a. These counties may also be referred to as "dormitory counties" because a sizeable population reside in them after their day's work in the Capital.

NIUPlan (2015) notes that NMA has been expanding significantly due to population growth and further continues to experience problems such as worsening traffic congestion, urban sprawl, informal settlements expansion and environmental degradation and deterioration among others. These problems have not been adequately resolved and cause negative economic and social impact on the daily lives of the residents in NMA. Urban developments have occurred without due regard to limitations associated with the existing transport infrastructure and utilities to support increasing developments especially in the urban fringes. This causes many challenges in the urban area.

The increase in urban population in NMA requires provision of requisite transport facilities and services. Due to uncoordinated planning, shortage of resources to implement available plans and fragmented infrastructure development by various actors, NMA has not had sufficient urban transport systems that can effectively cater for the growing urban population. Additionally crucial transport interlinkages between the NMA counties, towns and urban centres which act as employment or residential alternatives need to be given utmost attention in the plans and programmes.

From mere observation, commuting from the neighbouring counties to Nairobi City and vice versa can be seen to be a key economic support activity which requires provision of elaborate and enormous transport facilities and services. However, the level of traffic congestion along the numerous transport routes providing linkages within the NMA has been increasing. NIUPlan (2015) singled out some key factor leading to high traffic congestion which are:

- Lack of an established and integrated Mass Rapid Transit System (MRTS) that cuts across various modes with high passenger evacuation speed and capacity for public use. This has led to over-reliance on low-capacity public transport vehicles commonly referred to as *matatus* (mini-buses and vans) as well as personal cars. The vehicles are exceeding capacity of existing highways, streets, and parking facilities available at a fast rate.

- Delays in development of an elaborate transport network covering the NMA suburban area characterised by ordinary road layouts with bottle necks such as roundabouts and at-grade intersections. These concentrate and slow down traffic. Higher capacity separate-grade intersections that allow seamless movement of traffic in all directions are needed.

- There have been many documented plans for reference in regard to transport development and improvement such as Vision 2030 Development blueprint, Infrastructure Sector Medium Term Plans, Road Sector Investment Programme among others. While these plans are at times conflicting, not all of the planned projects and programmes have been implemented due to budgetary constraints or even misplaced priorities.

- There are no deliberate and systematic interlinkages for the transport network within the NMA as each of the constituent County Governments in the region tend to implement their plans independently.

1.1.1 Urban Railway Transport

The railway line which is the transport mode of focus in this study is known for its effectiveness in moving large number of commuters in cities as trains with numerous wagons can run several trips in a day without unnecessary delays often faced along highways and streets. It is widely used across the world especially in American, European and in the East Asian cities of Countries like Japan, China, Korea and Singapore among others for urban transport. African countries like South Africa and Morocco have also made efforts to utilize railway systems for mass transport in their cities and towns and Ethiopia has recently introduced electric trains in Addis Ababa.

In Kenya and precisely the NMA, urban railway transport is operated by Kenya Railways Corporation (KRC), an agency of the Ministry of Roads and Transport (MoRT) of the national Government of Kenya (GoK). Commuter railway transport operations are conducted on the existing Medium Gauge Railway (MGR) which was constructed by the British government prior to attainment of independence for the Republic of Kenya. The MGR has low speeds with diminished haulage capacity as it relies on diesel engines.

In the recent past, there has been minor extensions to the MGR with relatively new stations developed with parking facilities to enable users of personal cars to park at the stations and ride the commuter train, in what is popularly known as Park-and-Ride (P&R) concept. The following stations so far have been constructed along the Nairobi – Mombasa MGR line to serve commuters:

(i) Makadara Commuter Railway Station .
(ii) Imara Daima Commuter Railway Station.
(iii) Syokimau Commuter Railway Station; and
(iv) Athi River Commuter Railway Station.

There has also been extensions of operations to mainly pick or drop commuters from Kitengela and Lukenya Stations located to the south of Athi River Station. KRC has also introduced Diesel Multiple Units (DMU) to improve haulage and journey speeds in the Syokimau commuter railway route and railway connector bus from the Nairobi Central Station to working zones in the capital like Upper Hill among other areas.

1.2 Problem Statement

Performance and condition attributes can be used as criteria to evaluate effectiveness of infrastructural investments done on a transportation system (Meyer, 2016). The GoK through

KRC has invested millions of shillings to develop the P&R stations mentioned above. Key cost components include construction of extension lines to some of the new stations, station buildings, storm water drainage infrastructure and large parking areas for commuters using personal cars. To derive value for money for such investments, it is expected that these facilities should functionally perform as suitably designed.

Of concern are P&R stations that have not been utilised effectively and efficiently raising public attention as to their suitability in terms of planning, operation, and future sustainability. One key station is Athi River Commuter Railway Station (ACRS) whereby the provided parking has been observed to be nearly empty during weekdays when operation of the train services is peak. An immediate neighbouring station towards the City Centre of Nairobi, i.e., Syokimau Commuter Railway Station (SCRS) has also been recently observed to have had a significant drop in car numbers parked by travellers during weekdays unlike its early years of its commissioning and operation.

While the introduction of P&R stations in the NMA may be considered as one way to reduce cars in the main highways to the CBD and consequently alleviate traffic congestion, under-utilization of the parking facility which has already consumed public funds to construct tends to be considered as a waste of public resources as it fails to ameliorate increased car use along the highways to ease traffic congestion. The parking development in the station may therefore not measure up as an effective infrastructural investment for public gain.

Meyer (2016) states that parking need not to be over-prescribed. The goal of a parking plan should be finding the correct balance among competing alternatives. These are providing adequate parking that supports the utilization of the public transit facility and minimizing the negativity of excessive land area and resources that are committed to parking. Effective parking supply is determined by the level of occupancy for optimum operating efficiency. A further observation by Meyer (2016) is that a parking lot may be perceived to be efficiently used when its occupancy threshold is generally in the range of 85% to 95%.

The perceived low parking utilization at the stations is what triggered the researcher to study the performance of P&R stations in NMA and focused on comparing the two stations, i.e. Athi River and Syokimau Stations.

1.3 Study Objectives

The objectives of the study are:

(i) To investigate the best practices in planning and development of P&R stations.

(ii) To establish the influence areas and their significance in contributing to ridership numbers to ACRS and SCRS.

(iii) To find out the utilization levels of the P&R service at ACRS and SCRS and reasons behind such levels.

(iv) To determine the suitability of ACRS and SCRS as P&R stations and make appropriate recommendations towards their improvement.

1.4 Research Questions

The study seeks to find answers to pertinent questions as follows:

(i) What are the best practices in planning and development of P&R station?

(ii) Which are the key influence areas significant in contributing to ridership numbers to ACRS and SCRS?

(iii) What is the utilization level of the P&R service at ACRS and SCRS and the reasons behind the levels?

(iv) Are ACRS and SCRS suited as P&R stations and if not, how else can they be improved to function optimally?

1.5 Justification for the Study

Among the key recommendations made in the NIUPlan 2015 was development and implementation of MRTS which not only covers Nairobi City but also extends to the neighbouring Metropolitan Counties of Machakos, Kiambu and Kajiado. Subsequently, various arms of the GoK dealing with transport infrastructure development began implementation of some proposed programmes to solve the urban transport problems of the NMA. Key agencies that have since embarked on urban transport developments and improvements in NMA include the Kenya Railways Corporation (KRC) and a recently formed metropolitan transport authority, the Nairobi Metropolitan Area Transport Authority (NaMATA).

In terms of railway development and operation, KRC is the only mandated agency by Kenyan law to establish and operate railway transport activities. For that matter, KRC in coordination with other actors in the transport sector have embarked on an ambitious programme to improve urban railway transport facilities within the NMA. At the moment, these improvements have been achieved through:

a) rehabilitation of the existing MGR line.
b) creation of vital extensions of the railway to proposed new commuter stations.
c) construction of new commuter railway stations as necessary in the NMA; and
d) acquisition of the rolling stock, i.e., wagons and diesel engines for railway transport operations (KRC website, 2023).

To attract users of personal cars to the commuter railway transport and reduce congestion levels along the main arterial roads, new railway stations are being built with parking facilities to enable users of personal cars to park and ride the commuter train. Along the main MGR line that runs from Nairobi to Mombasa, revamping of the Nairobi Central Station has been undertaken and new pick-and-drop or P&R stations constructed.

However, the Athi River Train Station has witnessed very low users of personal cars by a simple observation of car numbers parked at provided parking slots as compared to the immediate station towards Nairobi City, Syokimau Station. The photograph images **Figures 1.1 and 1.2** here below present a visual comparison of the Stations.

Figure 1.1: Syokimau P&R Commuter Railway Station (Source: Author, 2023)

Figure 1.2: Athi River P&R Commuter Railway Station (Source: Author, 2023).

Spillar (1997) alludes that individual lots of P&R facilities lacking successful demand characteristics depict an exaggerated transit system that is not efficient and therefore a classical waste of public funds. This observation justifies the need to assess performance and therefore the study subject.

1.6 Significance of the P&R Study

The study is on performance of P&R stations in NMA and targeting Athi River and Syokimau Stations. The study is expected to benefit the government agency concerned, i.e. KRC and other interested parties like urban managers in the field of urban public transport development matters in deciding on the model of a commuter station to apply. This will not only apply in the Nairobi metropolis but also in other rapidly urbanising centres elsewhere that might want to adopt P&R concepts.

The study will make contribution to existing literature on planning and development of a P&R station, a form of an Intermodal Transfer Facility (ITF) and the emerging challenges from the NMA case. It shall give recommendations on informed strategies in actualising successful P&R schemes to ensure optimal utilization and value for money. Additionally, and for purpose of academic contribution in the field of mass urban transportation systems, future researchers will use this research as a foundation for advanced research in the thematic area.

1.7 Scope of the Study

1.7.1 Geographical scope

The study was based in Mavoko Sub-County of Machakos County, the geographical location in which both ACRS and SCRS are situated. The study focused on the performance of the

stations as P&R facilities supporting the urban railway transport in NMA, their influence areas and suitability to serve the P&R function as appropriately established from best practice for such facilities. The extend of the geographical boundaries for the study areas are further defined in Chapter 3 on Situational Analysis.

1.7.2 Theoretical scope

The theories applied by the researcher to underpin this study included Systems theory, Actor-Network theory and the Rhizomes theory.

1.7.3 Methodological scope

The study is quantitative and qualitative in nature. The research sample comprised of 57 and 62 respondents drawn from ACRS and SCRS respectively. It also included interviews with Stationmasters for the two stations as well as headquarters staff for the railway management. The primary method of data collection employed was questionnaires which were used to determine views and perspectives of the target population on the P&R service performance.

1.8 Limitations of the Study

Whilst time and financial resources were the main limitation of the study, it is to be noted that a few stations (Athi River, Syokimau and Imara Daima) are of the P&R concept in the entire NMA with ACRS case observed to be on the extreme side in terms of parking utilization levels. Thus, the study was limited to two cases in evaluating and comparing performance, i.e. ACRS and SCRS.

1.9 Delimitations and Exclusions of the Study

Urban public transport can be very broad and more so in the developed world where various forms of urban railway commuter transport facilities like Light Rail Transport (LRT), Monorails or even cable cars may be found. This study specifically is a focus on the urban commuter rail in NMA and the subsequent P&R stations to support its functioning. P&R stations are emerging as one way to avoid use of personal cars to access the CBD and ease traffic congestion on heavily trafficked corridors of Nairobi City and NMA.

Basically, other forms of commuter stations that may be found in NMA are quite straightforward from a physical and operational sense as they comprise simple sheds with some rest benches and entail picking and dropping of passengers.

However, it should also be noted that review of P&R schemes and concepts at global level has been given attention in Chapter 2 on Literature Review.

1.10 Research Proposition

A research proposition for this study has been derived from observations on the performance of stations. The proposition is that the ***car parking provided at Athi River Station has low utilization as compared to that of the Syokimau Station***.

1.11 Research Assumptions

This study made the following assumptions:

a) Rapid urbanization continues to take place in the NMA and more so in the residential districts of Kiambu, Machakos and Kajiado Counties. These areas shall generate working populations that need to commute to the Nairobi City CBD. Commuting in turn require requisite public transport means and not personal cars due to increasing traffic congestion.
b) This paramount need for mass transport means calls for transport and infrastructure undertakers in the public and private sector to think through conceptualization, planning and development of efficient and effective commuter transport facilities to serve the urban population effectively.

1.12 Organization of the Study

This study has been organised into five chapters. Chapter One is Introduction which covers the background of the study, the statement of the problem, the objectives of the study, research questions, justification of the study, significance of the study, the scope of the study, limitations and delimitations, research proposition and assumptions of the study and the definition of key terms used in the study.

Chapter Two is basically literature review of written work pertaining to the study area whereby investigation of applicable theories and philosophies of relevance to park and ride concepts is done. The review of written materials then explores the development of P&R systems across the world and some applicable practises to actualise functional schemes. A conceptual framework is also devised by the author in this chapter with research gaps forming the last part of it.

Chapter Three is a situational analysis of the transport governance arrangements in Kenya, the land use plans and supporting infrastructure around the stations and elaboration of the settings of the research stations. These are examined to give insight into making appropriate recommendations in Chapter 6.

Chapter Four discusses the methodology employed to undertake the research, which covers research design, data sources, target population, sample sizing and sampling procedure. Moreover, it discusses further the data collection instruments and their validity and reliability. The structure of main research instruments (the questionnaire and interview schedules) are similarly discussed in this chapter in terms of the questions and data they are expect to collect, the main unit of analysis and the presentation techniques. This chapter additionally discusses ethical considerations in the study and culminates in the overall research operationalization matrix.

The Fifth chapter is about data processing, interpretation, presentation and findings discussion as deduced from field investigation in accordance with the study's goals and the inherent challenges encountered during field investigations.

The Sixth and final chapter is a summary of the study findings and conclusions with recommendations and suggested areas of further research forming the last part of the chapter.

1.13 Definition of Terms

At-grade intersections – A layout of roads and streets where convergence is at horizontal plane with traffic movements cutting across one another such that traffic control measures must be employed to allow movement from one direction at a time.

Boda-boda – A public transport means operated by tricycles, motorcycles, and ordinary bicycles. The term is commonly used in Kenya.

County Assembly - the legislative arm of a County Government equivalent to Parliament of the National Government.

County Government – The constitutional regional governments in the republic of Kenya headed by Governors. Kenya has a total of 47 County Governments.

Intermodal Transfer Facility - a facility that allows a traveller to transfer from one mode of transport, e.g., a private vehicle to another, e.g. public transport means like a train.

Mass Rapid Transit System – any system of transport designed and developed with high capacity to evacuate large number of travellers continuously from one place to another with speed.

Matatu – a term used in Kenyan transport sector which commonly refers to a vehicle smaller than a bus but larger than a five-seater passenger car licensed to carry out public transport.

MPesa – a system of electronic payment via mobile phone that is acceptable and extensively in use in Kenya.

Para-transit – a term used to define low-capacity transport vehicles ranging from three wheelers to vans. These include matatus and boda boda riders.

Park-and-ride – a term used in urban transport whereby a traveller leaves a private vehicle in a parking and transfers to some form of public transport to continue with his journey.

Pick-and-drop – a term introduced in this study to signify the operations of a public transport vehicle involving stopping or waiting for passengers to board or alight at a designated point along the public transport route.

Ridership – refers to the number of passengers using a public transport means like a train or a bus.

Separate grade intersections – A layout of roads and streets where convergence is at different vertical levels which eliminates traffic conflicts and allows independent, smooth and continuous traffic movements.

Sidewalk – a narrow street constructed parallel to the main vehicle lanes specifically dedicated for pedestrians to walk along.

Sub-county– a unit of administration in a County Government smaller than the County itself and bigger than a Ward. Several sub-counties make up a County Government while several Wards make up a Sub-county.

Ward – the smallest administrative unit in a County Government represented by an elected Member of County Assembly (MCA).

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Based on the problem statement and objectives of this research project, a review of the available literature on the subject matter was undertaken. The review focused on the historical information on development of the P&R concept across the world and exploratory reviews on practices or approaches towards realization of functional P&R systems in the urban transportation context. The literature material reviewed included peer-reviewed journals, handbooks, guidelines and manuals in urban transportation, reports, periodicals, working papers, past studies in the research field as well as websites.

2.2 Broad Definition of Park-and-Ride

Meyer (2016) defines a P&R station is a facility that allows a traveller to transfer from a private vehicle to some form of public transport. Parking facilities found at airports, train stations, and other transportation transition stations are such examples. A P&R may also be defined as a parking that has public transport connections to allow travellers heading to city centres to leave behind their passenger cars and transfer to a bus, commuter train or even carpool for the remainder of the journey. In a broader definition, a P&R station can also be referred to as Intermodal Transfer Facility (Kaneko, 2014).

P&R stations tend to be located in the fringes of large metropolis and allow commuters to avoid a stressful drive attributed with congested urban roads and the ultimate search for the scarce and expensive parking at the city centre (Meyer 2016). P&R stations have passenger waiting areas and convenience point like toilets, provide travel information over leaflets or posters and even extra services such as a travel office, shopping malls, food shop, car wash, or cafeteria (Kaneko, 2014).

2.3 Historical Background of the Park-and-Ride Concept

The first formal P&R stations were introduced in Detroit in the 1930s (Noel, 1988) and the early adopters of the facilities were often motorists who had previously been used to park informally at the outskirts of the CBD (Heggie and Papoulias, 1976). These were first implemented in United States of America (USA) and Britain as well. P&R became more prevalent in the USA after the 1968 Federal Aid Highway Act. The Act enabled planning authorities to request reimbursements from the Federal Government of up to half of their P&R development expenses (Noel 1988).

According to an article in the Oxford Mail (2013), P&R facilities encompassing dedicated parking lots and subsequent bus services began in the United Kingdom (UK) in the 1960s. Oxford City was the first of its kind to operate such a scheme then, initially beginning as an experimental service operating part-time on major trunk road in England before transitioning to full-time basis from 1973.

Congestion became one of the foremost objectives for the UK government's ten-year plan, published in 2000 and remained the top policy agenda. A New Deal for Transport White Paper of 1998 also by the UK government had called for more cities and towns with P&R schemes and advocated a system founded upon high quality P&R schemes to avoid people driving into congested town centres (Manns, 2010). Local authorities then began to draft local transport plans, including strategic plans and fourteen more authorities wished to develop bus-based P&R schemes. Together, these schemes represented a new broad-brush approach on P&R being promoted through policy (Manns, 2010).

The UK Government cited the Cambridge P&R system as demonstrating how transport integration can increase patronage through their Future of Transport White Paper of 2004. By 2008, permanent bus-based P&R schemes were generally under implementation in medium-sized towns and cities, with extensive conurbations such as London, Birmingham and Manchester which operated rail-based schemes. In the year 2015, Oxford City had the biggest urban P&R network in the entire UK with a capacity of over 5,000 car parking spaces (Manns, 2010).

In the United States, outlying rail stations are commonly characterised by automobile parking with hundreds of spaces. The Houston Intermodal Transit Centre is another example of a hub for local, commuter, and intercity transit in Houston City of Texas State, USA. East Asian countries like Japan have also created P&R stations in various cities to cut down reliance on use of cars (Kaneko, 2014).

P&R schemes don't have to necessarily involve public transport. They can be provided for purposes of reducing the number of cars on the road by way of promoting carpooling, vanpooling, and car-sharing. Partly due to concentration of riders, these P&R terminals often have direct transit services going into the CBD area with a large percentage of high-occupancy vehicles (Oxford Mail, 2013).

2.4 Practises to Actualise Functional Park-and-Ride Schemes

The P&R stations under review in this study are some forms of suburban P&R lots. As the name suggests, suburban P&R lots are located at the urban fringe zones. Their chief function as defined by Spillar (1997) is to collect potential commuters in transit as close to their homes as possible and to transfer them to a long-haul often express transit service. The facilities are solely dependent on the car as the collection and distribution mode while the trunk-line transit routes (bus or rail) provide the long-haul component of the remaining trip.

The most important factor for a successful and well-functioning sub-urban P&R facility is its ability to attract cars users to park their cars and transfer to a public transport system to continue with their journey and vice versa for the return trip (Spillar, 1997). In this regard, two key factors can gauge how well the P&R facility is performing, which are the parking utilization levels and the ridership numbers generated ((Hamsa *et al*., 2021, p. 982).

P&R facilities, by their nature, are capital-intensive investments that can be leveraged in the marketplace. Rather, the P&R facility can also be whatever the community wishes to make of it. They constitute an integrated part of the urban fabric or a single use facility (Spillar, 1997). This therefore emphasises why the opinion of the people is critical during conceptualisation and planning of the P&R schemes. The researcher is of the opinion that an integrated approach in actualizing P&R schemes is preferable in developing a successful facility.

2.4.1 Land Use and Urban Transport Integration

Land developments for particular uses results in the generation of new trips originating from that area or new trips attracted to that area, or both. Development of urban land creates demand for travel, and thus the need for adequate urban transport infrastructure to facilitate sustainable urban development (Banister, 1999).

Development or improvements on urban transportation systems and infrastructure again makes land more accessible to previously distant existing activity centres, thereby making it more desirable and affecting its monetary value. Increased accessibility and improved land values in turn influences the locational decisions of individuals and firms, once again spurring new land development and starting this cycle again until an equilibrium is reached or until some external factors intervene (Meyer, 2016).

Land uses support urban activities, which may be spatially separated. People need transport to transition from one point to another so as facilitate specific economic activities, e.g., from home to work, from home to shopping, back home from work and shopping for instance. Transport is a derived demand, in that transport is unnecessary except for the activities pursued at the ends of trips (Banister, 1999).

Good land use practise keeps interrelated activities close e.g., housing and food shopping and places higher-density developments closer to transportation lines and hubs. Poor land use tends to keep activities far from others. In brief, land use and transportation systems are closely entwined. Models used in transportation planning need to be integrated with land use models to support the resultant land use activities (Waddell 2011).

In summary, as cities expand and traffic congestion increase, the need to control use of private vehicles instantaneously becomes necessary and concepts like P&R begin to emerge. Effective transport network linkages and extension techniques then need to come into play as well to solve transport-related problems (Liao & Bothe, 2015).

2.4.2 Urban Transportation Modelling

The transportation planning and modelling process gives us an orderly and systematic framework for estimation and prediction of urban traffic flow. First steps address questions like what is it that causes trip making or what environmental circumstances lead to the production or attraction of traffic. It is estimated that between eighty and ninety percent of all urban trips are generated by residential areas whereby the basic trip-generating unit is the individual household. The number of trips generated tends to be dependent on the number of cars owned and income, among other characteristics.

Many of the attempts to estimate transport needs have suffered from the absence of any development goals that could provide a picture of what the transport system will be called on to do. In several countries, goals have been established, but the techniques for translating developed objectives and potentials into transport requirements have been inadequate. The problem calls for national and regional planning processes that can provide the framework for transport plans, their execution, and their adjustment to changing conditions. This provides a basis for estimating transport needs.

Owen (1964) observes that the cost of providing adequate transport in large cities is a heavy burden to developing countries and even effort to cope with the problem have not permitted an escape from the consequences of congestion. He notes that the first step in planning for

any transportation need is to immediately identify all the needs that are urgent, and then to establish the order in which these improvements should be accomplished to produce the most significant results. Owen (1964) observes that data availability establishes the dimension of the transport task and the extent to which additional transport capacity or improved quality will be required. Where such needs are indicated, the added question is whether existing facilities can be made to perform more efficiently or whether additional capacity is needed to meet the transport demands.

2.4.2.1 The Public Transport-Oriented Approach

Whether they are road-based or rail based, public transport systems like P&R are associated with less energy consumption (energy efficient), emit less airborne pollutants, minimize the land size used for transport infrastructure purposes (including CBD parking) thereby resulting in better physical environments in urban areas. However, people are unlikely to turn to public transport systems unless the cost is reasonable and there are clean, comfortable vehicles with regular, predictable and reliable service (Owen, 1964).

The railway is one of the most effective means to service densely populated cities with relatively long journey-to-work distances, which normally runs alongside radial corridors with congested roads which are central area or CBD oriented. Because of high cost of provision of railway systems in the urban areas, making the full use of the available infrastructure is key. Thus, schemes like P&R stations come into play to turn around and enhance the success of existing railways extending into the suburban areas to enhance effectiveness and efficiency.

2.4.3 Planning for Park-and-Ride Schemes

The metropolitan environment for many cities and the prevailing governance structure can complicate the whole process of planning and developing P&R schemes. The mandated agencies and regional governments may want to construct such facilities but only the transit authority may be responsible for providing and operating the main transit line and associated infrastructure, like the Kenyan case of KRC versus the NMA County Governments.

Spillar (1997) observed that this situation requires the transit authority to be the primary participant in the planning process. However, the conceptualisation, planning, design, and development of a P&R station, being an Intermodal Transfer Facility (ITF) requires a structured process right from city planning, normally a preserve of regional governments, to ensure the facility is in harmony with city development masterplans or blueprints that have

focus on land use, among other reference documents. The flow diagram **Figure 2.1** below by Kaneko (2014) summarises the whole process.

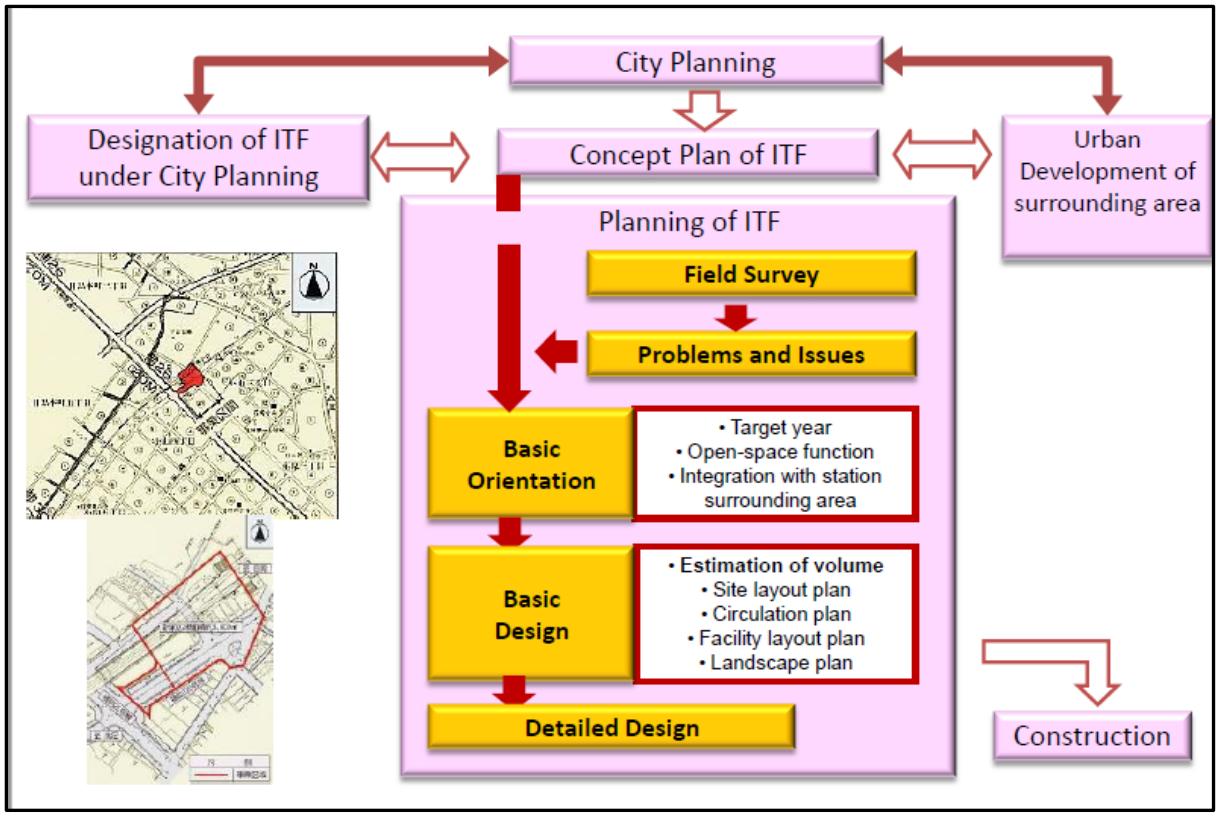

Figure 2.1: A Representation of ITF Delivery Process (Source: Kaneko, 2014).

In any economy, budget constraints and shrinking funds for capital projects are often the main issues to content with. Thus improved planning processes need to be employed in the development of P&R and other multimodal facilities. Developing a comprehensive system plan inclusive of P&R facilities before developing other individual elements or facilities within that overall system plan is therefore important. P&R facilities need to connect with the regional transportation network in terms of suitable site location to ensure their effectiveness (Spillar, 1997).

Incorporation of effective planning and architectural design can ensure that the suburban P&R facilities serve as major transit centres, becoming focal points for the communities they serve. Spillar (1997) observes that these P&R facilities establish a transit presence which reflects a continuing commitment to the ever growing suburban market and can encourage transit-friendly developments with land use densification within walking distances when appropriate land use policies are applied.

In principle, urban managers need sensitivity to community issues and the people they are serving, and every effort is needed to use customary planning processes tailored to fit the host society and the local planning environment. Their role thus in the system planning process tends to be largely one of facilitator and information gatherer. The participating agencies, the community, and all other concerned stakeholders have a key decision making role to assure broad acceptance of the plan (Spillar, 1997).

2.4.3.1 The Inter-modal Transfer Facility Concept

Kaneko (2014) concisely makes a case for the following to be put into consideration in deciding the conceptual nature of an Inter-modal Transfer Facility (ITF) such as P&R facility:

- As a **transport hub** for ensuring smooth transfer from one mode to another mode. Facilities associated with smooth transfer include bus terminal, bus berth, waiting space, riding/dropping space for private car and taxi, private car parking space for P&R, motorcycle and bicycle parking space, pedestrian deck, resting spaces, and sidewalks. **Figure 2.2** below represents this narrative.

Figure 2.2: Bus Terminal Infront of Railway Station and a Car Park in a P&R Station (Source: Kaneko, 2014).

- As a **place to revitalize** the urban location or district where the facility is situated thereby promoting community interaction. In this regard, some commercial and recreational facilities need to be given consideration depending on the neighbourhood character. This is again better visualised in **Figure 2.3** below.

Figure 2.3: A Station Plaza with Green Spaces & Benches at Waiting Spaces in a Station (Source: Kaneko, 2014).

Another case of an enhanced ITF exemplifying transport hub and revitalisation of open space concepts is depicted in **Figure 2.4** here below.

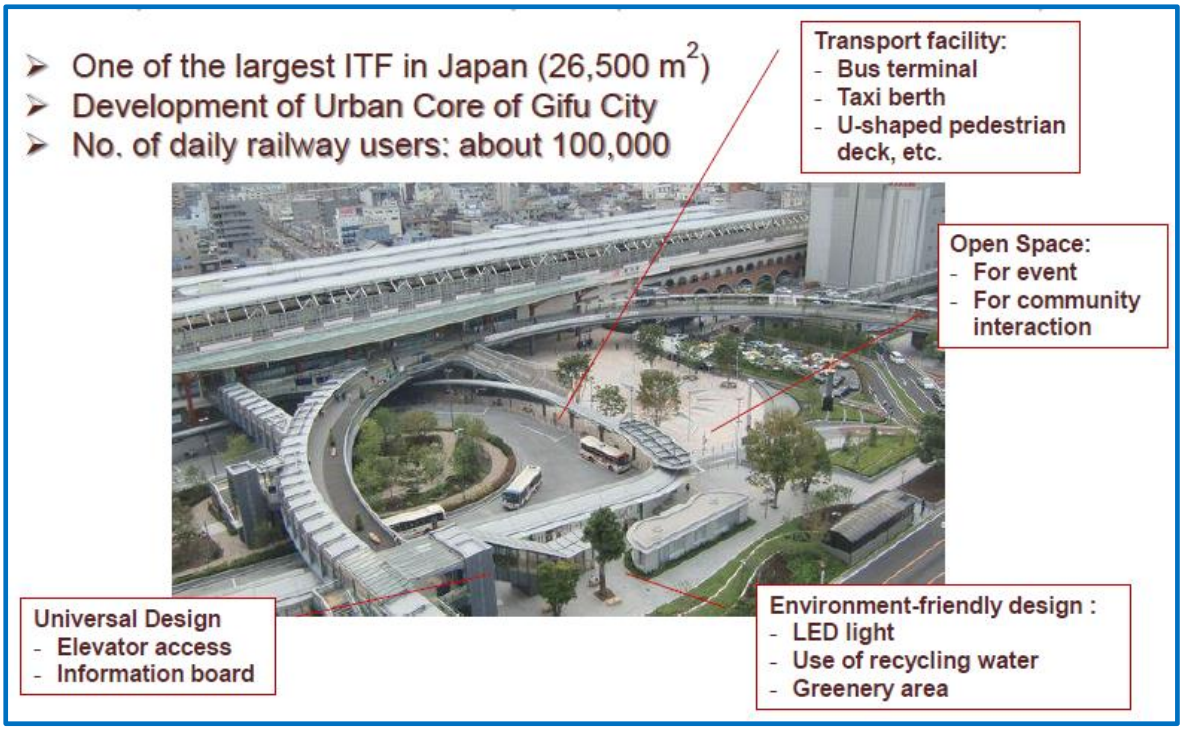

Figure 2.4: Gifu Station in Gifu Prefecture of Japan (Source: Kaneko, 2014).

The primary objectives and advantages of a community-compatible or integrated P&R facility. These include:

- Adjacent residential, service-oriented, and commercial land activities can provide transit patronage, services and security to the transit agency operating the P&R facility. Attractive designs providing high visibility can engender a sense of community ownership and stewardship.

- Adequate attention to pedestrian and bicycle facilities, both on-site and in the surrounding developments, encourage a multimodal use.
- Public investment in an integrated transit facility can serve as a focal point for suburban community development.
- Increased massing of transit facilities and surrounding land uses increase the visibility of public transit and create a potential for future markets.
- Centralizing transportation services increases accessibility to surrounding land uses and the community (Spillar, 1997).

2.4.3.2 Facility Location Decision

Selection of the appropriate location for any facility can be a difficult element in the planning process. Further, optimization of the location tends to be complicated due to limited site options available to the implementer. According to Spillar (1997), the existing developments, environmental constraints, inadequacy of available alternative sites, and the fixed location of transit route line for buses or trains are the challenges faced by the implementers. The optimum P&R location then becomes the site which best meets a threshold of pre-determined needs while ensuring the ridership demands are peak. This will provide acceptable cost-benefit performance ratios for the facility.

Since it is nearly impossible to obtain a location that provides all the desired site characteristics, the only practical approach is to evaluate all the potential locations in terms of their ability to meet effectively substantial requirements as enivsaged. The following checklist of site selection criteria can be applied in making location decisions: -

a) Assurance of strong patronage demand – on a rule of thumb basis, decisions on the suitable location of applicable site alternatives for evaluation among other patronage factors:

(i) ***Geographic affinity to the centres of activity served.*** The requirement here is that the proposed facility needs to be situated in an area that display strong origin-destination trip interchange traits with the primary activity point which is typically the metropolitan CBD. The spatial area on the upstream side of the lot should adequately demonstrate suburban or urban residential densities to supply the acceptable threshold of ridership demand for the facility.

(ii) ***Minimize access time by automobile.*** Vehicular access to the P&R facility needs to be as convenient to users as possible with delays minimized considerably.

(iii) ***Maximize the facility's visibility.*** Every effort should be made so that the facility is not invasive and is in harmony with the surrounding environment. The P&R facility should also be highly visible from the primary corridor of travel. Increased visibility will curtail the need for additional publicity signage and advertising (Spillar, 1997).

b) Provision for integration with the community – A suitable P&R site integrated with the surrounding community is desirable for enhancement of security of such locations and the economic benefit it brings to area in terms of businesses. The P&R facility will have the ability to develop a transit-oriented suburban market.

c) Reduction of the financial impact and risk to the responsible agency – The utilization demands for the P&R facility needs to be kept high. This will contribute significantly to a site's ability to provide minimal cost impacts and reduce the financial risk to the agency. Trade-offs between expected life-cycle operating costs and capital costs of site acquisition and construction should be evaluated using a suitable economic appraisal tool, like net present value (NPV) analysis. Competition with local operators for public transport needs to be avoided within the same area as this could make it easily fail especially when a cost differential is prevalent between the two services and in favour of the existing alternative. Rather, P&R should rather be designed to complement the existing local service.

2.4.3.3 Influence Area and Demand Estimation

The influence area for P&R facility is critical to establish as this will be the source of users of the facility. This includes getting the current daytime / night-time population and the future development potential. If a feeder bus network is required, estimation of the coverage area has to be determined (Kaneko, 2014).

The station influence area can range from 1km to 5km radius or even more, depending on the intensity of developments, available transport options and inherent needs connected to use of the station in the surrounding. The influence items, area and planning components are summarised in **Table 2.1** below.

Table 2.1: Setting of a Station Influence Area (Source: Kaneko, 2014)

Item Description	Influence Area	Planning Component / Urban Activity
Inter-modal Transfer Facility (ITF)	Area within legally defined station properties and adjoining area up to 100m	• Station buildings or plazas with underground or ground level space. • Entrance/exit including direct access points/links • Bus terminal, taxi stands. • Parking areas, open space.
Station Coverage	The station coverage area includes area directly surrounding the station from a range of 100m radius up to 1 km walking distance to the station	• Various residential, commercial, manufacturing or industrial establishments and community facilities like hospitals, schools and churches. • Supporting infrastructure network like roads, electric power, water, sewerage, fiber-optic cable). • Feeder transport facilities and services (para-transit, mini-buses).
Station Catchment Area	Area from over 1km to 5Km radius that can be connected to the stations by feeder services	• As for Station Coverage but feeder transport facilities and services may be more enhanced like connector bus or light rail)

The demand estimation for an intermodal transfer station (ITF) requires consideration of the existing condition characterized by current users and a future demand forecast. In making these considerations, the in-transit user and the non-transit users should be factored. The diagram **Figure 2.5** below illustrates the volume estimation process.

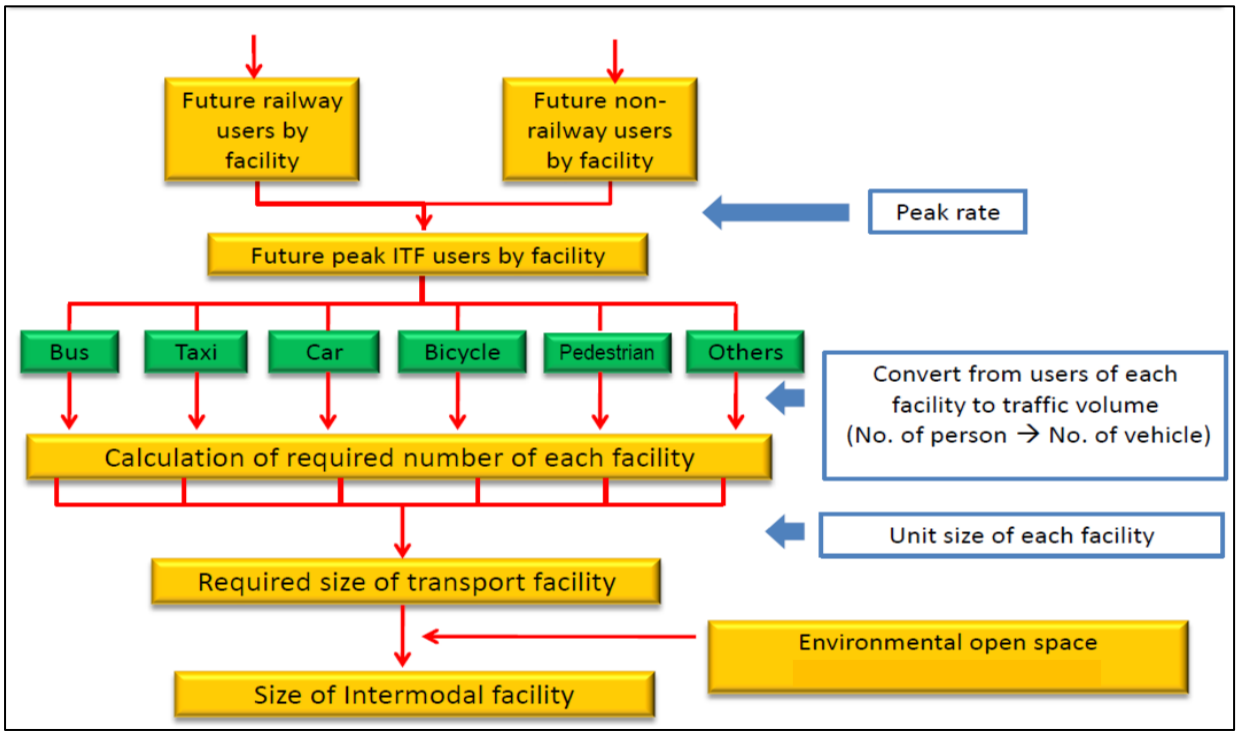

Figure 2.5: Volume Estimation to Size an Intermodal Transfer Facility (Source: Kaneko, 2014).

2.4.3.4 Feeder Transport Network for Park-and-Ride Stations

Comprehensive public transport network is normally composed of a high capacity MRTS like a railway network with feeder services for the public which include buses, paratransit (matatus and boda-bodas), shuttle-bus services and taxis. The feeder services also include personal cars to and from specific facilities. The feeder transport network provides complementary or supporting services to the railway network in addition to the critical role of providing access to the suburban or hinterland areas and thereby expanding the coverage area and influence zone for the P&R station.

All the anticipated feeder transport services will run on a network of roads. In urban areas, some roads are normally designated as public transport routes which means buses and other public transport vehicles operate along these routes. Other roads are purely for ordinary traffic which may comprise some commercial vehicles as well as passenger cars. There is thus an evidential need to adapt and improve the existing transport routes and linkages that are determined to handle all the traffic to the P&R facility (Kaneko 2014).

The transit operator managing the P&R station and generally the railway company in most cases may have no authority to work on the road corridors. This implies that collaboration with the local or regional government under whose jurisdiction the P&R station lies or other

government agencies mandated to develop and maintain roads depending on the governing institutional framework (see also Chapter 3) will be of utmost importance to achieve this objective.

2.5 Conceptual Theories Underpinning the Study

The researcher adopted some theories or models that were found to be applicable to underpin the study. The theories found to be relevance to the study were the Systems theory, Actor Network Theory and Rhizomes Theory. These were useful lenses for viewing and understanding P&R systems and commuter related behaviour.

2.5.1 Systems Theory

Systems theory is based on "*the conception of phenomena as '**systems**', which are themselves coherent entities composed of interconnected and interdependent parts (Taylor, 1998)".* Systems theory is interdisciplinary and applies to virtually all systems in nature, society, and many scientific areas. It is the framework for investigating events from a holistic perspective (Capra, 1997). The shift in attention from viewing systems as parts to taking them as whole components leads to systems thinking, which views "*observed reality as an integrated and interacting unique phenomena in which the individual properties of the single parts become indistinct* (Jackson, 2003).

According to the systemic perspective by Bertalanffy (1968), we cannot fully comprehend a phenomenon when it is broken down into elementary parts. Although we can begin by analysing the fundamental components of an event, we must observe it from a higher level in order to properly appreciate it in its entirety, i.e. a holistic perspective. Therefore, systems theory is a theoretical approach that considers a phenomenon in its whole rather than its pieces. To understand how an entity is organised to function and deliver some predetermined outcomes, the focus should be on interactions and relationships between pieces.

A closer look at a P&R station ecosystem reveals some key determinants in its functioning contributing to each other and therefore forming a system. These include the urban land use generating various urban activities and the urban transport infrastructure to support the urban activities. These determinants can affect how the P&R facility will perform and therefore have to be taken care of in deciding the concept or model of the facility.

This theory is thus quite applicable to the study in understanding the relationships between the constituent parts of an intermodal transfer facility like a P&R station and its functioning

which is derived from the constituent parts, all forming a system. The planning, development and operationalization of P&R should be viewed with a systems functionality lens.

2.5.2 Actor-Network Theory

The Actor-Network Theory (ANT) according to Muniesa (2015) was first developed at the Center for the Sociology of Innovation (CSI) of the National School of Mines of Paris, a college distinguished for the outstanding performance of its research centres in the early 1980s. This was done by staff Michel Callon, Madeleine Akrich, Bruno Latour and visitors, including John Law. The term actor-network theory was coined by John Law in 1992 to describe the case studies carried out in different areas at the CSI at the time.

An actor (actant) is something that acts or to which activity is granted by others. An actant can literally be anything provided it is granted to be the source of action (Jackson, 2015). For example, in the "Pasteur Network", microorganisms are not inert, they cause unsterilized materials to ferment while leaving behind sterilized materials not affected (Jackson, 2015).

Akrich (2023) advances that ANT is best known for its controversial insistence on the "*capacity of non-humans to act or participate in systems or networks or in both"*. It can more technically be described as a *"material-semiotic"* method. This means that it maps relations that are simultaneously material (between things) and semiotic (between concepts). It assumes that many relations are both material and semiotic (Akrich, 2023).

In the context of P&R schemes and equally functional transportation systems, material things include land, infrastructural facilities or even the technology to apply while the semiotics are the policies and guidelines available to shape development or even the facilitative government services among others to enable smooth functioning and performance of the entire facility. The actors in this case whether human or non-human are aligned to some goals to achieve. The diagrammatic illustrations in figures 2.1, 2.6 and 2.7 in this report are manifestations of the actor network principles in play.

2.5.3 Rhizomes Theory

Rhizome is a concept that describes a nonlinear network that "connects any point to any other point" (Deleuze & Guattari, 1987). It appears in the work of theorists Deleuze and Guattari (1987), who used the term in one of their books to refer to networks that establish *"connections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences and social struggles*". It is a concept in post-structuralism, whereby post-structuralism refers to "*a way of thinking that emphasizes the radical uncertainty of knowledge; particularly knowledge in language and posits that "truth" is not a fixed concept,*

but instead constantly changes based on your cultural, political, social, and economic position in the world" (Bensmaïa, 2005).

A rhizome is purely a network of collections that are tree-like, or hierarchical with properties similar to lattices. Rhizomes mark a horizontal and non-hierarchical concept. Rhizomes are heterogeneous linkages between things. For example, Deleuze and Guattari (1987) linked together desire and machines to create the concept of desiring machines.

The applicability of Rhizomes philosophy in the context of urban transportation can be seen through the interlinkages between transport and land use which are heterogenous but quite inter-related. They are interlinked in the sense that what is originating from the land requires to be transported via existing infrastructure. In urban transport, the passenger or commuter desires to travel using a particular means and expects some certain performance levels (dependent variable) from the facility say faster and comfortable trains (independent variable). The whole chain involving commuter generation from abutting land use to commuter translocation from one place to the other by the available means of transport with their efficiencies or deficiencies is a pure example of heterogenous links under Rhizomes philosophy which is very relevant to this study.

2.6 Empirical Framework

As defined elsewhere, an urban transportation system is a basic component of an urban area socio-economic and physical structure (Meyer, 2016). Urban transit is regarded as a major factor in the growth of cities and its significance should remain at the heart of urban managers aspiring to succeed in managing cities. The development of a town's transportation system provide opportunities for mobility and over time influences pattern of growth as well as the level of economic activity through the accessibility and linkages provided to land thus promoting land use.

Transport improvements can decrease the price of commuting depending on the magnitude of improvements and their effectiveness while simultaneously increasing the economic land use value proposition of an area. Similarly, urban development influences public transportation and the process of urban growth influence the spatial form of cities which in turn affect how people get about and around as they access urban services. Urbanization and transportation are extricable, contributing to each other and being affected by each other.

An inter-relationship between land use generating a resident population which creates travel demand and subsequently transportation infrastructure needed to support this demand is illustrated in Figure 2.6 below. Transport infrastructure in turn activates more land use by improving mobility and access while it also requires land for its various resultant facilities. This phenomenon is illustrated in **Figure 2.6** here below.

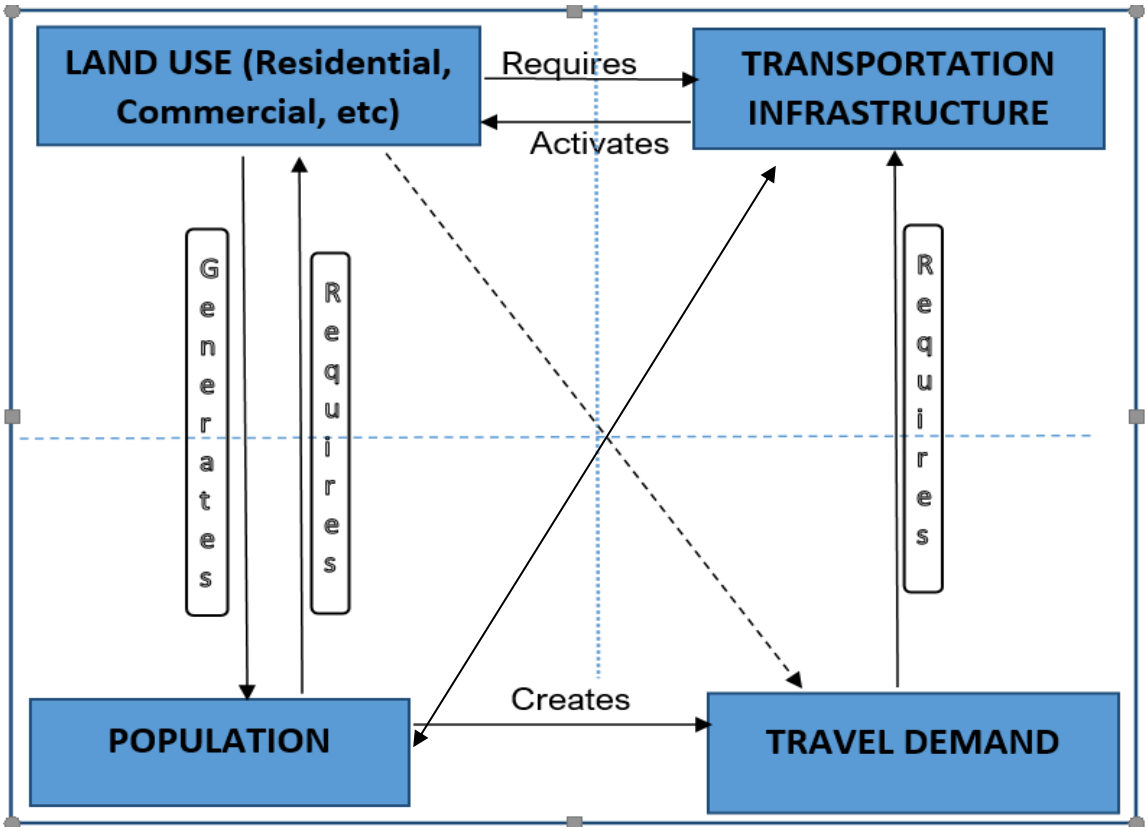

Figure 2.6: Empirical Relationship of Land Use, Population and Transport (Source: Author, 2023)

2.7 Conceptual Framework for the Study

A P&R facility is a form of transport infrastructure provided to cater for a supposedly determined travel demand. Its performance will therefore be determined by the inherent needs of the targeted travellers themselves and must be conceptualised with this as the focal point for its success. A conceptual framework has been devised for this study theme based on Miles & Huberman (1994) view that it is a graphical or narrative explanation of the ideas studied with the key variables brought out and highlighted with presumed relationship among them. Rukwaro (2016) further expounds that a conceptual framework when clearly articulated becomes a potential and useful tool to aid in deciding which data and information to collect and drawing meaning from the study findings.

The analysis of factors influencing performance of P&R facility while incorporating the intervening or mitigating variables through their interaction in the whole chain is visualised in **Figure 2.7** below.

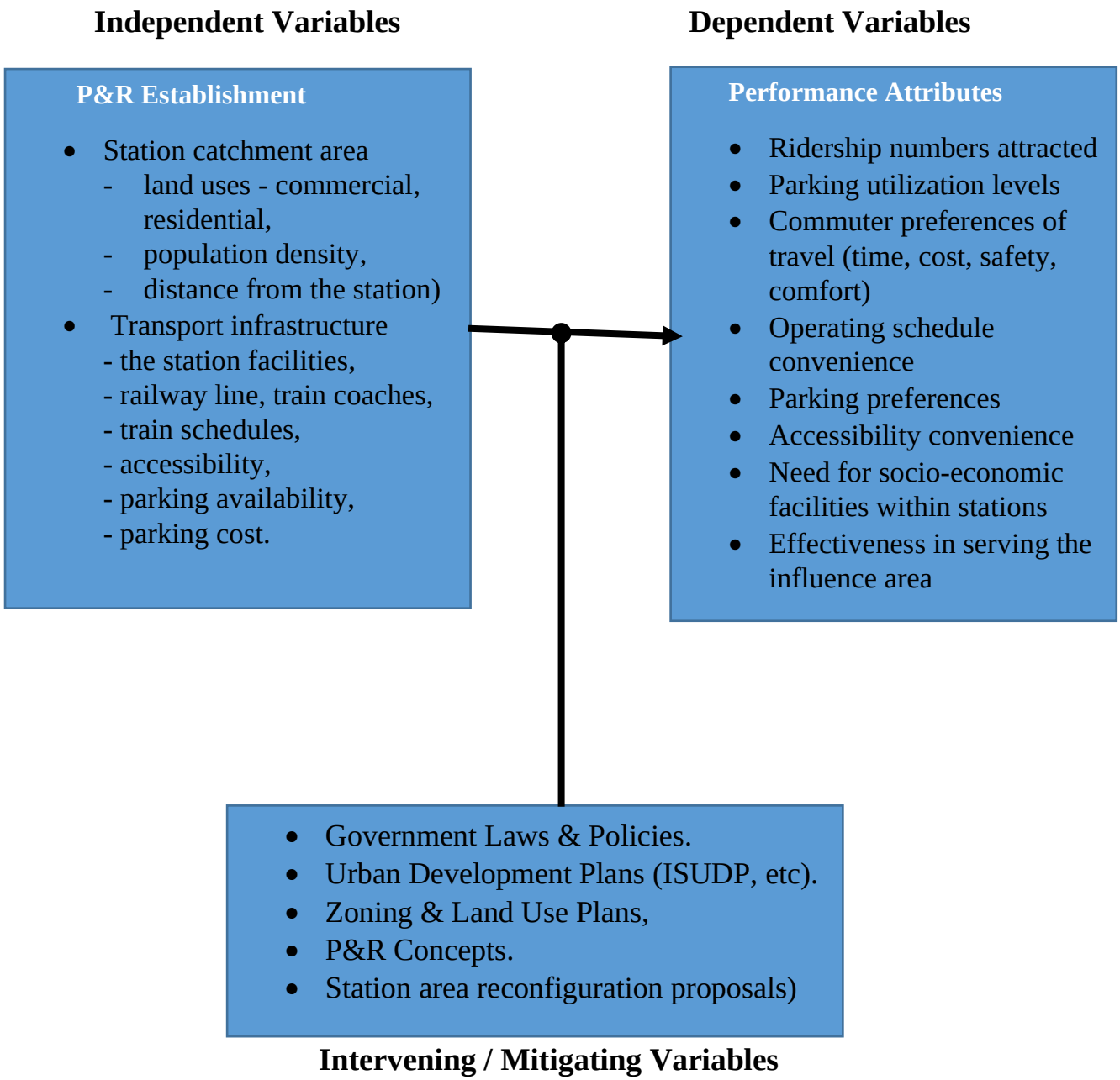

Figure 2.7: Conceptual Framework* (*Source*: *Author, 2023).

The conceptual model given above illustrates the link between the P&R establishment factors (independent variables) and the facility performance attributes (dependent variables), which may be affected by the intervening variables. The P&R establishment factors supported by the intervention measures will result to positive or negative performance, depending on the prevailing situation. A further explanation of these variables is given here below:

a) **Independent Variables** – these are the factors of influence and include permanent land use features like residential estates, commercial premises, transport infrastructure and their surrogates which are population residing in land, the commuters and transport means to access the stations among others. Independent variables and their significance on P&R were discussed in the preceding sub-chapter 2.4 on practises to actualise functional park-and-ride schemes.
b) **Dependent Variables** – these are the performance attributes of the P&R stations that are tied to the facilities provided. In actual sense, these are the variables to be measured in the study and include parking utilization levels, parking preferences, facility convenience, train ridership numbers and train schedule preferences among others.
c) **Intervening or Mitigating Variables** – these include the existing legal and regulatory frameworks in land use and urban transportation by both arms of government (regional and national). Chapter 4 on Situational Analysis substantially explores the intervening variables. Urban development masterplans and conceptual models that should be adopted to develop the P&R facilities also fall in this category of variables and have been discussed under this chapter in sub-chapter 2.4.

2.7.1 Criteria for Performance Assessment of the P&R Stations

From the study variables identified above and based on the overall objectives of this research, the researcher devised a weighted criteria to assess operational performance of the stations in meeting the needs desirable from a P&R environment. This is also based on the discussions in sub-chapter 1.2 and 2.4.

In this regard, seven (7) criterion items were identified from the conceptual framework and applied by the researcher in performance assessment. Percentage weights were assigned depending on their significance on the P&R concept. The assessment was carried out from the quantitative study data and findings in Chapter 5. The selected criterion items from the dependent variables were as follows:

i. Attraction and attainment of the expected train ridership numbers.
ii. Utilization levels of the provided parking facilities.
iii. Whether the P&R service meets the key commuter preferences of travel in a transport system which include avoidance of traffic jams, savings on travel cost and time, safety and comfort.
iv. Convenience of the train operating schedules to commuters.
v. Convenience of the parking facility to commuting car users.

vi. How commuters rated the need for developing socio-economic facilities for shopping or recreation, which are absent from the stations.

vii. Effectiveness of the stations in serving the influence area.

In arriving at the overall performance rating score for each station, percentage scores were categorised into five (5) bands using a commonly applied performance rating system in GoK institutions (Kenya Roads Board, 2023) as shown below.

- Below 50%: Unsatisfactory (signifies performance below expectations).
- 50% - 69%: Fair
- 70% - 79%: Good
- 80% - 89%: Very Good
- 90% - 100%: Excellent (this is the desired highest level of efficient performance).

The performance findings are in Chapter 5 and further discussions in chapter 6.

2.8 Research Gaps

The rationale for early P&R schemes was not grounded in research but rather on local experiments based upon supposition about the nature of traffic and congestion. In Kenya, the advent of P&R stations took place a decade ago in the NMA. However, their operational performance and economic impact to urban transport in the greater metropolitan scene is yet to be assessed properly. The UK for example has since the 1990s rapidly adopted P&R concept to manage congestion with a general assumption that it is effective without substantial research. Additionally, academic and policy literature has not shown much support to P&R schemes, yet it has been widely applied (Manns, 2010).

Thus P&R provision has continued albeit with relatively little research as to the benefits there on as noted by Manns (2010), who further observes that while policy support for P&R is decreasingly evident, further research needs to be undertaken in greater detail to ascertain those circumstances where it does hold tangible benefits. Manns (2010) further notes that data and information collected by all the national, regional or local government agencies must be more comprehensive to warrant full assessment of P&R schemes through rational evaluation. This will avoid being blinded by the light of unsupported sustainability and firmly establish whether P&R and other related planning policies deserve their repute.

Manns observations given above may well be compounded by an observation in the Guardian (2005) that "*though implementation of public transport P&R bus services in the UK*

accelerated through the 1980s and 1990s, some schemes have failed or have been scaled back due to lack of use."

From these discussions, it is evident that P&R schemes may not perform just as expected by mere assumption that they shall attract car users avoiding congestion in city highways and streets. The researcher saw this presumption as a gap that needs to be filled. Additionally, other studies by some other researchers have not given attention to the study objectives for this research as scrutinised by the researcher. **Table 2.2** below summarises the gaps identified.

Table 2.2: Knowledge Gaps Identified from Previous Studies (Source: Author, 2023)

Nature of the study area	**Knowledge gap identified**
A study in 2009 on the application of P&R and TOD concepts to develop a framework that can be used to maximize public transport patronage by S. Ginn.	• The study did not reveal the catchment area characteristics and distances to the stations which can influence the success of P&R facility. • The study did not examine other attributes like operating schedule convenience to commuters which can increase patronage.
A study in 2003 on factors that influence the choice of travel mode selection in major urban areas: "*The attractiveness of Park and Ride"* by L. Olson	The study did not reveal how users rate safety and security of the provided service among other key preferences of commuter travel.
A study in 2006 on the prices and quality of rail passenger services by Steer Davies Gleave Company, UK	The study was confined to fare pricing and the service itself but did not cover other measures that need to be taken by the railway operators to increase patronage like adjusting the train schedules or running faster trains for reliability and time saving.
A study in 2018 on factors that influence utilization of rail transport by private motorists at railway stations in Nairobi County, Kenya by J. Maina	The study did not investigate whether introduction of other facilities within or near the stations, e.g., shopping or recreation, could influence usage by the private motorist. Best practises in planning and development of P&R stations were also not researched or recommended.

2.9 Summary of Literature Review

This chapter has given historical background of development of P&R schemes and delved into insights towards their planning and development process. Best practices to adopt in actualizing these facilities have been explored, like the considerations to make as far as facility conceptualization and location, essentials of influence area and facility demand estimation are concerned. When successfully implemented, the planning and development practices can be instrumental in guaranteeing optimal performance as intended. The theoretical underpinnings of the study were discussed, and an empirical and a conceptual framework devised with its study variables derived appropriately. Consequently, the performance assessment criteria was devised from the study variables. The inputs to the criterion items are sourced from the analyzed data in Chapter 5.

CHAPTER THREE: SITUATIONAL ANALYSIS

3.1 Introduction

Sustainable transport requires appropriate spatial planning, design and implementation to effectively contribute to meeting its intended objective. For example, urban transport requires interconnected public transit and safe pedestrian infrastructure and cycleways to effectively address urban poverty, social inclusion and reducing inequalities. Good infrastructure planning and maintenance can contribute to reduction of urban congestion, and savings in time, energy, and money.

Transport infrastructure sector plays pivotal role in GoK development agenda. In cognizance of this, the Kenyan government has over the years invested heavily particularly in road infrastructure as well as SGR linking Mombasa to Nairobi. Despite the heavy investments, the country still faces a huge infrastructure gap (MoTIHUD, 2018). All government institutions should therefore ensure that all programmes are well coordinated and derive value for money. For this to happen, the enabling legal and institutional framework needs to be in place.

Kenya's transport policy framework is elaborated in the Sessional Paper on Integrated National Transport Policy (INTP). The paper proposes a new framework to manage the transport sector that would establish a directorate of transport, and consolidate transport functions under one Ministry where by policy making, regulatory and service provision functions are clearly separated (MoRT, 2010). Advocacy for enhancement of the role of the private sector in development of transport infrastructure, integration of non-motorised transport (NMT) with the other intermediate means of transport as part and parcel of the transport system and lastly a shift to high occupancy vehicles (HOVs) is also made in this document.

The framework and action points outlined above have to some extend been implemented by GoK over the years to various levels. For example, the regulatory framework has been strengthened and separation of roles has been established. However, challenges of generating sufficient revenues to support development and maintenance of transport infrastructure, enhancing the role of the private sector in financing projects, and encouraging the use of HOVs in urban areas are largely plans that have had little actualization in terms of expected tangible outcomes (MoTIHUD, 2018).

3.2 Legal and Institutional Framework in the Kenyan Transport Sector

The legal and institutional framework for the transport sector in Kenya is made up of the overarching Constitution of Kenya, existing laws, regulations, policies and the established government Ministries, Departments and Agencies (MDAs) which emanate from the legislations. This section explores the applicable laws and their implementing institutions tasked with undertaking transport related matters. It also discusses the extent of their accomplishment of the various transport sector challenges in Kenya.

In order to understand well the structure of governance of the transport sector in Kenya, the starting focal point is the Constitution of Kenya (2010) where distribution of functions between the National Government and County Governments in Kenya is spelt out under the fourth schedule of the Constitution. The National Government through its MDAs is mandated to deal with road traffic, construction and operation of national trunk roads, setting standards for construction and maintenance of all roads, railways and pipelines, marine navigation, and civil aviation among other diverse functions. The County Governments on the other hand deal with county specific transport matters which include developing their own roads, street lighting, traffic and town parking management, public road transport, ferries and harbours, among other functions (Constitution of Kenya, 2010) .

3.2.1 Key Legislations for the Transport Sector

Table 3.1 below highlights the key prevailing policies and legislation essential in Kenya's transport industry and briefly outlines their relevance.

Table 3.1: Key Kenyan Legislations of Relevance to the Study (Source: Relevant Legislation & Author, 2023)

Legislation	Relevance to Transport
Constitution of Kenya 2010	Outlines the distribution of functions between the national government and the county governments under the fourth schedule
Kenya Vision 2030	To realise the socio-economic transformation, the Vision requires that the three pillars be firmly anchored on six foundations with infrastructure as the leading one. Its vision is stated as *"to provide cost-effective world-class infrastructure facilities and services in support of Vision 2030"*.

Legislation	Relevance to Transport
National Environment Policy 2013	States that the government will: • Ensure Strategic Environmental Assessment (SEA), Environmental and Social Impact Assessment (ESIA), Social Impact Assessment (SIA) and Public participation in the planning and approval of infrastructural projects. • Develop and implement environmentally-friendly national infrastructural development strategy and action plan. • Ensure that periodic Environmental Audits are carried out for all infrastructural projects.
Kenya Roads Act 2007	Provide for the establishment of the Kenya National Highways Authority (KeNHA, the Kenya Urban Roads Authority (KURA) and the Kenya Rural Roads Authority (KeRRA) and the powers and functions of the authorities and for connected purpose of management, development, rehabilitation and maintenance of roads in Kenya
Kenya Railways Corporation Act CAP 397	Provide for the establishment of a corporation to be known as Kenya Railways, to deal exclusively with all matters related to railway development and management in Kenya
Kenya Roads Board Act 1999	Provide for the establishment, powers and functions of the Kenya Roads Board (KRB) and for connected purposes of managing the fuel levy fund, coordination of road network development & maintenance programs and their audits in Kenya
Urban Areas and Cities Act 2011	Gives effect to Article 184 of the Constitution of Kenya; to provide for the classification, governance and management of urban areas and cities; to provide for the criteria of establishing urban areas, to provide for the principle of governance and participation of residents and for connected purposes.

3.2.2 Key Institutions Relevant to the Transport Sector

Table 3.2 below is a summary of the key institutions tasked with the various functions as per their establishing legislations, their respective mandate and the inherent gaps that the author identified which affect their smooth execution of their given mandates.

Table 3.2: Mandated Institutions in the Kenyan Transport Sector (Source: Author, 2023)

Institution	Responsibility	Challenges faced
Ministry of Roads & Transport (MoRT) – has 2 State Departments, one for Roads (SDR) & the other for Transport (SDT	Policy formulation, oversight & coordination, setting standards. It has overall responsibility on all road and transport related agencies	- Policies should be backed up by research to have substantial impact. Little research is being undertaken in the sector at the moment. Coordination with researchers in the academia is lacking

Institution	Responsibility	Challenges faced
Institutions under SDR -Non-parastatal ones key for the study are: (MTRD, KIHBT)	MTRD – undertakes materials research & testing. KIHBT – offers technical training in the road sector	- Insufficient capacity both financially and technically to enable uptake of modern technology in materials and training in the sector.
Institutions under SDT -Key ones for the study: KRTI, NTSA.	KRTI - undertakes technical training for the railway industry NTSA – regulates the motor vehicle industry and handles issues of transport safety	KRTI is limited in training on modern railway technology, NTSA concentrates more on road safety than on safety concerning other modes of transport.
Kenya Roads Board (KRB)	Managing the fuel levy fund for road maintenance; coordination of road network development & maintenance programs, undertakes technical & financial audits	The fuel levy is not sufficient to cover development and maintenance of all roads in Kenya. The fund also doesn't cover other forms of infrastructure like railway.
Road Authorities (KeNHA, KURA, KeRRA)	The RAs deal with development, rehabilitation and maintenance of National Trunk Roads overall management of the road infrastructure totaling 40,000Km	-Political interference leading to misplaced priorities; - Insufficient funding - Technical capacity constraints.
County Governments:	The 47 CGs in Kenya deal specifically with all other roads that are not the mandate of the Road Authorities, i.e. County Roads and totaling 121,456Km	- Uncoordinated programmes; - Insufficient funding; - Technical capacity constraints - Excluded from railway transport as per the 4th Schedule of CoK 2010.
Kenya Railways Corporation (KRC)	Railway development, operation and management in the whole of Kenya	-very large network of the low capacity MGR which also constitutes the urban railway in NMA; -inadequate funding to undertake modern railways like SGR and acquire modern rolling stock of wagons like DMUs, electric trains.
Nairobi Metropolitan Area Transport Authority (NaMATA)	Established by a legal notice and its main mandate is to oversee the establishment of an integrated, efficient, effective and sustainable public transport system within the Nairobi Metropolitan Area (NMA).	- not established by an Act of Parliament thus lacks strong legal muscle to undertake programs; - lacks funding to pursue urban transport programs.

The transport context for this study is on P&R facilities existing on the urban railway transport network which as explained here above is the preserve of Kenya Railways Corporation. The researcher has devised the bare minimum organogram in visualising and illustrating how KRC

is established in relation to the other GoK institutions and based on the discussions in the tables above. **Figure 3.1** below illustrates the organizational set up of KRC.

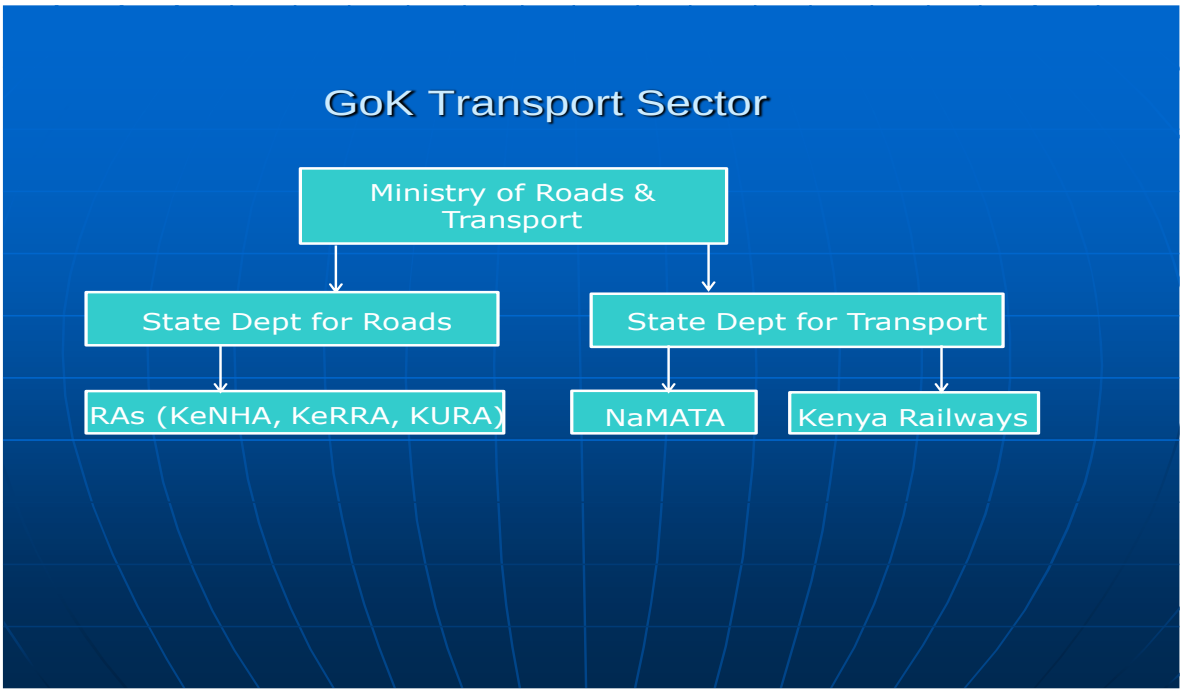

Figure 3.1: Kenyan Transport Sector Organisation (Source*: *Author, 2023)

3.2.3 Key Observation from the Existing Legal and Institutional Framework

As may be seen from the discussions above, matters of urban transport covers various means and modes which feed into each other and virtually all institutions must synergize to ensure projects and programmes are effective and efficient. In addition, all relevant GoK institutions should be actively involved in formulating and developing well-coordinated urban transport systems.

3.2.4 Transport Administration in Other Countries

Many other countries across the world employ not very different arrangements to the Kenyan case towards transport governance. In Japan for example, transport is handled by national and regional governments (known as prefectures) and municipalities (Niira, 2014). However, the regional governments are not limited to which type of transport infrastructure they can develop unlike the Kenyan case where the railway is the preserve of KRC only. Private companies are also allowed to develop their own railway lines in Japan and operate particularly sub-way networks in expansive urban centres (Niira, 2014).

A similar observation is also made for the transport sector in USA where the state governments undertake projects concerning their states while the federal government

finances major infrastructure projects cutting across various states, basically inter-state highways and railways. Neighbouring countries to Kenya like Uganda and Tanzania also have regional and provincial governments as well as cities and municipalities that undertake transport projects in the urban centres.

3.3 The Nairobi Metropolitan Area Commuter Railway

The NMA railway transport which is the focus for this study is operated by KRC. Various changes have taken place to integrate and expand it with the aim of modernizing and upgrading the existing infrastructure. The main components of the upgrade are construction of new stations and modernization of existing stations, acquisition of Diesel Multiple Units (DMUs), refurbishing of passenger coaches and rehabilitation of locomotives and other rolling stock and planned rehabilitation of the entire network deployed under commuter rail services (Kenya Railways Website, 2023). The expectations of commuter service are to improve the level of service of the commuter passengers, increase safety of operations and reduce the transit time of the trains. The key outstanding features of the facilities are P&R stations with parking, ample security cameras, automated ticketing system, and comfortable coaches.

To complement the commuter services, KRC introduced an integrated transport service that involves a seamless interconnection between the rail and road. This comprises of a scheduled connector bus system that transports commuters to and from the Nairobi Central Railway Station at the CBD, Upperhill and Westlands (Kenya Railways Website, 2023). However, KRC is yet to introduce the scheduled connector buses to its outlying stations like Imara Daima, Syokimau and Athi River where P&R facilities have been provided.

3.4 Urban Development Plans for the Stations Location

3.4.1 Mavoko Integrated Strategic Urban Development Plan

Machakos County prepared an Integrated Strategic Urban Development Plan (ISUDP) covering the period 2020 to 2030 for one of its major Sub-counties, Mavoko. Mavoko Sub-county is also the main source of commuters to the two stations. According to the Mavoko ISUDP (2020), Mavoko's current population stands at 322,499 residents and is expected to triple over the next two decades and projecting these statistics until the end of the planning period for the ISUDP, the population is estimated to reach 617,403 by the year 2030.

The ISUDP further indicates that Mavoko is primarily a residential, industrial and service town, with over 40% of the town's land covered by residential housing and 30% occupied by

industrial and transport industry. There is therefore substantial potential and hope for growth and expansion of business activities in Mavoko Sub-county.

3.4.1.1 Land Use Plan for Mavoko Sub-County

The greater Mavoko area was basically a grassland with cattle ranching in the 1950s as the main land use activity. Until the mid-1990s, the area saw comparatively little development. Recent years have however seen rapid growth of the area, resulting mainly from industrial expansion, residential development and concomitant services. Interestingly, most residential properties are occupied by people working in Nairobi and Machakos town. This is because they find the Mavoko Municipality more affordable in spite of the longer commuting distance.

Land use patterns in Mavoko have changed considerably to high density residential, commercial and industrial land uses. The change in land uses has further contributed to increasing the population, consequently increasing demand for residential housing and spaces for commercial as well as industrial activities.

Particularly, the Mavoko ISUDP emphasises on integrated urban planning and development approach that contextualises the environmental setting and the constituent transportation linkages for the planned area and its functional role in the Nairobi Metropolitan Area. In this regard, key land use plans for specific areas were proposed and developed in the ISUDP including for the areas covering the two stations under this study, which are Athi River and Syokimau Land Use Plans as shown in **Figures 3.2** and **3.3** below.

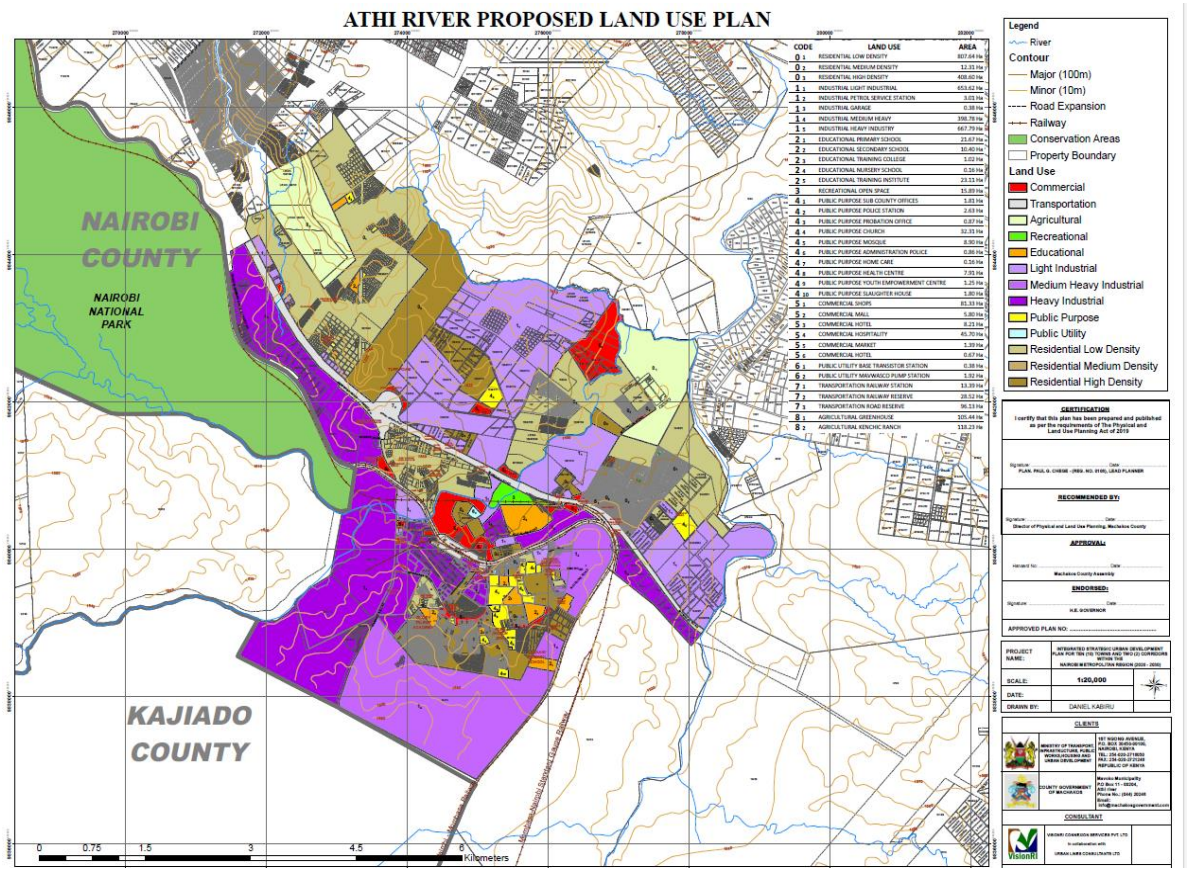

Figure 3.2: Land Use Plans for Athi River Area (Source: Mavoko ISUDP, 2020)

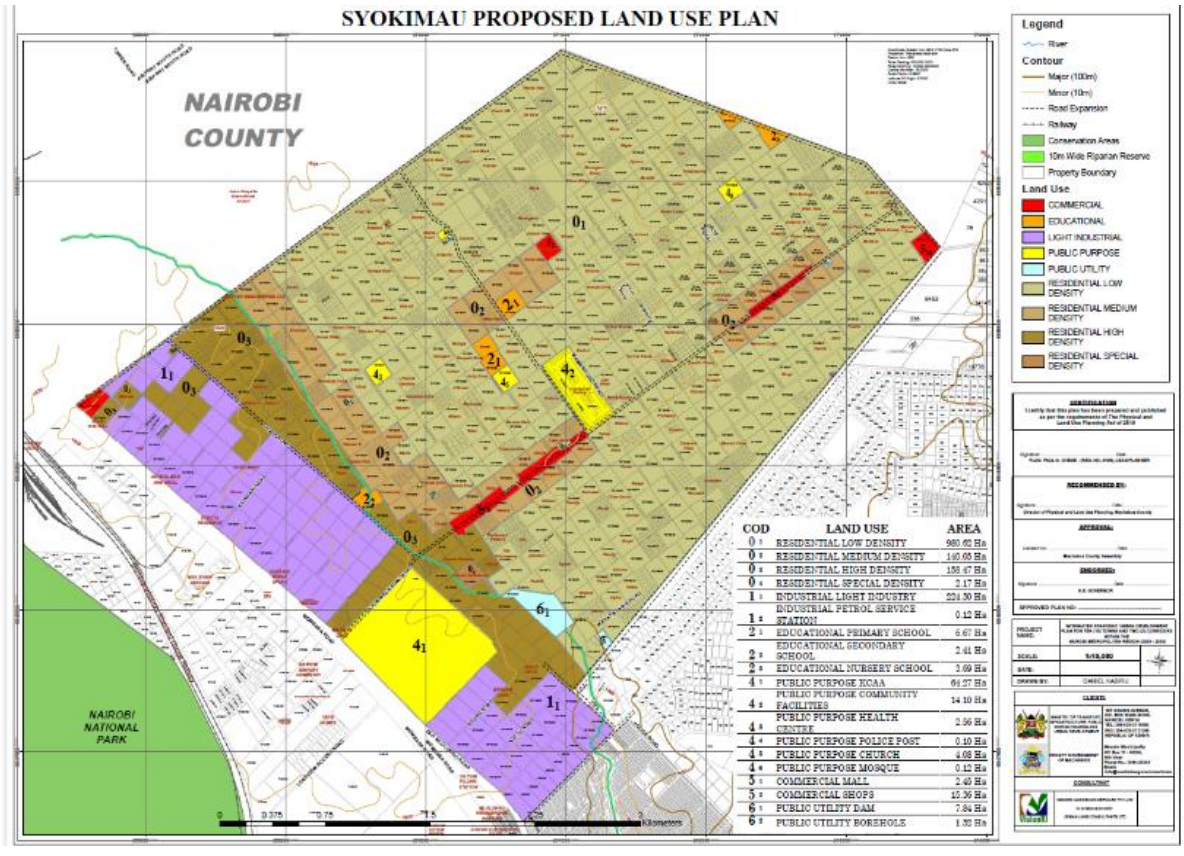

Figure 3.3: Land Use Plans for Syokimau Area (Source: Mavoko ISUDP, 2020)

3.4.1.2 Long Term Transportation Proposals for Mavoko

Mavoko has existing transport nodes such as the railway stations, and dominant road transport nodes like Mlolongo, and Kyumvi. However, Mavoko experiences urban sprawl, traffic congestion, inadequate pedestrian and NMT facilities, incompatible land uses and insufficient public utilities and spaces.

The Mavoko ISUDP (2020) in the spatial planning concept indicates that Mavoko like Kitengela, is classified to be a growth centre whose main function in the NMA is to promote urbanization of the greater peri-urban and rural area to achieve a balanced distribution of urban population. Another role is to provide functional linkage between the smaller towns and the bigger urban centres like Nairobi City.

The development plan further signifies that the proposed Greater Southern By-Pass (Ongata Rongai-Ngong-Kikuyu towns axis) will pass between Kitengela and Mavoko. This by-pass together with the SGR line will position the two towns as transport hubs for freight and passengers destined to Nairobi CBD and other towns on the Mavoko–Namanga corridor (Isinya, Kajiado and Namanga towns axis).

The ISUDP proposes adoption of a Transit Oriented Development (TOD) in Mavoko which should be applied to help develop a compact city with the following aspects:

- Public transport hubs: These hubs could be established around the railway stations in Athi River town with mixed residential and commercial uses among other locations.
- Public space and infrastructure: the development of compact mixed-use communities around the transport hubs accompanied by structured public spaces, parks and supporting utilities.

3.5 Locational Settings of the Stations

The P&R stations under study are approximately 13Km apart along the Nairobi-Mombasa MGR line and are typically of suburban nature. To the south of the stations is Kitengela Town which is in Kajiado County at the north-eastern border with Machakos County while Nairobi City falls to the north-west. Mlolongo Town falls off the MGR line in between the two stations and is thus not served directly by the commuter train.

Figure 3.4 below shows the precise location of the towns and their 5km radius influence areas circled by blue and cyan lines.

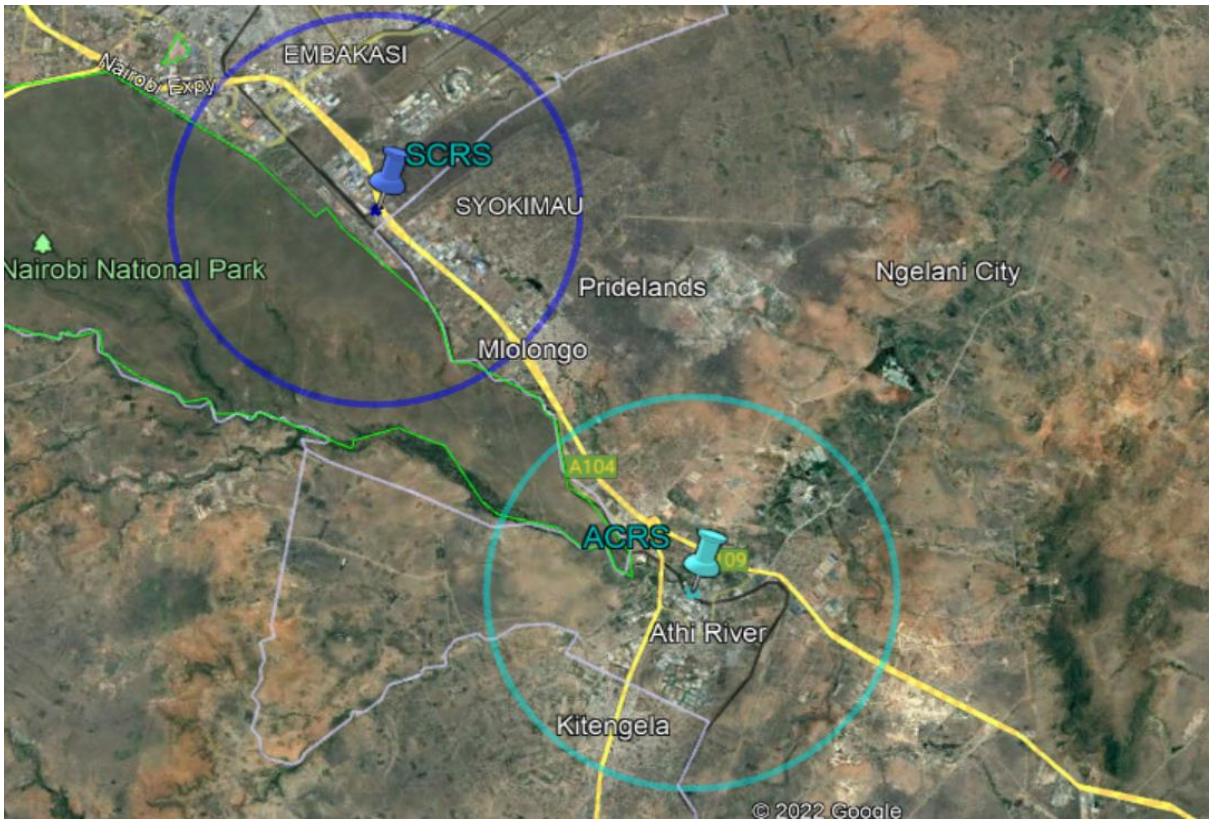

Figure 3.4: Location of both Syokimau & Athi River P&R Station (Source: Google Earth)

The locational spacing in terms of the standard influence area is quite ideal as discussed in sub-chapter 2.4.3. Specific locational, population and land use information per station is given in the sub-chapters below.

3.5.1 Athi River Commuter Railway Station (ACRS)

ACRS is located in Athi River Town within Mavoko Sub-County of Machakos County, right next to the main MGR that runs from Nairobi Central Railway Station all the way to Mombasa City. ACRS is served by a paved road that connects it to two key highways within its vicinity (red line in Figure 3.5 below). These highways are: -

a) Athi River - Namanga Highway to the West at 0.9Km, and
b) Nairobi - Mombasa Highway to the East at 1.75Km.

The station covers an area of approximately 6.4 Acres of land. The google satellite earth image **Figure 3.5** below shows the precise station location.

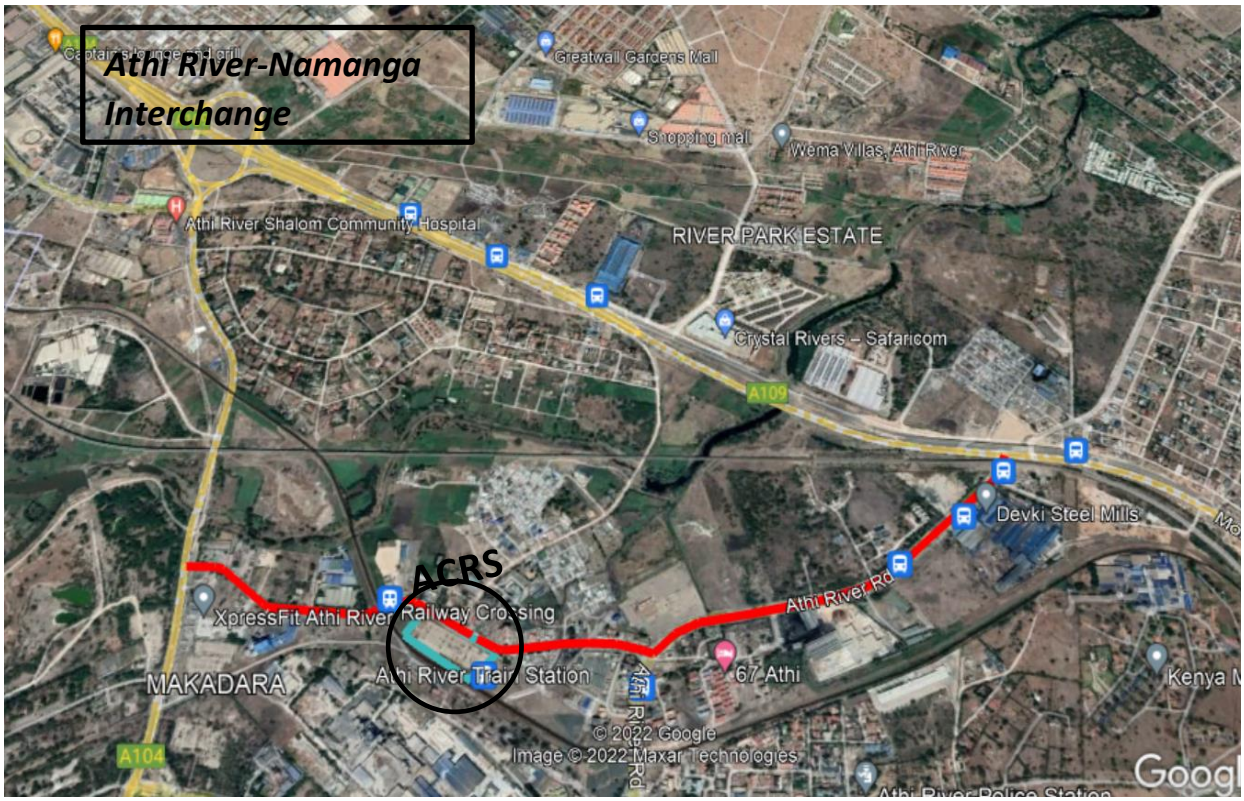

Figure 3.5: Location of Athi River Station (Source: Google Earth)

Within the 5Km radius of the station catchment area, the prevailing urban land use activities were evaluated with reference to the catchment area guide given in Table 2.1 in Chapter 2. These are documented in **Table 3.3** below.

Table 3.3: ACRS Influence Area Land Use Activities (Source: Field surveys by Author, Google Earth Map)

Item Description	Influence Area	Land Use Activities
Station Area	Area directly adjoining the station or within the defined station property boundaries	• Station buildings / structures; parking area and open space; • Access road
Station Coverage	Area directly surrounding ITF or area within 100m radius of the railway station	• Commercial premises (mini-shop, bar, eateries points); Businesses and offices (post office, bank, Water & Sanitation Company) • Immediate supporting road and utilities infrastructure
	Area within 500m to 1Km radius of the railway station or within walking distance	• Commercial premises (shop, bar, eateries points); Real estate and residential dwellings; Industrial and warehouse activities; fuelling Stations;

Item Description	Influence Area	Land Use Activities
		• Community facilities like markets, schools, hospitals, churches, mosques; • Steel and cement manufacture; • Open ground / undeveloped land; • Vegetables farming; River and flood plains; • Feeder roads network and PSV Stations
Station Catchment Area	Area that can be connected to the stations by feeder services (extends up to 5Km radius)	• GoK and County administrative offices • Technical training institutions; Police station • Public transport vehicle terminal; Shopping malls; Meat production; SGR station; • Export Processing Zone (EPZ) • Hotels and resorts • Livestock keeping and crop farming • Stone quarry and ballast production • All other urban activities in the 1km radius zone

3.5.2 Syokimau Commuter Railway Station (SCRS)

SCRS is located at the North end border with Nairobi County. The name Syokimau originates from the immediate neighbourhood to the south of the station in Mavoko Sub-county of Machakos County. SCRS receives most of the commuters from Syokimau as realised from the field survey. An extension railway to the left connects it to the main MGR that runs from Nairobi Central Railway Station all the way to Mombasa City. SCRS is mainly accessed by a Nairobi - Mombasa Highway Service Road to the East which runs along its main entry and exit gates. Access to the service road by traffic plying the Nairobi-Mombasa highway has been facilitated by a grade separation or fly-over road located about 300m away that allows vehicles to cross to either side of the Nairobi Urban Expressway.

The Nairobi SGR Station which handles inter-city passengers travelling to and from Mombasa is 1km away while Jomo Kenyatta International Airport (JKIA) is about 5Km away. The Nairobi Expressway is also accessible at 1.7Km to the North of the station.

The station covers an area of approximately 4.25 Acres of land. The google satellite earth image **Figure 3.6** below shows the precise station location.

Figure 3.6: Location of Syokimau Station (Source: Google Earth)

Within the 5Km radius of the station catchment area, the prevailing urban land use activities were evaluated and documented in **Table 3.4** below.

Table 3.4: SCRS Influence Area Land Use Activities (Source: Field surveys by Author & Google Earth Map)

Item Description	Influence Area	Land Use Activities
Station Area	Area directly adjoining the station or within the defined station property boundaries	• Station buildings / structures; parking area • Entry/exit from the service road • Station internal shopping premises
Station Coverage	Area directly surrounding ITF or area within 100m radius of the railway station.	• Precast concrete production • Immediate supporting road and utilities infrastructure • Open ground or undeveloped land
	Area within 500m to 1Km radius of the railway station or within walking distance	• Shopping malls; Industrial and warehouse Activities; Residential premises/facilities • Open ground or undeveloped land • SGR passenger terminal; cooking oil refinery • Fuelling station

Item Description	Influence Area	Land Use Activities
		• Feeder roads network, facilities and transport services like matatus pick up / drop off points
Station Catchment Area	Area that can be connected to the stations by feeder services (extends up to 5Km)	• Administrative offices (National & County Government); Police stations • Weigh bridge station, SGR freight terminal • Bulk grain handling terminal • Shopping malls; Hotels and resorts • International airport • Wildlife national park • Industrial and warehouse activities • Real estate and residential dwellings • Open ground or undeveloped land • Fuelling stations • PSV pick up / drop off points

3.6 Concluding Remarks on the Situational Analysis

The situational analysis chapter has examined the transport situation in Kenya and explored the existing legal and institutional frameworks and some of the inherent challenges that may need to be tackled to enable success of major urban transport infrastructure projects. A review of the pertinent urban development plans of reference in the research area settings has also been made with a focus on long term transportation plans that may have an impact on the existing P&R stations in the area.

The situational analysis gives insight into making appropriate and instrumental recommendations towards improvement of the P&R service in Chapter 6 of this report.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This chapter is an overview of the research methods adopted by the researcher to execute the objectives of this study. Particularly, the main areas of focus in this chapter are the research design, data sources, targeted population, sampling techniques and chosen sample size. The data collection instruments have also been discussed as well as how valid and reliable they are for this study. The unit of analysis and justification on its suitability for the study has also been discussed together with the structure of main data collection instruments which are the questionnaires and interview schedules. Presentation techniques and inherent ethical issues for consideration in this study have also been included.

4.2 Research Design

Rukwaro (2016) defines research design as a plan, structure and strategy of investigation conceived with a view to obtaining answers to research questions. It is a planned procedure that is adopted such that answers to questions are obtained objectively, accurately, and economically. Kothari (2004) further defines research design as the conceptual structure within which research is conducted. It constitutes the blueprint for making decisions to answer such questions as what, where, when, how much and by what means concerning the study through collection, measurement, and analysis of data.

This study aimed at investigating ideal practises in P&R station planning and development, establishing the influence areas for the stations and their significance in contributing to ridership numbers, finding out the utilization levels and reasons behind the current utilization levels at the stations and ultimately on suitability of the stations in serving as P&R facility and making suitable recommendations to make the station suitable in the future.

Maxwell (2012) argues that a mixed research design is essential as it strikes a balance of efficient data collection and analysis, with the obtained data being more reliable, valid and providing context. In this regard, a mixed research design was adopted for the study where by both the quantitative and qualitative elements were applied in a complementary manner. Literature review on available work and materials was carried out to answer the first objective on best practise to actualise functional P&R stations.

Quantitative approach allowed the researcher to observe or measure statistics to assess the relationship between variables while keeping the independent variables constant (Orodho, 2003) after collecting such information from a sample of individuals. For this study, these variables include area sources of commuters, the commuters themselves and their travel behavioural characteristics like desired departure or arrival timings. Parking slots availability, parking space utilization by cars and the train ridership were also considered which have a direct relationship with the utilization levels of the station facility and are tied to the second and third objectives of the study.

On the other hand, qualitative approach to research is interpretative (Rukwaro, 2016) and is geared towards in-depth understanding of the phenomena. Perceptions and feelings are a basis of this research rather than numbers since they greatly influence travel behaviour and descriptive analysis is applied to analyse the data. Syagga (2019) stated that qualitative approach seeks to provide in-depth description of real-life experiences and give them meaning and that the data is collected in form of words rather than numbers. This approach assisted the researcher to seek answers from the respondents on mitigating measures for optimization of the station areas in addressing the fourth research objective.

Additionally review and analysis of the urban land use plans and activities within the station's coverage area was some form of spatial analysis which in local and regional planning and development addresses issues to do with land optimization such as ideal locations for land users and the supporting transport route networks. This can help in analysing the structure of land use versus networks (connectivity pattern) and movement (flow) over the entire system (Meyer, 2016). The spatial analysis aided the study to originate some statistical inferences or assumptions representative of actionable insights to address the second and fourth objective.

4.3 Target Population

Polit and Hungler (1999) defined the population as an aggregation of all things, subjects, or individuals that meet a set of criteria. A population is a well-defined set of people, services, elements, events, group of things or households under investigation according to Ngechu (2004). The key target population under investigation for this study is the railway commuters. Other stakeholders in this study include the KRC station workers and occupants of vehicles entering the stations to either drop passengers or to park and ride the trains. Additionally, other population elements of statistical importance that were documented are the available

parking slots and the average parking numbers in terms of cars. This helped to gauge the parking utilization levels and to test the research proposition.

Table 4.1 below gives the KRC commuter statistics from both Athi River and Syokimau Stations. The average commuter numbers were given by the station masters for each station and used to compare with the computed train capacities.

Table 4.1: Commuter Railway One-Way Trip Statistics

Station Name	Capacity of One (1) Coach	No. of Coaches	No. of Trips	Passenger Statistics		
				Computed Capacity	Average Recorded Daily	% Ridership
Athi River Original Train	**62**	**5**	**1**	**310**	**190**	**61%**
Syokimau Original Train	62	7	1	434	270	65%
Syokimau DMU	98	2	2	392	330	82%
Syokimau Total				**826**	**600**	**73%**

(Source: KRC, February 2023)

From **Table 4.1** above, it is noted that the average daily turn out of commuters is less than the computed train capacities for the two stations. For purposes of sampling, the target number of commuters was based on the computed train capacities which is the higher figure in both the stations.

4.4 Sample Size and Sampling Procedure

A sample size is the number of items to be selected from the population under study to provide specific information that shall aid the study in documenting findings used to make informed conclusions and recommendations for the study subject (Kothari 2004). The sampling procedure involves taking a fraction of data, or sample, from a large set of data, or the population and making judgments pertaining the whole group drawn from the sample.

A sample size should not be too small or excessively large, but rather be optimum such that it is efficient, reliable, and economical representative to deal with. In this regard, the research adopted the Nachmias & Nachmias (1992) formula in determining the sample size for commuters from the population of respondents given in table 4.2 above, while assuming 95% confidence level;

n = {(z*z) (p*q) N} / {e*e(N-1) +(z*z) (p*q)} where:

n = sample size;

z = standard deviation at 95% confidence level (in this case 1.96 worked from tables showing areas under normal curve);

p = % of target population assumed to have similar characteristics (taken as 95% for this study);

q = 1-p

N = population size

e = margin of error at 95% confidence level

= 1-0.95; =0.05. (*Source:* Nachmias & Nachmias, 1992)

By substituting accordingly in the above equation,

n = 0.182N / (0.0025N + 0.1795)

From Table 4.1 above N for ACRS = 310 and N for SCRS = 826. Substituting N in the equation above, then:

- n (for ACRS) = 59.11; Say 60 and
- n (for SCRS) = 66.97; say 67.

To compensate for non-response during data collection, a 30% upward adjustment was made to the calculated sample as postulated by Israel (2012).

Adjusting the sample size for non-response, new sample size, n (new) = 130% * n. The final sample size are thus obtained as follows:

(i) ACRS sample size = 60 * 1.3 = 78 No. commuters;

(ii) SCRS sample size = 67 * 1.3 = 87 No. commuters.

The table below gives the final sample population for the target respondents in the study.

Table 4.2 Breakdown of Target Respondents (Source: Author, 2023)

***u*Category**	**Target Number**
a) Questionnaires	
Commuters to Athi River Station	78
Commuters to Syokimau Station	87
b) Interviews	
KRC Station Officers	2 Station Masters (1 at each station)
KRC Head Quarters Officer	1 officer

4.5 Unit of Analysis

Mugenda and Mugenda (2012) defined the unit of analysis as the main element in the study whose data is aggregated and analysed in findings to make conclusions, decisions, or inferences. The unit of analysis for this study remains the commuter. Keeping in mind that the parking utilization levels were also significant in evaluating the performance of the stations as P&R stations, an analysis was also made between the provided versus the utilized parking to gauge on effectiveness of the facility for the intended purpose.

4.6 Methods and Tools of Data Collection

The methods and tools for data collection were grouped under two (2) categories:

4.6.1 Primary Data Collection Techniques

This is basically field survey work and the techniques employed included:

a) **Questionnaires** – these were administered to the commuters being the key respondents in this study. The questionnaire contained both structured and unstructured questions drawn with reference to the research objectives and organized in three (3) sections. Section A of the questionnaire intended to collect general information about individual attributes and basically on gender, age, and the number of years one had used the commuter P&R service. In a study by Clayton *et al.* (2014), the key factors influencing travellers' choice of P&R are the income, job, age, and gender. However, at the pilot stage, respondents for their own reasons were found to be hesitant in sharing information about their income levels. This hesitation was attributed to coincidence of the survey with ongoing debate in the Kenyan media regarding tax evasion by businesses and other income earning individuals. From this preliminary negative feedback, the researcher decided to eliminate income thresholds in the questionnaires to avoid misguiding information and to assess indirectly the income levels by other means like car ownership statistics and average rents payable in residential zones generating the largest number of commuters for the two stations. These two indicators would give a bearing on economic well-being of the commuter.

   Section B of the questionnaire sought to gather information on the station influence area, transport choice and commuter preferences. Influence of identified factors on the P&R service, car ownership statistics, parking provided and other preferences like train schedules and connector transport or PSV were investigated. This survey comprised three

tables representing the three groupings of the factors each containing structured points with responses presented in a range of choices in a five-point Likert Scale. In addition, this section also sought opinion of the respondents on improving the P&R Service through unstructured questions.

Section C contained land use factors and station area re-configuration on pre-structured statements designed to get feedback in a five-point Likert Scale. One consideration made in crafting these statements was based on perceived need in cities of developing countries to move shopping away from the congested inner-city and other major shopping centres towards a relatively free and relaxed suburban area located near P&R stations (Parkhurst and Richardson 2002).Whereas structured questions aim at conserving time and money, as well as facilitating easier analysis as they are in immediate usable form, unstructured questions constitute the qualitative survey and seek to encourage the respondent to give their in-depth and felt response without feeling held back in revealing any information (Mugenda & Mugenda, 2003).

b) Interviews – these were undertaken with the railway management and targeted KRC officers at the railway stations and in the Head Office. The items of interview were drawn based on the study objectives for purposes of corroborating the commuters' questionnaire findings and any factors touching on KRC as the commuter train operator. Moreover, the interviews with the staff members sought to obtain information relating to best mechanisms for improving the P&R service based on their rich experience on the commuter service operation and performance.

c) Field surveys and observation – this was carried out to establish the station coverage area characteristics and commercial activities carried out around the stations' vicinity. The size of the parking area, available parking spaces and number of cars parked were also obtained to evaluate the utilization level of the facility. Field visit for further findings was undertaken after all the questionnaires were received and preliminary analysis undertaken to ensure that complementary data and information was picked. Some information obtained from the field was documented in the Situational Analysis Chapter 3 under the Stations Area Settings sub-topic.

4.6.2 Secondary Data Collection Techniques

The research relied on published and unpublished studies and other available literature on the concept of P&R mainly from a global perspective. The secondary data was useful in understanding the planning and development of P&R concept and strategies that can be applied to realise effective P&R schemes and aided in answering the first objective of this research. It was also useful in the identification of the general challenges of P&R schemes.

In addition to available literature reviewed, further sourcing of existing data and information was from KRC documented information on P&R stations from the website. At the data collection stage, more statistical abstracts, and records available with KRC and GoK were reviewed and analysed. Additionally, google maps provided useful information on station location and the 5km radius surrounding area to the stations.

4.7 Methods and Tools of Data Analysis and Presentation

Data analysis for this study was ranging from simple summaries such as tables and charts to statistical inferences to facilitate a derivation of meaningful relationships from which conclusions will be drawn to enable reasonable generalizations. Data analysis and processing involved the following steps:

a) **Data sorting** – this involved numbering of the questionnaires and arranging them in order, together with other field records for easy entering of data and analysis.
b) **Data editing** – this involved making corrections to the questionnaires to discard the inappropriate data and retain relevant data. This increased the quality of data analysed.
c) **Coding** – coding typically involved assigning alpha or numeric codes to survey questions and answers so that statistical techniques can be applied with ease.
d) **Data processing** – data processing involved some several sub-steps, which include data entry, verification, and validation.
e) **Data analysis and presentation** – data analysis was done using Microsoft Excel and presented in different forms (tables, charts, graphs or maps) to enable visualisation of the existing situation in the study area.

Data was processed using Microsoft Excel software to produce descriptive statistics. Systematic analysis was carried out to yield statistical measures such as percentages, means and frequencies. Ms Excel software was used in analysis due to its ease of understanding and application. The choice for frequencies and percentages was informed by their simplistic

nature and ease of understanding and interpretation (Sinayev *et al.,* 2015). Frequencies and percentages are also appropriate tools for prioritizing and ranking indicators rated on Likert-type scales which was significant in achieving the third and fourth objective of this research.

4.8 Validity and Reliability of Research Instruments

This study relied heavily on questionnaires, interview schedules and field observations in collecting of data and basing the same on the research variables as outlined in the conceptual framework. Pilot tests were conducted mainly to assess the validity and reliability of the research instruments, as recognized by Orodho (2003). Questionnaires were issued to respondents picked at random from each station to test the clarity of the questions and their ability to get answers according to the research objectives. This was necessary to gauge areas of review of the questionnaires accordingly and before actual data collection.

Validity of the instruments was achieved by ensuring that the questions included in the questionnaire are pre-validated, precise, clear, and objective. One key observation that was made from the piloting exercise of the questionnaire was that respondents were not keen to reveal their income levels as mentioned in the primary data collection sub-topic, questionnaires section.

Questionnaires were sent randomly to five (5) respondents in each station under study. The aim of testing the clarity of the questions was to just be sure that it was possible for the respondents to answer them in line with the research objectives. The areas to review in the questionnaires would also be identified accordingly before actual data collection. The validity was determined by application of Content Validity Index (CVI). From the validation exercise, a CVI of 0.90 was obtained by outsourcing the data for analysis by SPSS. The CVI obtained was sufficient as observed by Zamanzadeh *et al*. (2015) hence the questionnaire contents were deemed valid for the study. Additionally, the choice for a 5-point Likert Scale was aimed at ensuring validity of the study results as it allows for a lower margin of error, unlike 4-point Likert Scale as any scale without a neutral option can distort results and compromise their validity. The 5-point scale gives a deeper insight of the respondents' opinion and feeling, contrary to the 4- point or rather the *"forced Likert Scale"* which forces the respondents to form another opinion if the neutral option is not included.

In ascertaining reliability of the data collection instrument, an internal consistency technique and in this case the Cronbach's Alpha was applied to the data collected in the pilot study

(Mugenda & Mugenda, 2003). The model equation that gives Cronbach's Alpha is among the instruments developed and simplified within the SPSS software where only the variables are input, and the alpha results are interpreted. The coefficient gives an unbiased estimate of how the data may be generalised. An alpha coefficient of between 0.7 and 1 is an indication that the collected data is reliable, with a relatively high internal consistency worth generalization to reflect opinions of all respondents in the target population. An alpha coefficient of 0.79 was obtained by outsourcing the collected data for analysis by SPSS. The data collection instrument was therefore deemed reliable.

In administering the questionnaires, the researcher sought the help of KRC staff at the stations as it was difficult to deal with commuters on a personal level, most of whom are in a rush to board or exit the train from the stations. This saved time for the researcher and effort to administer all the questionnaires within the limited study period. The questionnaires were serialised for tracking and left with the station masters in charge to issue appropriately. Enough time was given for them to obtain feedback from substantial number of commuters. This would also minimize chances of getting flawed results by rushing the exercise or by wrong timing of administering questionnaires.

4.9 Ethical considerations

The key ethical issues upheld during data and information gathering were:

a) **Informed consent** – no information sourced from anyone without his / her wish.
b) **Respect for privacy** – no unnecessary intrusion made into anyone's privacy.
c) **Confidentiality** – anonymity of data provider was maintained throughout the study.

4.10 Research Operationalization Matrix

Finally, a matrix for making the research operational was crafted by the researcher, based on the research objectives of the study. The matrix contained investigative questions to yield some responses for decision making. The type of variable and indicator, data source, collection, and analysis methods, what to measure and how to measure them were also captured in the matrix as given in the succeeding **Table 4.3** below.

Table 4.3 Research Operationalization Matrix (Source: Author, 2023)

Research Objectives	*(i) To investigate the best practices in planning and development of P&R stations.* *(ii) To establish the influence areas and their significance in contributing to ridership numbers to ACRS and SCRS.* *(iii) To find out the utilization levels of the P&R service at ACRS and SCRS and reasons behind such levels.* *(iv) To determine the suitability of ACRS and SCRS as P&R stations and make appropriate recommendations towards their improvement.*						
Investigative Question	**Name of Variable**	**Type of Variable**	**Indicator**	**Data Source**	**Data Collection method**	**Data Analysis Technique**	**Statistical Measure/Output**
Which place is source of the largest commuter numbers?	Source of commuters	Independent	Place names	Commuters	Questionnaire	Descriptive Analysis	Table; Frequencies. Percentages
What is the predominant land use within 5km radius of the Station?	Land use	Independent	Predominant land use activity	Field Observations, Maps	Field data & Maps review	Spatial Analysis	Spatial area description
How significant is the 5Km radius area in contributing to commuter numbers?	Influence area	Independent	Commuter numbers	Commuters	Questionnaire	Descriptive Analysis	Percentages; Bar Graphs
Which is the commonly used means of access to the station?	Transport means	Independent	Transport mode	Commuters	Questionnaire	Descriptive Analysis	Percentages; Pie charts
What is the capacity of the provided transport system	Transport facility	Independent	No. of coaches; No. of train trips	KRC Staff	Questionnaire	Quantitative Analysis	Tables; numbers
What is the average number of commuters using the station daily?	Ridership numbers	Dependent	Commuter numbers	Commuters	Questionnaire	Descriptive Analysis	Tables; Averages
What is the utilization level of the parking facility?	Level of utilization	Dependent	Utilised parking slots	KRC Staff; Author	Questionnaire; Field survey	Descriptive Analysis	Tables; Numbers; Percentages
How convenient is the provided P&R service to commuters?	P&R Service;	Dependent	Convenience level; Commuter opinion	Commuters	Questionnaire	Quantitative & Qualitative Analysis	Table, Percentages; Inferences (from qualitative analysis)

Research Objectives	*(i) To investigate the best practices in planning and development of P&R stations.* *(ii) To establish the influence areas and their significance in contributing to ridership numbers to ACRS and SCRS.* *(iii) To find out the utilization levels of the P&R service at ACRS and SCRS and reasons behind such levels.* *(iv) To determine the suitability of ACRS and SCRS as P&R stations and make appropriate recommendations towards their improvement.*						
Investigative Question	**Name of Variable**	**Type of Variable**	**Indicator**	**Data Source**	**Data Collection method**	**Data Analysis Technique**	**Statistical Measure/Output**
What are some of the appropriate practises to actualise functional P&R schemes?	Concept	Intervening	Applicable methods	Secondary Data	Literature Review	Deductive Reasoning	Applicable concepts
Would you recommend development of shopping premises and recreational facilities within or near the station to liven commuter experience?	Station area re-development	Mitigating / Intervening	Re-development proposals	Commuters. KRC Staff	Questionnaire	Descriptive Analysis	Table, Percentages,
What else could be done to attract more users to the park and ride service?	Attraction factors	Dependent	Actionable areas	Commuters KRC Staff	Questionnaire	Qualitative Analysis	Inferences

CHAPTER FIVE: DATA ANALYSIS, FINDINGS AND DISCUSSIONS

5.1 Introduction

This chapter presents the findings from the field data collection exercise to investigate the situation at the stations. A discussion of the findings made and analysis was further undertaken to support the study objectives, as well as to validate the study proposition. Any challenges encountered in the field survey were also outlined.

It is pointed out that all the data and information in tables and figures given under this chapter were all from the field survey conducted in the month of February 2023 and are therefore purely of the author's construct.

5.2 Survey Response Rate

Questionnaires were prepared as discussed in Chapter 4 and administered randomly through physical distribution to commuters of the P&R service at the stations, as given Table 5.1 below. The overall response from each of the stations is also shown.

Table 5.1 Questionnaires Response Rate

Station	No. Issued	No. Returned	% Response
Athi River	78	57	73%
Syokimau	87	62	71%

Mugenda and Mugenda (2003) opines that a response rate of 70% and above is an excellent representative of the study sample. Thus, the two stations produced adequate responses for further analysis. The non-response by other commuters was attributed to circumstances surrounding their travel inside the train like their comfort levels to allow filling of the questionnaire freely.

5.3 General Information

Demographic information was gathered from the respondents like gender, age, and the timespan the commuter has been using the commuter train. This kind of information is of vital implication in travellers' choice of P&R transport service as argued by Clayton *et al.* (2014).

5.3.1 Gender of the Respondent

The sample population in Athi River Station (ACRS) registered more male respondents which were double the size of female respondents as shown in Figure 5.1(a) below.

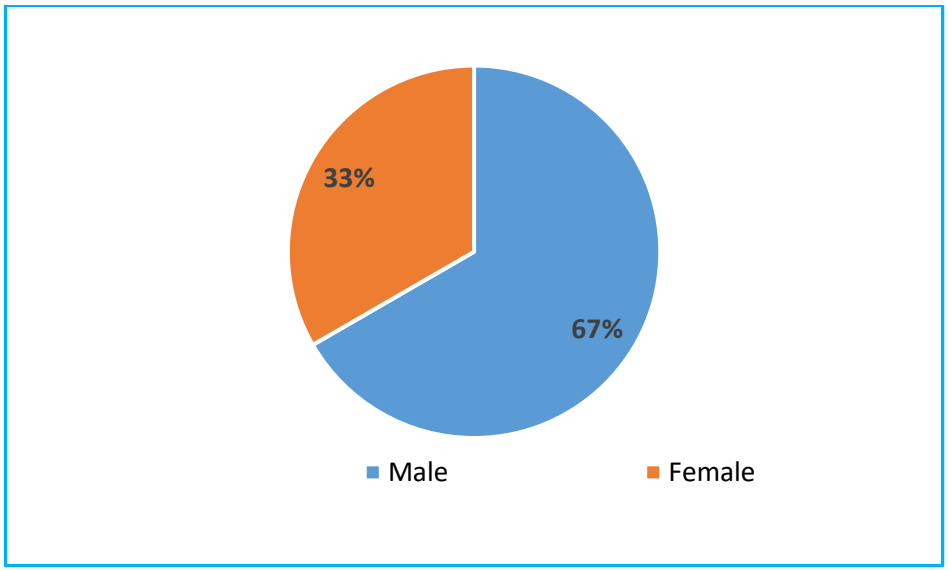

Figure 5.1(a): Gender Distribution - Athi River Station

At Syokimau Station (SCRS), the female respondents were slightly more than men at 54% as shown in Figure 5.1(b) below.

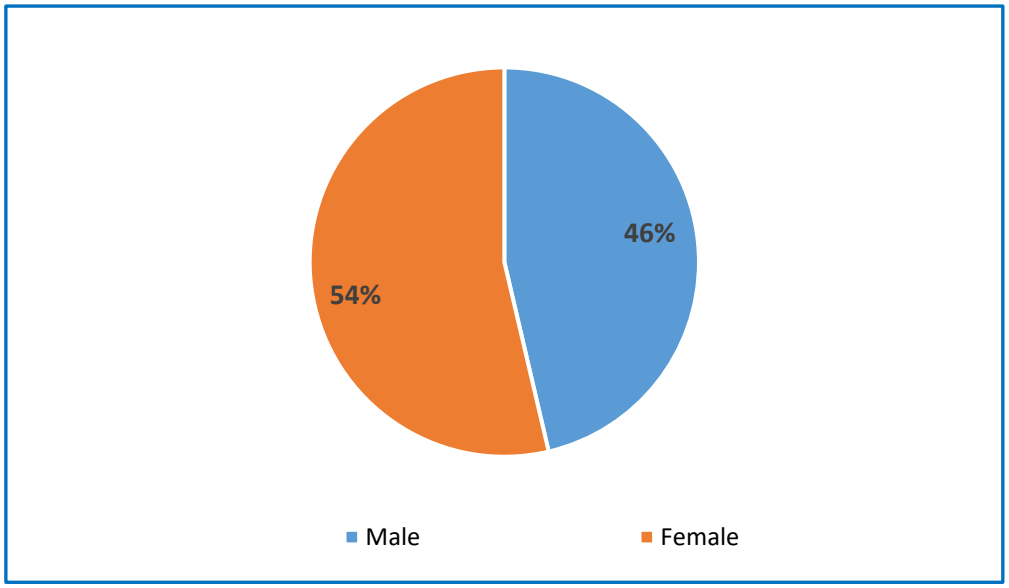

Figure 5.1(b): Gender Distribution - Syokimau Station

From the findings above, it is possible to link the high number of car users parking and riding the train at Syokimau Station with female car owners who are assumed to want to avoid the strains and stresses associated with driving to the town centre along congested roads and streets.

Conversely, this same gender at Athi River Station where car use was lower (see Section 5.4.4) was also less than the male gender.

5.3.2 Age of the Respondent

There is a strong correlation between age and travel behaviour. This can as well influence opinions arising from the survey. The figures below illustrate the age range for respondents in the study.

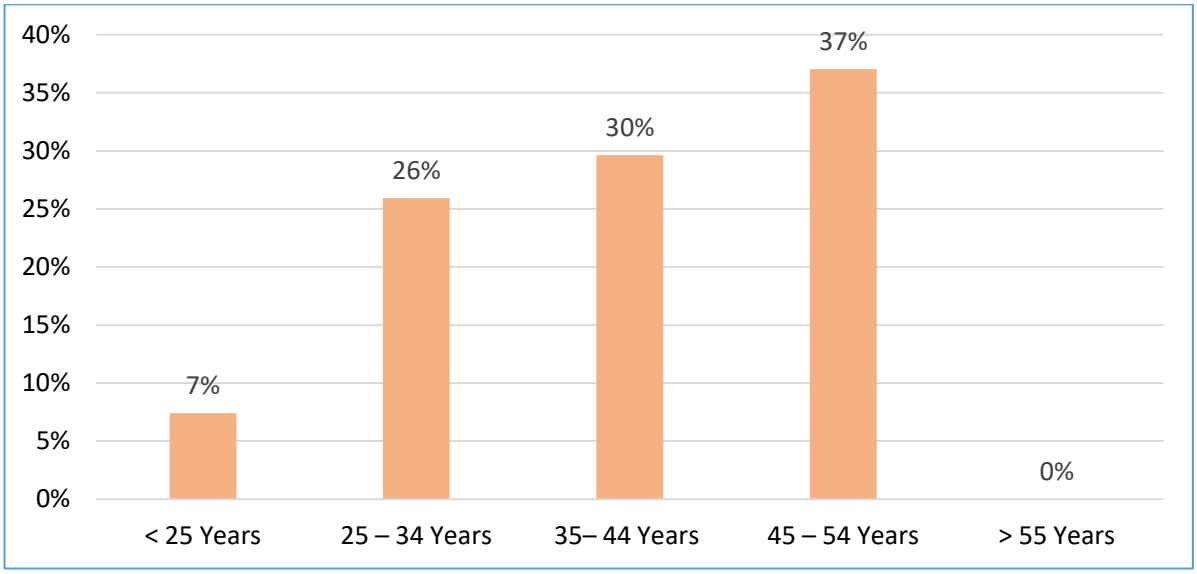

Figure 5.2(a): Age of Respondents - Athi River Station

The dominant age for respondents in Athi River Station was in the range of 45 to 54 years at 37%. However, it was also observed that the age bracket of 25 to 54 years produced the largest proportion of travellers at 93%. In many cases, this is the working population in the Kenyan labour market, which captures the start of working life after college or university studies and early retirement age at 50 years.

The next figure below further illustrates the outcome for Syokimau Station.

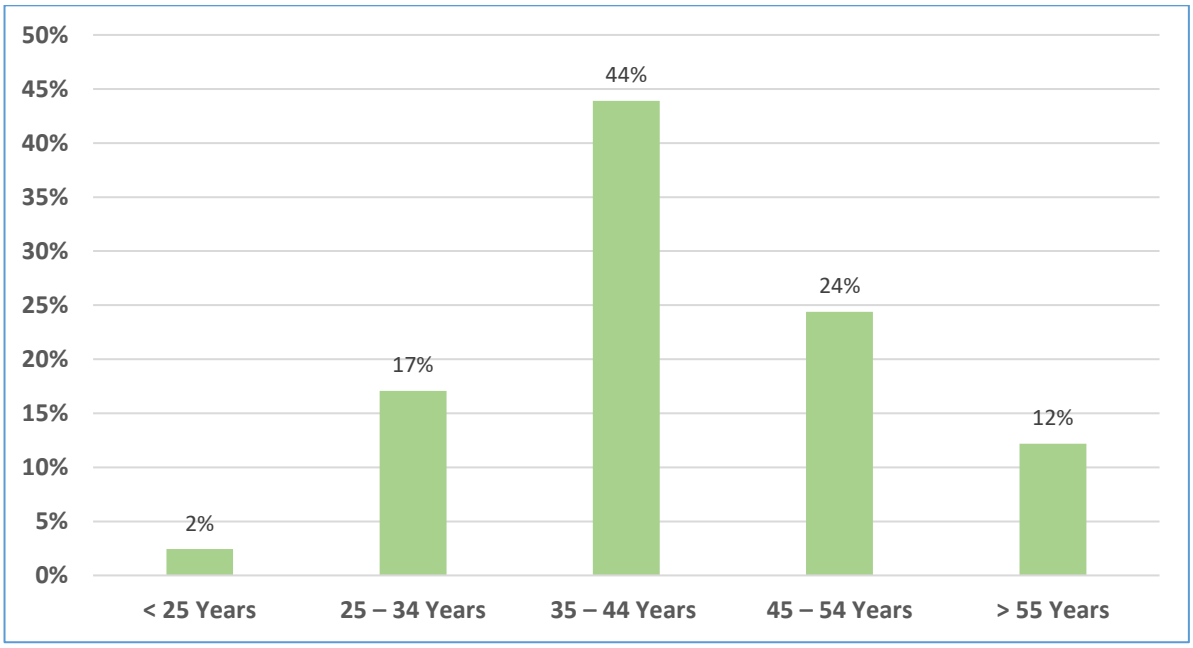

Figure 5.2(b): Age of Respondents - Syokimau Station

The dominant age for respondents in Syokimau Station was in the range of 34 to 44 years at 44%. Similarly, and like for Athi River, the station had the working age bracket of 25 to 54 years producing the largest proportion of travellers at 85%.

It may easily be concluded that most of the travellers in the two stations were workers in various companies or institutions in the private or public sector.

5.3.3 Timespan for Usage of the Commuter Train

The timespan that respondents had used the commuter train was surveyed. The aim of this data was to judge whether the respondents could speak with certainty on issues of concern that touch on the commuter train based on their experience on a day-to-day basis in using the commuter train. The results of this survey are given in the bar charts here below.

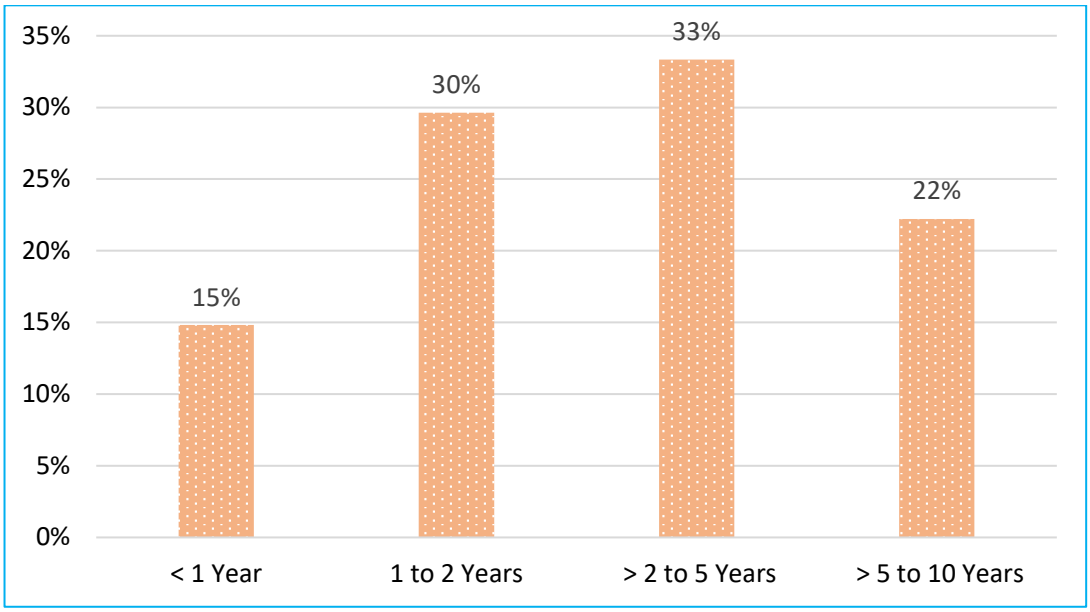

Figure 5.3(a): Years of Train Use - Athi River Station

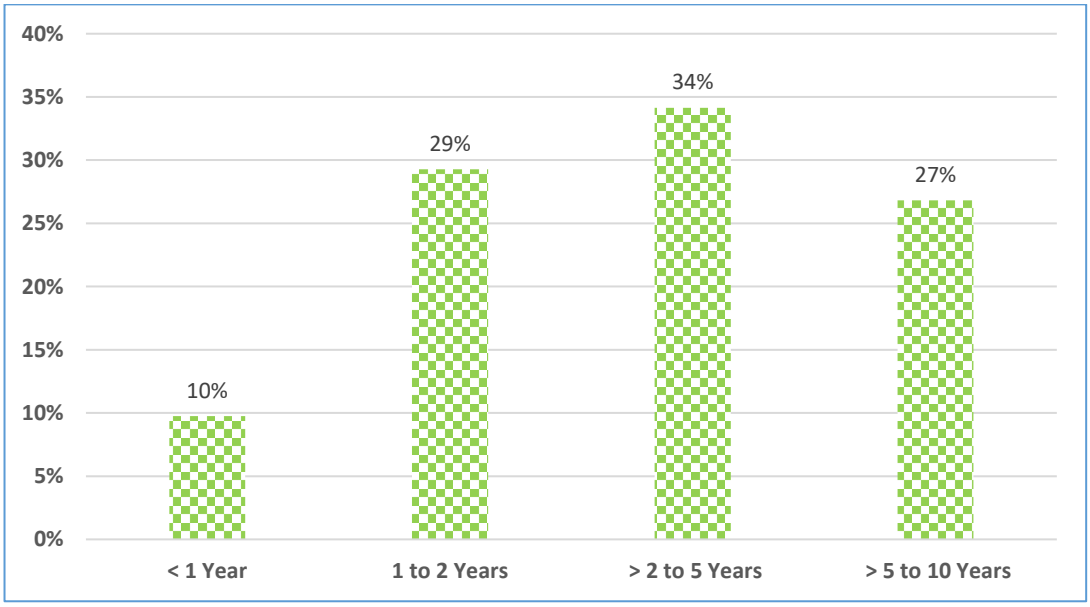

Figure 5.3(b): Years of Train Use - Syokimau Station

Both stations recorded **2 to 5 years** as the most prevalent timespan users had used the commuter train. By combination of the age ranges, a sizeable number of respondents had used the trains for over a year at 85% for ACRS and 90% for SCRS and were therefore considered to be well informed on issues of concern that have affected commuters on a day to day.

5.4 Station Influence Area, Transport and Commuter Preferences

This section was designed to establish the location where most of the commuters were coming from, their transport means to the stations, and their reasons for preferring to use the train.

5.4.1 Residence of Respondents

The source of commuters to the station was established through this tool and statistics on various sources are represented graphically in the pie chart here below.

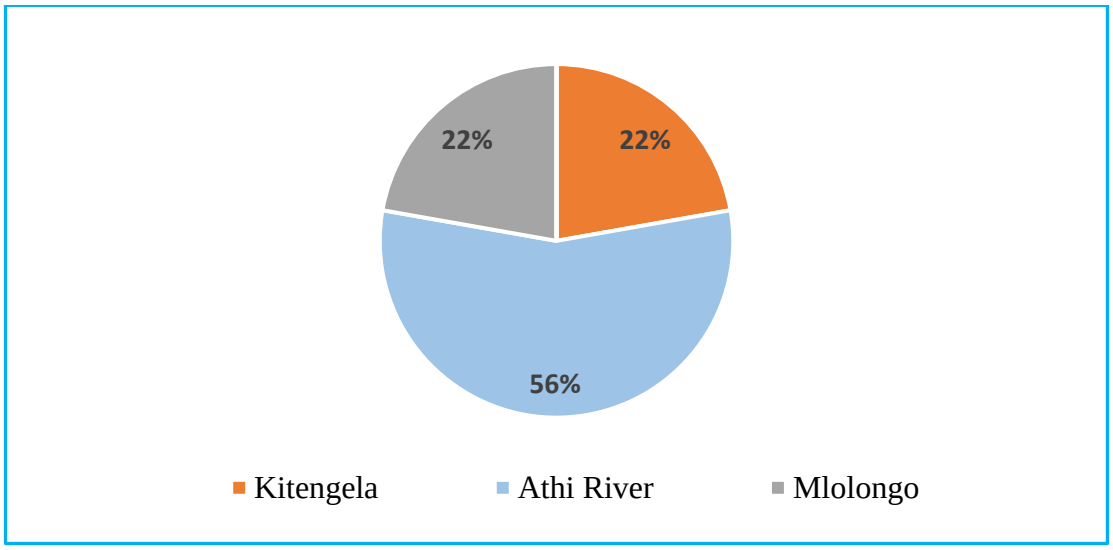

Figure 5.4(a): Respondents Residential Area - Athi River Station

From the pie chart above, it was observed that more than half of the commuter railway users in Athi River Station were from Athi River Town. The survey also revealed that there were users of the train service from Mlolongo Area (mostly expected to use Syokimau Station) which was the same number as that from Kitengela.

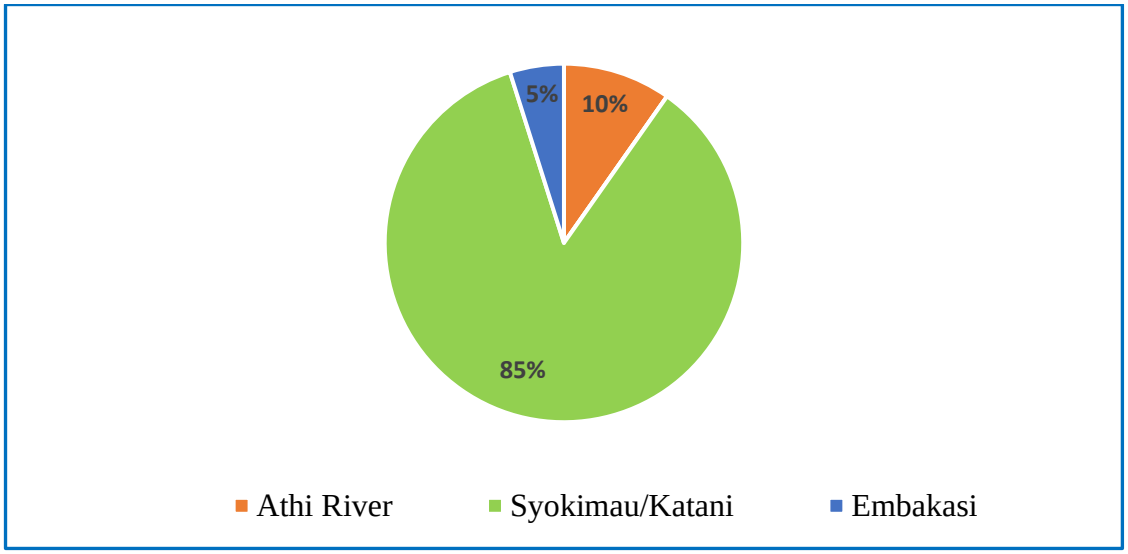

Figure 5.4(b): Respondents Residential Area - Syokimau Station

From the pie chart above, it is noted that most of the commuter railway users in Syokimau Station were from the Syokimau / Katani Residential Area.

5.4.2 Locational Distance of Residences for Respondents

Locational distances of residences for the respondents in terms of varying distances to the train station were assessed with a view to establishing the distance covered by most of the commuters and ultimately the station influence area, which is the second objective of the study.

The data below shows the results obtained from this analysis.

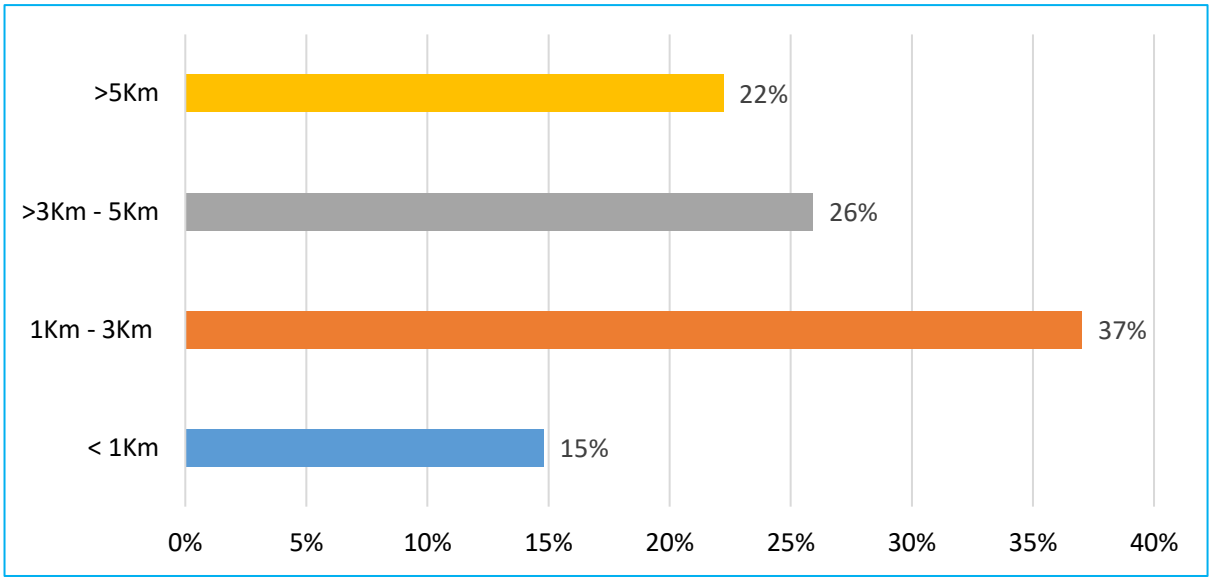

Figure 5.5(a) Residential Distances - Athi River Station

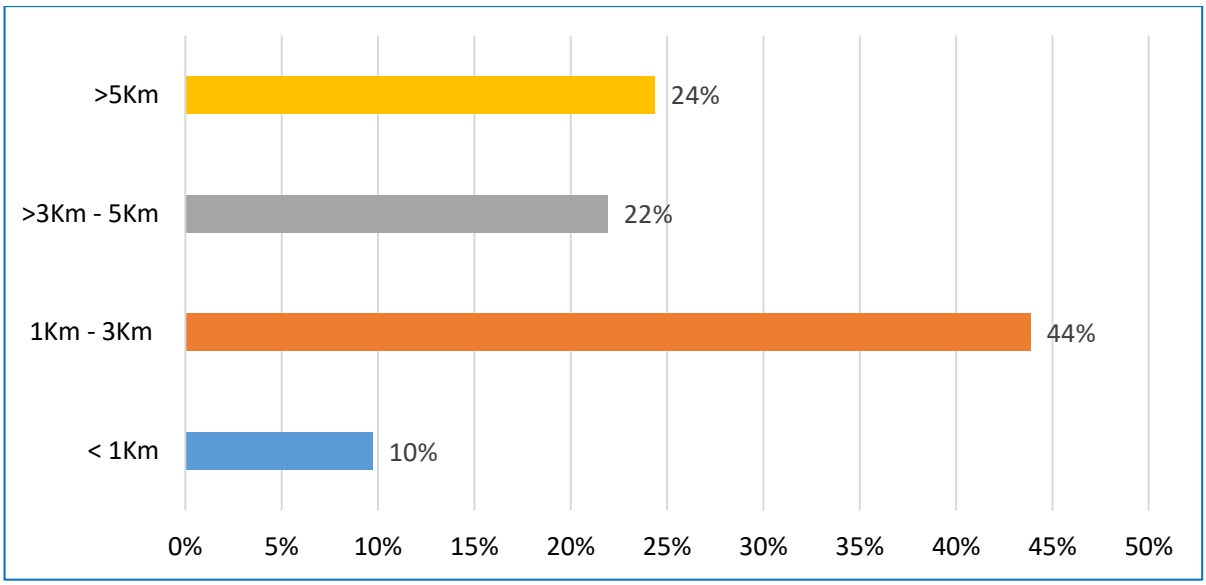

Figure 5.5(b): Residential Distances - Syokimau Station

In both cases, it was notable that over 75% of the commuters in both stations were from a 5Km radius with Athi River Station at 78% and Syokimau Station at 76%. These distances were also commensurate with the recommended locational influence areas as given under Section 2.4.3.3 - Influence Area and Demand Estimation and in Table 2.1.

5.4.3 Reasons for Preferring the Commuter Train

The survey sought to establish on some pre-determined reasons why the commuters preferred to use the P&R service. The objective was to identify the most popular reasons which would then require appropriate measures to best address it to improve utilization of the P&R service. This would aid in answering the third and fourth objectives of the study. The five-point Likert Scale rating was applied in this survey with parameters defined as follows:

1 = Strongly Disagree (SD); **2** =Disagree (D); **3** =Neutral (N); **4** = Agree (A) and **5** = Strongly Agree (SA).

To analyse the most popular reason in using the P&R service, there was aggregation of measures **4** = Agree and **5** = Strongly Agree. Similarly, to analyse the least popular reason in using the P&R service, measures **1** = Strongly Disagree and **2** = Disagree were combined for a unified score. The analysis then excluded parameter **3**-Neutral since it was interpreted as indecision by the respondents. The outcome of the survey for the two stations is given in the tables here below. A similar approach was used for all the subsequent Likert scale cases undertaken in the study.

Table 5.2(a) Reasons for Commuter Train Preference – Athi River Station

S/No.	Description	Least Popular (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Popular (4 & 5)
1	To avoid traffic jams	**8.3%**	8.3%	0.0%	8.3%	37.5%	45.8%	**83.3%**
2	To save on travel cost and time	**20.8%**	12.5%	8.3%	12.5%	20.8%	45.8%	**66.7%**
3	The station parking cost is less than the parking fee in Nairobi CBD	**9.5%**	4.8%	4.8%	23.8%	28.6%	38.1%	**66.7%**
4	The train service is safe and secure	**4.3%**	4.3%	0.0%	4.3%	34.8%	56.5%	**91.3%**
	Average Percentage	**10.8%**	**7.5%**	**3.3%**	**12.2%**	**30.4%**	**46.6%**	**77.0%**

From the analysis illustrated in Table 5.2(a) above for Athi River Station, safety and security of the train emerged the most popular and agreed reason for preferring the train at 91.3%. This finding may have a correlation with age of the train users as established at Athi River station most of whom were falling in the 45 to 54 years age bracket. This age group may want to take the secure and safe options of transport to avoid accidents. Avoidance of traffic jams followed at

83.3% while savings on travel cost and time tied with the station parking cost being less than that at Nairobi CBD, the destination point, at 66.7%.

Generally, 10.8% of the respondents conveyed their disagreement with the statements as factors influencing commuter train preference with only 12.2% of them indicating their neutrality in the reasons. A total of 77% of respondents agreed with the reasons thus validating their relevance and significance in usage of the commuter train.

Table 5.2(b) Reasons for Commuter Train Preference – Syokimau Station

S/No.	Description	Least Popular (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Popular (4 & 5)
1	To avoid traffic jams	**7.9%**	5.3%	2.6%	5.3%	21.1%	65.8%	**86.8%**
2	To save on travel cost and time	**10.3%**	0.0%	10.3%	10.3%	17.9%	61.5%	**79.5%**
3	The station parking cost is less than the parking fee in Nairobi CBD	**14.3%**	5.7%	8.6%	14.3%	14.3%	57.1%	**71.4%**
4	The train service is safe and secure	**13.9%**	2.8%	11.1%	8.3%	19.4%	58.3%	**77.8%**
	Average Percentage	**11.5%**	3.4%	8.1%	9.5%	18.2%	60.7%	**78.9%**

From the analysis in Table 5.2(b) above for Syokimau Station, avoidance of traffic jams emerged the most popular and agreed reason for preferring the train at 86.8% followed by savings on travel cost and time at 79.5% while safety and security followed closely at 77.8% with the station parking cost being less than that at CBD coming last at 71.4%.

Overall, 11.5% of the respondents voiced their disagreement with the statements as reasons influencing commuter train preference with only 9.5% of the respondents indicating their neutrality in the reasons. A total of 78.9% of respondents agreed with the reasons thus validating their relevance and significance in usage of the commuter train.

5.4.4 Car Ownership Statistics for Commuters

A key variable that this research sought to investigate is the number of car-owning commuters for each of the study station. The pie charts below represent the percentage ownership of cars among the train commuters.

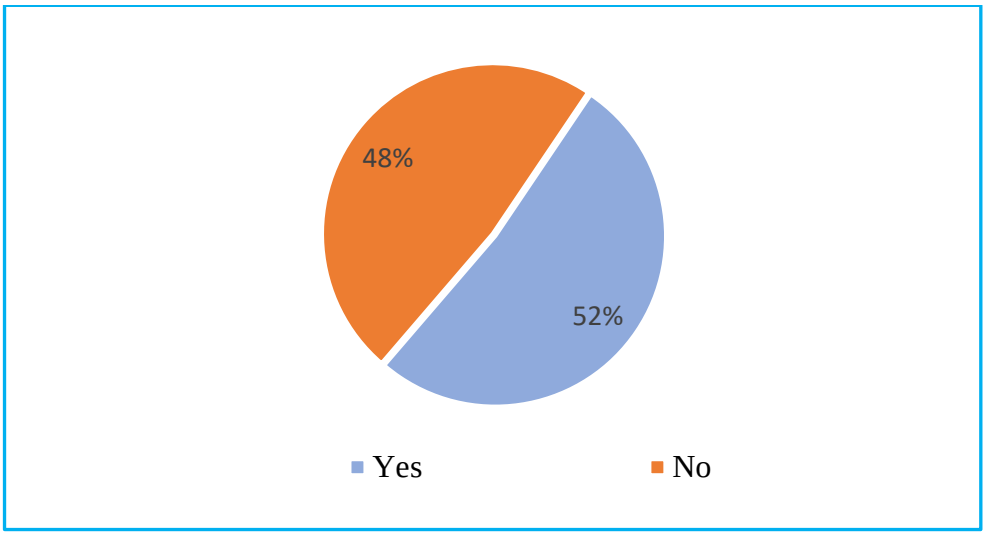

Figure 5.6(a): Commuters Car Ownership at Athi River Station

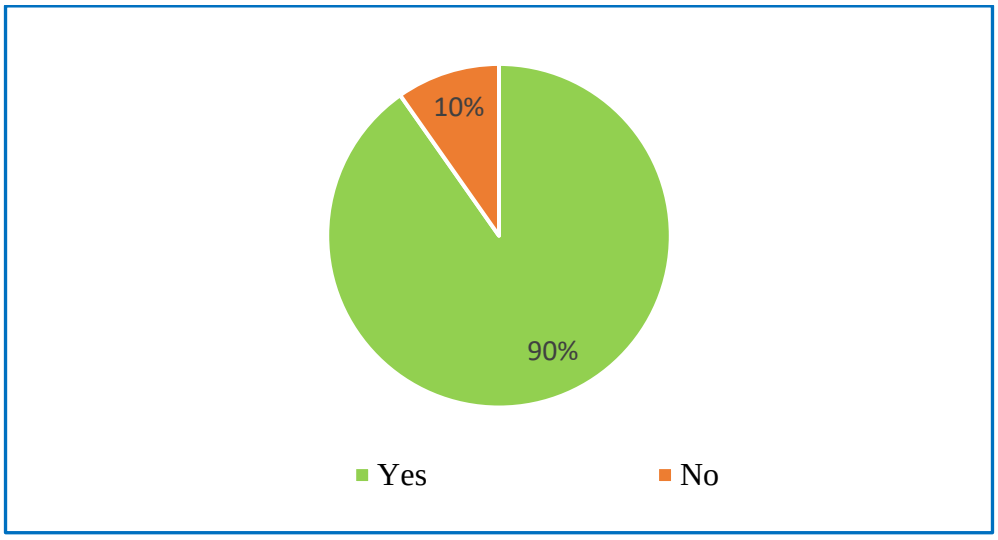

Figure 5.6(b): Commuters Car Ownership at Syokimau Station

As may be seen from the pie charts above, use of personal car to access the stations was dominant at Syokimau Station at 90% as compared to Athi River Station at 48% (nearly half the number at Syokimau). A further investigation of alternative means of access to the station revealed that 71% of respondents at Athi River Station relied on walking against 41% in Syokimau Station. This was a clear indication that car use in accessing Athi River Station was low. This finding would have significance in proffering recommendations for sustainability of the station as P&R facility as envisaged under the fourth objective of the study.

5.4.5 Convenience of the Park-and-Ride Service

The P&R service was further evaluated in terms of satisfaction of the commuters to the facilities offered by KRC. The five-point Likert scale was applied in this evaluation for defined areas of facility provision. The following key areas were explored:

a) Parking for commuters.
b) Prevailing train departure and arrival schedule; and
c) The available public transport means (matatu or connector bus) to take passengers to the stations.

5.4.5.1 Parking for Commuters

The Parking for each station was evaluated separately as given in the tables below.

Table 5.3(a) Parking Convenience at Athi River Station

S/No.	Statement	Least Convenient (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Convenient (4 & 5)
1	Parking fee is affordable	**15.4%**	0.0%	15.4%	7.7%	46.2%	30.8%	**76.9%**
2	Payment mode is convenient	**30.8%**	7.7%	23.1%	23.1%	30.8%	15.4%	**46.2%**
3	Parking facility is accessible	**7.7%**	0.0%	7.7%	7.7%	53.8%	30.8%	**84.6%**
4	Cars are secure in the parking	**0.0%**	0.0%	0.0%	7.7%	38.5%	53.8%	**92.3%**
5	Persons with disability can use it conveniently	**8.3%**	0.0%	8.3%	16.7%	58.3%	16.7%	**75.0%**
	Average Percentage	**12.4%**	**1.5%**	**10.9%**	**12.6%**	**45.5%**	**29.5%**	**75.0%**

From the analysis illustrated in Table 5.3(a) above for Athi River Station, parking convenience ranked as follows:

a) Security of cars at the parking was highest ranked at 92.3%.
b) Accessibility of the parking followed at 84.6%.
c) Affordability of parking fee and usability of the P&R service by persons with disability ranked closely at third and fourth with 76.9% and 75% respectively.
d) Convenience of the payment mode for parking scored lowest at 46.2%.

12.4% of the respondents disagreeed with the statements on parking facility provided and influencing utilization of the facility with 12.6% of the respondents indicating their neutrality in the reasons. A total of 75% of respondents agreed with the reasons thus validating the status quo of the parking facility.

However, the survey took a keen attention on the **payment mode used at the station** being the lowest ranked in importance and which also elicited an appreciably high proportion of negative

responses compared to the rest with 30.8% disagreeing with the statement. In this regard, various respondents suggested adoption of other convenient methods of payment which were:

(i) Fully automate car park payment system.

(ii) Introduce MPesa payments for parking.

Here below are the results for Syokimau Station on the same aspects of parking.

Table 5.3(b) Parking Convenience at Syokimau Station

S/No.	Statement	Least Convenient (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Convenient (4 & 5)
1	Parking fee is affordable	**13.9%**	11.1%	2.8%	11.1%	22.2%	52.8%	**75.0%**
2	Payment mode is convenient	**11.4%**	5.7%	5.7%	14.3%	28.6%	45.7%	**74.3%**
3	Parking facility is accessible	**5.6%**	5.6%	0.0%	11.1%	27.8%	55.6%	**83.3%**
4	Cars are secure in the parking	**8.3%**	5.6%	2.8%	8.3%	19.4%	63.9%	**83.3%**
5	Persons with disability can use it conveniently	**6.1%**	3.0%	3.0%	27.3%	15.2%	51.5%	**66.7%**
	Average Percentage	**9.1%**	**6.2%**	**2.9%**	**14.4%**	**22.6%**	**53.9%**	**76.5%**

From the analysis above for Syokimau Station, parking convenience ranked as follows:

(a) Parking accessibility and security of cars at the parking were highest ranked and tied at 83.3%.

(b) Affordability of the parking fee and convenience of the parking method ranked closely at second and third with 75% and 74.3% respectively.

(c) Usability of the P&R service by persons with disability scored lowest at 66.7%.

9.1% of the respondents conveyed their disagreement with the statements with only 14.4% of the respondents deciding to be neutral. A total of 76.5% of respondents agreed with the reasons thus validating the parking facility and its significance in usage of the commuter train.

5.4.5.2 Trains Schedule and Means of Access to the Stations

The convenience of the stations was again evaluated against three statements tailored on the available means of access and the commuter train timetable as scheduled by KRC. These two aspects were evaluated together as the prevailing departure/arrival schedule may influence a traveller's choice of the means to use to access station. The results on the statements assessed on

a Likert scale and pie charts on suitability of the train schedules are given here below. This assessment aided in answering the third and fourth objective of the study.

a) Athi River Station

Table 5.4(a) Athi River Station Train Schedule and Station Access

S/No.	Statement	Least Preferred (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Preferred (4 & 5)
1	The train departure/arrival schedule time is convenient	**29.6%**	14.8%	14.8%	22.2%	25.9%	22.2%	**48.1%**
2	My residential area has no available public transport means (matatu, bus) to take passengers to the station	**19.2%**	15.4%	3.8%	15.4%	15.4%	50.0%	**65.4%**
3	Introducing a Railway Connector Bus or PSV in my area can increase the number passengers to the train station	**12.5%**	4.2%	8.3%	20.8%	20.8%	45.8%	**66.7%**
	Average Percentage	**20.5%**	**11.5%**	**9.0%**	**19.5%**	**20.7%**	**39.4%**	**60.1%**

The ranking on the three statements for Athi River Station above was as follows:

a) Introduction of a railway connector bus was highest at 66.7%
b) Response on areas without public transport for access to the stations followed with 65.4% (needs connector bus)
c) Train schedule was last at 48.1%.

The convenience of the train schedule was further investigated by requesting the respondents to indicate their preferred train departure and arrival timings. Kenya Railways operates only one train trip to and from the Athi River Station each day from Monday to Friday. The findings of this running schedule against any other preferred timings by respondents are capture in the pie charts below.

(i) Athi River Morning Train

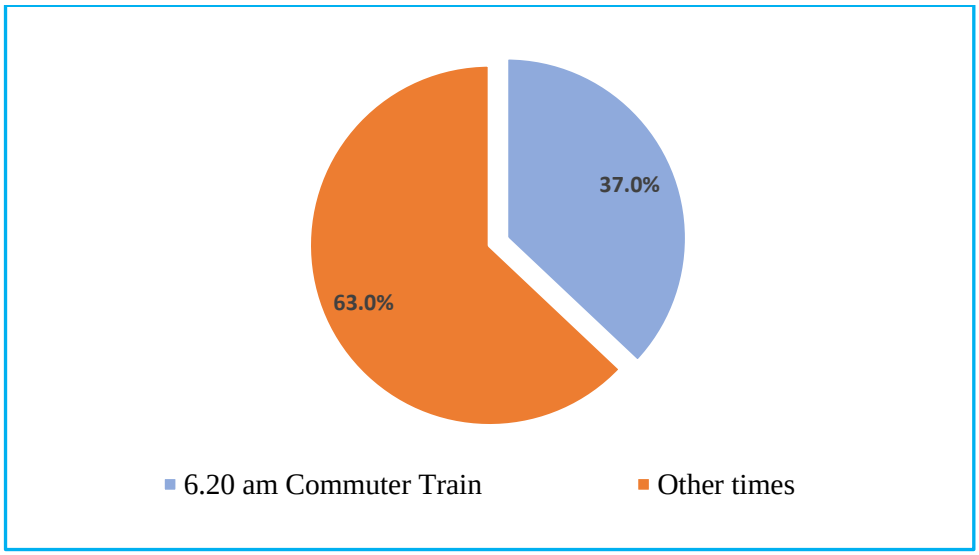

Figure 5.7(a): Athi River Train Preferred Morning Departure Time

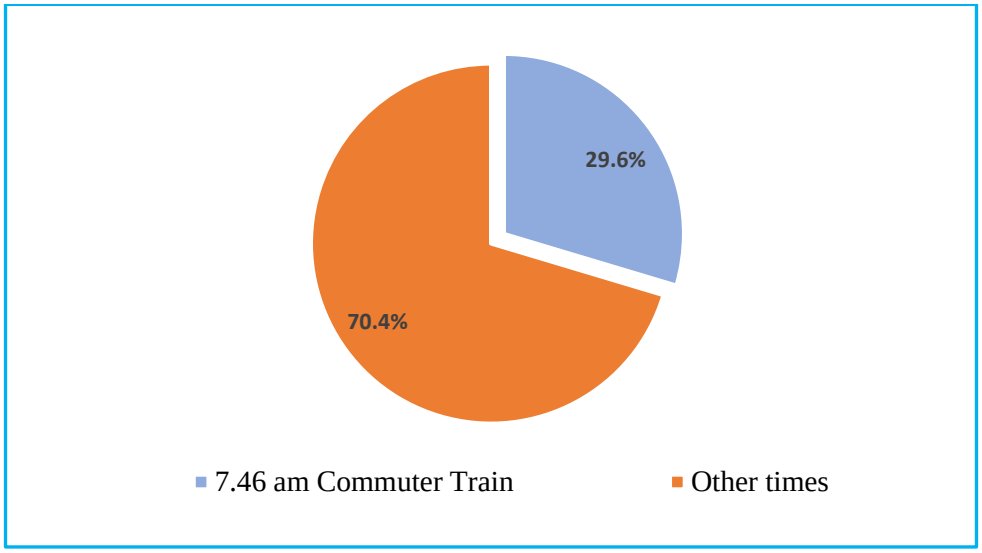

Figure 5.7(b): Athi River Train - Preferred Morning Arrival Time at Nrb CBD Central Station

The outcome of the survey on the Athi River Commuter train schedule, morning departure at 6.20am and arrival at CBD central station at 7.46am which takes 1hr and 26 mins revealed that the current departure and arrival times at 37% and 29.6% respectively by the respondents is not convenient for the commuters.

(ii) Athi River Evening Train

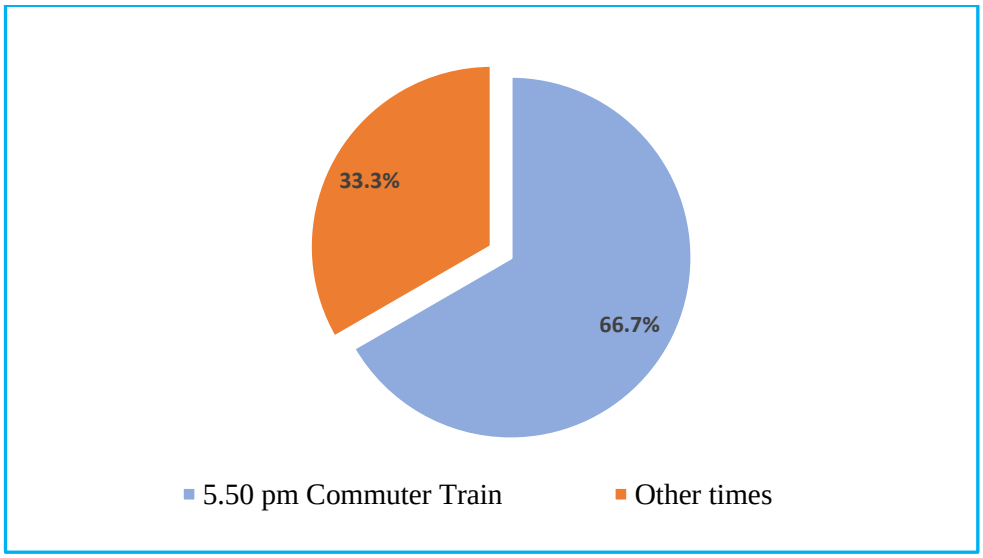

Figure 5.7(c): Athi River Train Preferred Departure Time from Nrb Central Station

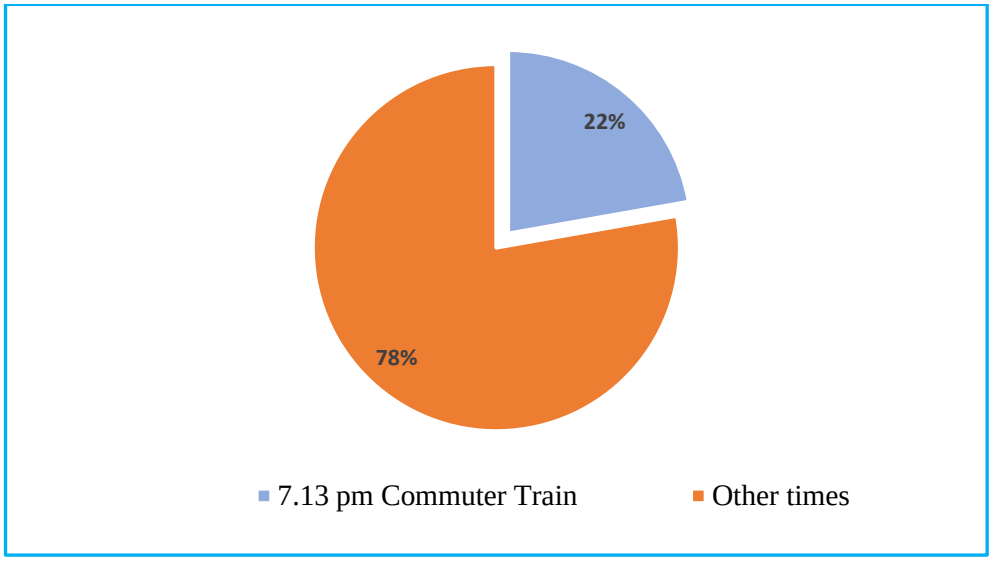

Figure 5.7(d): Athi River Train Preferred Evening Arrival Time at Athi River Station

From the pie charts on evening departure time here above, it was of interest to learn that the evening departure time of 5.50 pm from Nairobi Central Station was preferred by most of the respondents at 66.7% while the arrival time of 7.13 pm at Athi River was not convenient for many, scoring lowly at 22%. The resultant train journey was 1hr and 23minutes nearly the same as the morning journey.

Thus, from the analysis above, ***only the evening departure time from Nairobi CBD Central Station*** was found to be okay with most of the commuters at ACRS.

b) Syokimau Station

Table 5.4(b) Syokimau Station Train Schedule and Station Access

S/No.	Statement	Least Preferred (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Preferred (4 & 5)
1	The train departure/arrival schedule time is convenient	**10.8%**	0.0%	10.8%	18.9%	45.9%	24.3%	**70.3%**
2	My residential area has no available public transport means (matatu, bus) to take passengers to the station	**26.5%**	20.6%	5.9%	17.6%	23.5%	32.4%	**55.9%**
3	Introducing a Railway Connector Bus or PSV in my area can increase the number passengers to the train station	**8.1%**	5.4%	2.7%	10.8%	16.2%	64.9%	**81.1%**
	Average Percentage	**15.1%**	**8.7%**	**6.5%**	**15.8%**	**28.6%**	**40.5%**	**69.1%**

The ranking on the three statements for Syokimau Station above was as follows:

a) Introduction of a railway connector bus was highest at 81.1%
b) Train schedule was second at 70.3%
c) Areas without public transport for access to the stations ranked lowest at 55.9%.

The convenience was further investigated by requesting the respondents to indicate their preferred train departure and arrival timings based on the various train trips that Kenya Railways runs to and from the Syokimau Station. In the morning, KRC operated three (3) train trips while in the evening, the train trips were reduced to two (2). The findings of this survey on the prevailing train schedules operated at Syokimau Station are capture in the pie charts below.

(i) Syokimau Morning Trains

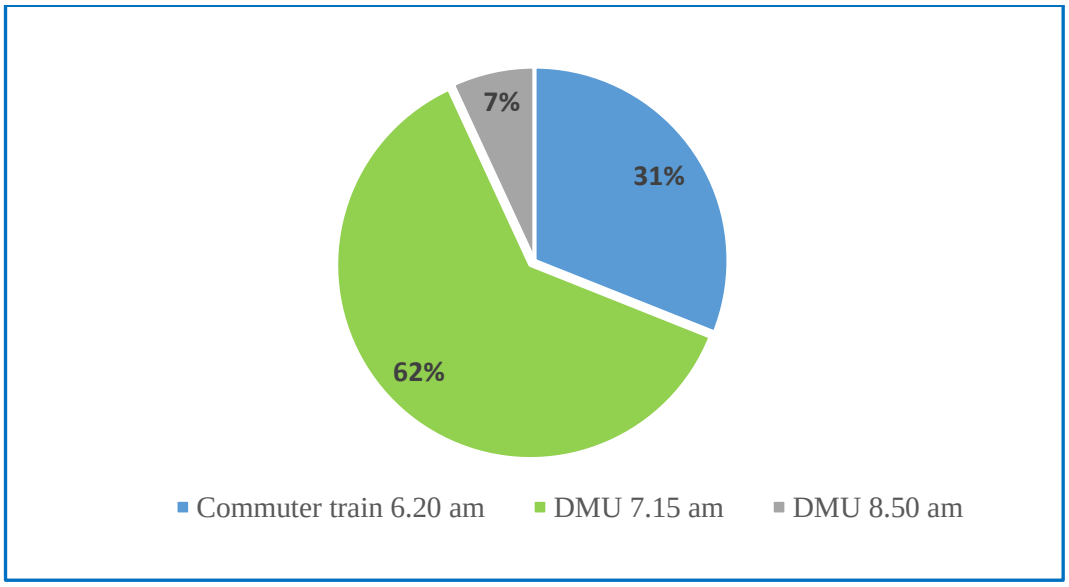

Figure 5.8(a): Preferred Morning Departure Train Schedule - Syokimau Station

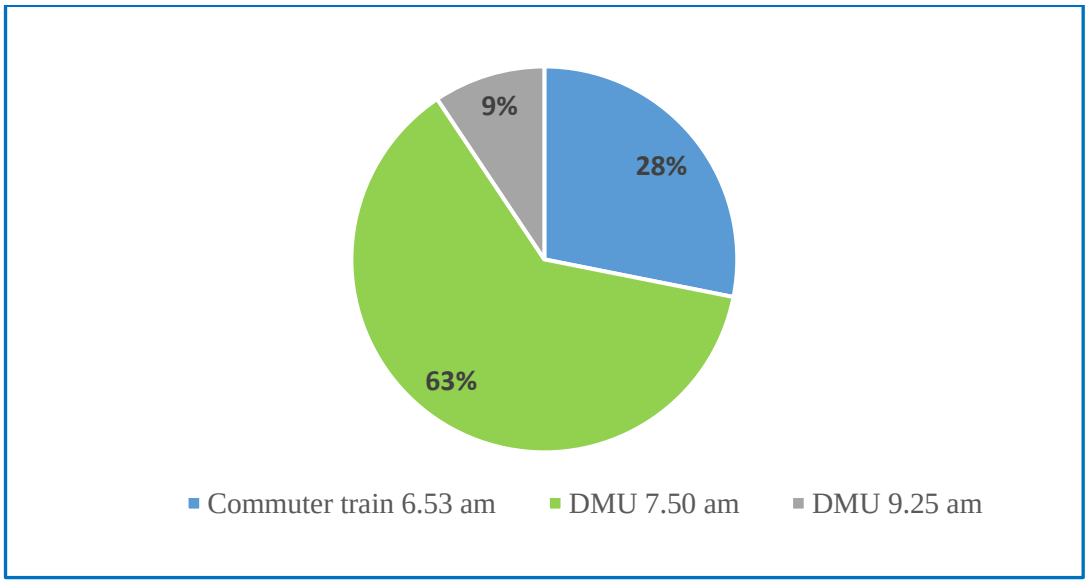

Figure 5.8(b): Preferred Morning Nrb CBD Arrival Train Schedule - Syokimau Station

As can be seen from the pie charts 5.5(a) and (b) above, the DMU schedule option introduced by Kenya Railways at Syokimau Station emerged the most preferred at 62% for departure at 7.15 am and 63% arrival at CBD at 7.50 am respectively.

(ii) Syokimau Evening Trains

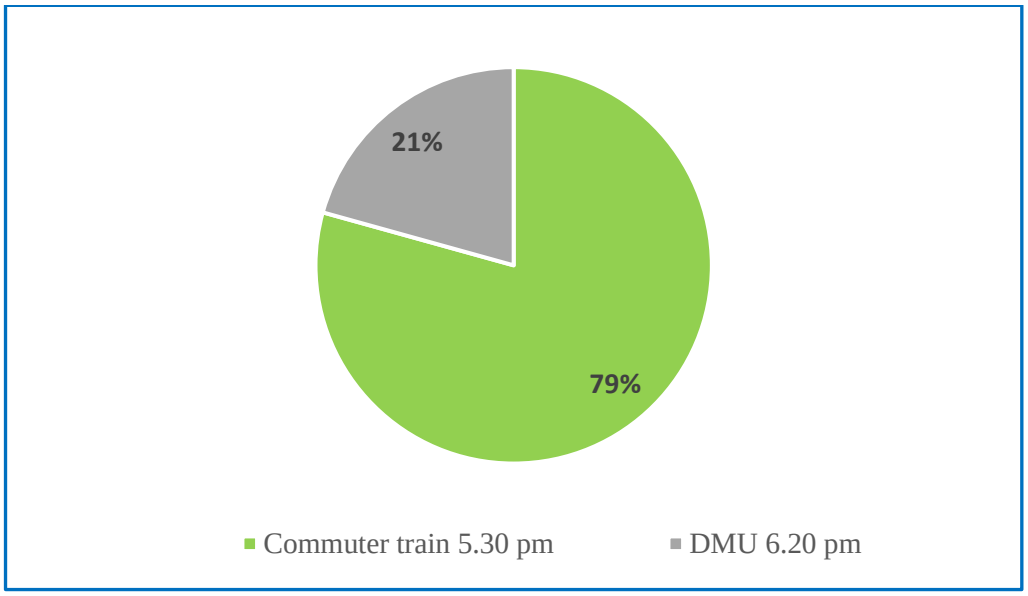

Figure 5.8(c): Preferred Evening Nrb CBD Departure Train Schedule - Syokimau Station

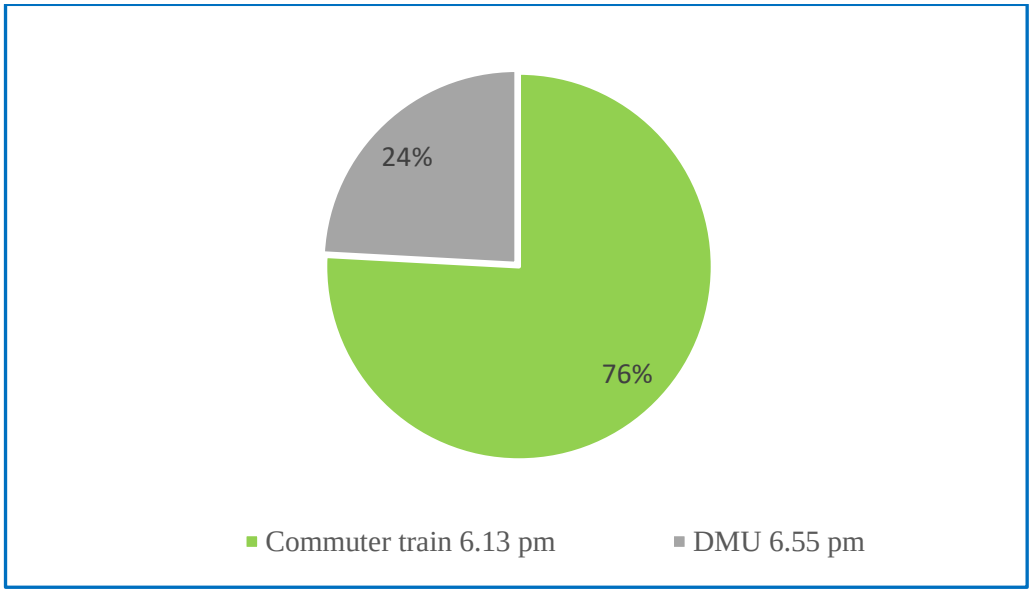

Figure 5.8(d): Preferred Evening Arrival Train Schedule - Syokimau Station

From the analysis by pie charts here above, the ordinary evening commuter train with a schedule of 5.30 pm departure from CBD Central Station and 6.13 pm arrival at Syokimau Station emerged the most preferred at 79% and 76% respectively. Apparently, the type of train operated didn't matter as DMU was unpopular in the evening return trip while it was popular in the morning trip, which is implies the running schedule is more critical in terms of departure and arrival timings.

5.4.5.3 Suggestions on Ways to Improve on the Park-and-Ride Service

Respondents were further required to give suggestions on what they thought KRC should do to improve the convenience of the P&R service. The varied suggestions given were extracted from the questionnaires as itemised here below.

a) Suggestions by Commuters

- Put up more infrastructure on the stations such as commuting videos, security lights, car sheds, car wash facilities etc.
- Adhere to time schedule and avoid stop overs (express train).
- Undertake media campaigns to enlighten the public on existence of the P&R service.
- Introduce new or modern trains to attract more users to the P&R service.
- Make the parking fees and fare rates affordable to many commuters.
- Fully automate car park payment system.
- Introduce MPesa payments for parking.
- Avail pre-loaded cards for payment at the entry gates to the riding platform.
- Allow 24hrs access to the station for commuters to pick their cars.
- Introduce much faster train or a DMU to depart from ACRS at 7.30am.
- Reduce the journey time taken by the train to and from ACRS to maximum 40 minutes.
- Run more than three train trips in a day to Athi River for more options to the public.
- Introduce another rail line from Imara Daima to Central Station to avoid wasting time waiting for the other trains from Embakasi, Ruiru, etc to pass.
- Introduce a P&R service at Kitengela Station.
- Repair the road serving ACRS from the Athi river - Namanga Highway. The rail-road junction crossing is very rough for cars.

b) Suggestions by Station Managers

Similarly, the station managers for the two stations were requested for feedback from customer perspective point of view based on their experience derived from handling commuters. The consolidated feedback cutting across both stations as received is as given below: -

- Advertise or market the P&R service to increase awareness by urban dwellers.
- Introduce DMUs which are faster to the routes.

- Introduce overnight parking in case one is delayed in town to pick the car before 9pm (cars parked beyond this time attracts a fine).
- Develop and introduce differentiated fares for DMUs considering peak and off-peak hours for increased patronage of the service.
- Introduce amenities like car wash and electric vehicle charging points at the advent of electric driven vehicles.

As may be seen from the feedback by both commuters and the station managers, the following suggestions featured prominently and may comprise the quick wins that KRC could take to improve the P&R service:

(i) Introduce faster trains like DMUs to the Athi River Route.
(ii) Carry out Media campaigns on the use of commuter rails to enlighten the urbanites.
(iii) Allow 24hrs access to the station by commuters to collect cars.
(iv) Develop and introduce differentiated affordable fares for various train trips (DMUs) considering peak and off-peak hours for increased patronage of the service.
(v) Introduce amenities like car washing facilities, car shed, security lights commuting videos and even electric vehicle charging points at the advent of electric driven vehicles.

5.5 Land Use Factors and Station Area Re-configuration

This is the last and final section of the questionnaires which aimed at establishing whether the station users or commuters would prefer other essential investments of residential, commercial, or recreational nature within and around the stations. This could be achieved by way of land use changes that can be occasioned to transform the stations and their environs. KRC might consider developing or facilitating the investments through other entities.

By reconfiguring the area based on the ascertained needs, this could make them more attractive and even increase the ridership numbers in future and goes a long way in answering the fourth objective of the study.

The survey was based on statements measured on a 5-point Likert Scale as shown below.

Table 5.5(a) Athi River Station Area Land Use Changes and Transformation

S/No.	Statement	Least Accepted (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Accepted (4 & 5)
1	If there were affordable houses near the station, I would prefer them for my access convenience	**30.8%**	19.2%	11.5%	19.2%	11.5%	38.5%	**50.0%**
2	KRC should develop shopping premises/mini malls within the station area to allow commuters to shop for basic items on their way home in the evening	**25.9%**	14.8%	11.1%	3.7%	29.6%	40.7%	**70.4%**
3	Recreational facilities like landscaped mini parks with benches or a fitness gym are necessary to liven or energize the commuter experience at the station	**17.2%**	10.3%	6.9%	13.8%	34.5%	34.5%	**69.0%**
	Average Percentage	**24.6%**	**14.8%**	**9.8%**	**12.2%**	**25.2%**	**37.9%**	**63.1%**

Table 5.5(b) Syokimau Station Area Land Use Changes and Transformation

S/No.	Statement	Least Accepted (1 & 2)	1 (SD)	2 (D)	3 (N)	4 (A)	5 (SA)	Most Accepted (4 & 5)
1	If there were affordable houses near the station, I would prefer them for my access convenience	**24.3%**	13.5%	10.8%	24.3%	16.2%	35.1%	**51.4%**
2	KRC should develop shopping premises/mini malls within the station area to allow commuters to shop for basic items on their way home in the evening	**18.9%**	5.4%	13.5%	13.5%	18.9%	48.6%	**67.6%**
3	Recreational facilities like landscaped mini parks with benches or a fitness gym are necessary to liven or energize the commuter experience at the station	**16.2%**	8.1%	8.1%	18.9%	8.1%	56.8%	**64.9%**
	Average Percentage	**19.8%**	**9.0%**	**10.8%**	**18.9%**	**14.4%**	**46.8%**	**61.3%**

From Tables 5.5 (a) and (b) above, it can be observed that development of shopping premises or mini malls within the station area for shopping by commuters emerged the most accepted or popular change that can be introduced at both stations with ACRS at 70.4% and SCRS at 67.6%. The introduction of recreational facilities like landscaped mini parks or fitness gyms came close at second place with 69% for ACRS and 64.9% for SCRS respectively. Affordable housing near the stations scored averagely at 50% and 51.4% for ACRS and SCRS respectively.

However, it is not sensible to assume that all users of P&R stations will be car users as there will still be the walking population or the proportion of users using connector PSV for transport.

5.6 Research Proposition

The research proposition advanced by the researcher was that the car parking provided at Athi River Station has low utilization. The data below obtained from field investigation was used to analyse and make deductions for this proposition.

Table 5.6: Available versus Utilized Parking in both Stations (Source: Author, 2023)

Station	Available Parking Slots	No. of Cars Parked per day (Average)	Unutilized Car Park Slots	% Utilized
Athi River	200	20	180	10%
Syokimau	360	120	240	33%

From **Table 5.6** above, the study established that the utilisation level of parking at Athi River Station was at 10% while that at Syokimau Station was at 33%. This study finding therefore fully supported the proposition that the car parking at Athi River Station has low utilization. However, the utilized parking at Syokimau Station was also quite low at 33%, with a decreasing trend in current times. The station master for Syokimau Station indicated that before the opening of the Nairobi Expressway, the station had quite a good turnout of car users as the parking would nearly be full to capacity, as may be seen from figure 1.1. The development of the Nairobi Expressway is deemed to have contributed to the drop in commuter numbers probably due to the reduction of congestion along the traversed corridor, thus making car users to choose to travel all the way to Nairobi CBD and environs.

5.7 Performance Assessment for the Stations

As discussed in Sub-chapter 2.7.1, the performance of the stations was assessed on the basis of seven (7) key criterion items that influence the functioning and success of a P&R Station. Each of the criterion item was assigned a percentage weight to enable a rational evaluation (Manns, 2010) on a rule of thumb basis (Kenya Roads Board, 2023) and depending on its significance in the whole P&R ecosystem. This was carried out as follows:

- the most significant determinants on the success of P&R (attaining expected ridership and utilizing the parking effectively) were each assigned more than a quarter of the total percentage weight, each at 30% thus taking 60% of the total percentage weight of 100%.
- moderately significant determinants (commuters' preferences of travel and the operating schedule convenience) were assigned percentage weights in the range of 10% to 25%.
- Other less significant determinants received less than 10% each from the total percentage weight.

Table 5.7 below gives a summary of the performance assessment. The table contains the criterion description, remarks on importance of each criterion, assigned percentage weight for each criterion, the results obtained for each criterion per station and its final weighted score (obtained by multiplication of the assigned % weight by the results obtained from the survey). The overall performance index per station was obtained by summation of all the criterion weighted scores. The reference source of the input data (results) was also included.

For clarity, it is further noted that the results applied to weight the criterion for developing socio-economic facilities like shopping premises/mini malls within the station area as obtained in Table 5.5(a) and (b) was based on the negative response obtained which indicates that the status quo of the stations is to be maintained. In that way, its performance before the development of the facilities will have been gauged.

Table 5.7: Performance Assessment Results for ACRS & SCRS (Source: Author, 2023)

S/No.	Criterion Description	Remarks on Importance of the Criterion	Assigned % Weight	ACRS Results (%)	SCRS Results (%)	Weighted Criterion Score for ACRS	Weighted Criterion Score for SCRS	Results Source & Reference
1	Attraction and attainment of the expected train ridership numbers	This is main priority for the P&R service	30.0	61.0	73.0	18.3	21.9	*KRC (Table 4.1)*
2	Utilization levels of the provided parking facilities	Utilised parking signifies relevance of the facility to the P&R concept	30.0	10.0	33.0	3.0	9.9	*Researcher (Table 5.6)*
3	Meeting the key commuter preferences of travel by commuters in a transport system	Includes saving on time and cost, safety, security and comfort	15.0	77.0	78.9	11.6	11.8	*Respondents (Tables 5.2(a) & 5.2(b)*
4	Convenience of the operating train schedules	A commuter preference parameter that covers both car users and non-car users	10.0	48.1	70.3	4.8	7.0	*Respondents (Tables 5.4(a) & 5.4(b)*
5	Convenience of the parking	Affects car users accessing the parking facility	6.0	75.0	76.5	4.5	4.6	*Respondents (Tables 5.3(a) & 5.3(b)*
6	No need for socio-economic facilities in or near the station (shopping, eateries, etc). These are not provided at the moment.	Not the main focus for the developing P&R facility but may influence usage and replanning of the station	5.0	25.9	18.9	1.3	0.9	*Respondents (Tables 5.5(a) & 5.5(b)*
7	Station is serving the effectively influence area and locational distance of commuter residences up to 5Km radius	Instrumental to future forward planning by authorities but not of immediate importance to commuters transport	4.0	78.0	76.0	3.1	3.0	*Respondents (Figures 5.5(a) & 5.5(b)*
	Overall		**100.0**			**46.6**	**59.2**	

As can be seen from **Table 5.7** above, ACRS (Athi River Station) attained an overall performance score of 46.6% which is categorised as ***unsatisfactory performance*** while SCRS (Syokimau Station) achieved 59.2%, which is ***fair performance*** as per performance rating ranges given under Section 2.7.1 of this report.

5.8 Challenges Encountered in the Field Investigation

The main challenge that the researcher had to contend with was how to administer the questionnaires. This was envisaged at the start of the survey considering that commuters are always in a rush and may not afford time to fill a lengthy questionnaire. However, with the help of KRC staff, it was agreed that commuters would be issued with the questionnaire during boarding of the train and also given pencils for filling for those who didn't carry any pen. The questionnaires would then be collected during disembarking from the station on the exit end. This would require coordination at the departure and arrival station and could only be handled authoritatively by the KRC officers and it was effective for the survey. Some commuters however requested to go with the questionnaires at their workplace or home depending on the trip direction to fill and drop them back either in the evening or the following day for those in the evening trip from town. This group of commuters may have contributed to the percentage of unreturned questionnaires.

CHAPTER SIX: RESEARCH SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This study aimed at evaluating the performance of P&R stations in NMA with a focus on Athi River and Syokimau Railway Stations and giving proposals to improve the performance and utilization of the P&R service. This chapter presents the research summary from study findings analysed and discussed in the previous chapter. Conclusions are drawn from these findings in with appropriate recommendations made to address the research objectives. Finally, some proposed areas of further research are proffered based on some of the study findings.

6.2 Summary of Main Findings

The objectives of the study are further explored in terms of how the study managed to actualise each. These are distinctly discussed in the succeeding sub-topics.

6.2.1 Regarding the first objective: ***To investigate best practice in planning and development of P&R stations***, the study described best practices in development of P&R schemes from experiences across the world in Chapter 2. The approaches were identified, discussed, and illustrated in diagrams. The content is proposed in laying out strategies for developing new P&R stations not only for the Nairobi Metropolitan Area but also across other emerging cities and towns in the republic of Kenya. In particular, the following is emphasised:

a) *Land Use and Urban Transport Integration* - Good land use practise keeps common activities like housing and food market close while placing higher-density development closer to transportation lines and hubs. Poor land use on the other hand concentrates activities like jobs far from other vital destinations like residential housing zones. In brief, land use and transportation systems are closely intertwined, and models that are used in supporting transportation planning need integration with land use models for best results.

b) *Conceptualisation, planning, design and development of a P&R station* - this requires a structured process right from city planning to ensure the facility is in harmony with city development masterplans or blueprints that have focus on land use. Key considerations are:

- As a transport hub for ensuring smooth transfer from one mode to another mode.

- As an open space to revitalize the urban location or district where the facility is situated thereby promoting community interaction.

The flow diagram in Figure 2.1 summarised the whole process ranging from planning concepts through facility design and subsequent construction.

c) *Facility location* - a checklist of site selection criteria was proposed for application in making location decisions and pegged upon: -

(i) Assurance of strong patronage demand – the following rules of thumb can be used to decide the location of applicable site alternatives for evaluation among other patronage factors:

- Geographic affinity to activity centres served.
- Minimizing auto access time.
- Maximizing the facility's visibility in the urban space**.**

(ii) Provision for integration with the community **-** choosing P&R site alternatives that provide for improved integration of the facility with the surrounding community enhances the economic benefit that the lot can bring to area businesses, and the ability of such facilities to develop a transit-oriented suburban market.

(iii)Reduction of the financial impact and risk to the implementing agency - Trade-offs between the expected life-cycle operating costs and capital costs of site acquisition and construction should be evaluated through a NPV analysis. Of significance is designing P&R schemes to complement the local service rather than compete them.

d) *Influence Area and Demand Estimation* - The station influence area is critical to establish as this will be the source of users of the facility. This includes getting the current daytime and night-time population and the future development potential. The economically acceptable station influence area is in the range of up to 5km radius. This zone is also expected to be characterised by intense residential developments which ultimately generate the commuter numbers. If a feeder connector bus network is required, an evaluation of the characteristics of the coverage area must be done including considerations for improvement of the transport routes linking the station to various neighbourhoods.

6.2.2 Regarding the second objective: ***To establish the influence areas and their significance in contributing to ridership numbers to ACRS and SCRS,*** the study found out that the significant sources of commuters for ACRS and SCRS were Athi River and Syokimau Residential areas at 56% and 85% respectively. Additionally, more than three quarters of respondents for both stations were found to be from within the 5Km radius as required of

effective P&R stations with ACRS at 78% and SCRS at 76%. The distances covered by most of the commuters were therefore within the acceptable range as recommended for both stations.

The importance of this objective was to confirm where the stations were suitably serving the desired spatial areas in terms of facility location as discussed under sub-chapter 2.4.3.2. Ascertaining the influence area sets the stage for development of abutting undeveloped land with residential housing in mind in what may be a transit-oriented approach to beef up the source of commuters and boost the ridership numbers for these stations. This observation is also in tandem with the aspirations of the Mavoko Integrated Strategic Urban Development Plan which proposes adoption of a Transit Oriented Development approach in Mavoko Sub-county and as expounded in section 3.4.1.2 of this report. The sub-county is also the host for the two research stations.

6.2.3 Regarding the third objective: ***To find out the utilization levels of the P&R service at ACRS and SCRS and reasons behind such levels,*** the survey established some facts about the station as follows:

a) The reasons for preferring the P&R service fronted by the researcher which were avoidance of traffic jams, saving on time and cost, safety and security were all validated by the respondents at 77% by ACRS users and 79% by SCRS users. However, at ACRS, saving on time and cost was most unpopular reason for using the service among all the reasons, registering 21% while the other reasons registered less than 10% response. This finding on saving on time further justified suggestions given by respondents on improving the service on the time and cost aspects, like introduction of faster trains and reduction of parking and fare rates.

b) Assessment of car ownership statistics for the commuters revealed that ACRS did not have many users of personal cars accessing the Station as compared to the SCRS with both stations at 52% and 90% respectively in car use. The spatial review of the neighbouring residential area characteristics undertaken by the researcher showed that ACRS is surrounded by the low-income residential class, except for the new middle class residential developments currently emerging on the left side of the Mombasa bound highway in Mavoko area. The older Athi River estate within the 3Km radius of ACRS is characterised by low-income earners who are unlikely to afford cars. This area was also the dominant in source of commuters to ACRS. Thus, ACRS doesn't compare favourably with SCRS which is in the middle-income residential bracket. The

residential area characteristics have a direct bearing on car ownership and use and ultimately on success of a P&R facility.

c) A further investigation of alternative means of access to the station by respondents revealed that 71% of respondents at ACRS often relied on walking against 41% in SCRS. Thus, walking was more prevalent in ACRS than in SCRS and therefore low utilization of the parking at ACRS. However, the station manager at SCRS also reported a reduction in number of car users accessing the station after commissioning of the Nairobi Expressway.

d) Generally, convenience of the parking facilities in terms of affordability, payment mode, accessibility, security of cars and use by Persons with Disabilities (PWDs) were all validated by the respondents for the two stations with ACRS at 75% and SCRS at 76% respectively. This means that the car parking facilities as designed were suitable for use under the investigated aspects. However, suggestion on improvements were made by respondents like automation of parking payments, facility enhancement by provision of car sheds, car washing areas and security lights.

e) In terms of train schedule convenience, only the evening train departing Nairobi CBD to ACRS at 5.50 pm was found to be convenient by commuters from Athi River with suggestions on a later morning departure time at ACRS and shortened journey times. This finding has negative bearing on usage of the P&R service at ACRS. On the contrary, SCRS which is served by various train trips in the morning and evening had respondents preferring some of the available train schedules. The 7.15am DMU train which only takes 35 minutes to arrive at the CBD at 7.50am was most preferred in the morning with departure and arrival at 62% and 63% respectively. The most preferred evening schedule was for the commuter train departing from Nairobi CBD at 5.30pm and arriving at SCRS at 6.13pm with departure and arrival registering 79% and 76% preference by commuters respectively.

f) In ACRS, the largest portion of respondents in terms of age range was the 45 - 54 years of age at 37% while SCRS had the 35 - 44 years age bracket dominant at 44%. The older generation of commuters at ACRS may be attributed to low reliance on personal cars unlike the younger generation at SCRS which may fancy cars than their older folks.

6.2.4 Regarding the fourth objective: ***To determine the suitability of ACRS and SCRS as P&R stations and make appropriate recommendations towards their improvement***, several

findings were made based on convenience of the P&R service to commuters as well as their preferences. These are summarised as follows:

a) Most commuters for ACRS accessed the station by walking as shown in Section 6.2.3 above. Thus, provision of parking space at ACRS should have been minimal with the station adopting a simplistic pick-and-drop concept in the station development.

b) Over 65% of respondents in ACRS preferred to have a PSV or railway connector bus in their residential area to help in accessing the station as compared to 55% at SCRS. This implies that most commuters within the ACRS residential area needed public transport to access the station thus negating the P&R concept.

c) 69% and above and 65% and above of respondents at ACRS and SCRS respectively agreed that land use changes and station area transformation were necessary to create the following:

- shopping premises or mini malls within the station area to allow commuters to shop for basic items on their way home in the evening.
- recreational facilities like landscaped mini parks with benches or a fitness gym to liven or energize commuter experience at the stations.

Lastly, the theories identified as anchors for this study by the researcher, i.e., Systems theory, Actor Network theory and Rhizomes theory as discussed in sub-chapter 2.3 were all found to be very relevant for a study of this nature and the subsequent findings pegged on P&R performance.

6.3 Study Conclusion

The researcher proposed and applied a weighted criteria to assess performance aspects of the stations in substantially meeting perceived needs of a P&R effectively and efficiently. The analysis and findings were documented in Section 5.7 of this report. The conclusion on performance aspects as envisaged under each criterion are further discussed as follows:

a) Whether the stations managed to attract and attain the expected train ridership numbers – *from the statistical data given by KRC and final analysis in Table 4.1, the average train ridership percentages of 61% at ACRS is fair performance. At SCRS, the ordinary commuters train achieved 73% while the DMU scored 82% due to its higher speed and preference by commuters. The attainment of ridership numbers is therefore rated as good at SCRS.*

b) Utilization levels of the provided parking facilities – *based on the data in summary Table 5.6, both stations are performing way below expectations at 10% for ACRS and 33% for*

SCRS in utilization of the provided parking. This is unsatisfactory performance and needs further attention.

c) Whether the P&R service meets the commuter preferences of travel in a transport system which are avoidance of traffic jams, saving on travel cost and time, safety and comfort – *both the stations under the study were found to meet this criterion as analysed under section 5.4.3 of the report. The commuter preferences of travel were validated at 77% for ACRS (Table 5.2(a)) and 78.9% for SCRS (Table 5.2(b) respectively, which are good performance ratings.*

d) Convenience of the train operating schedules to commuters – *the train schedule operated at ACRS bound train was rated as unsatisfactory at 48.1% (Table 5.4(a)) while the SCRS bound trains schedules were rated as good at the bare minimum threshold value of 70.3%. (Table 5.4(b)). Improvement of the train schedule particularly for Athi River train is therefore needed.*

e) Convenience of the parking facility –*the parking convenience was validated at 75% and 76.5% for ACRS and SCRS as can be seen in Table 5.3(a) and Table 5.3(b) respectively. Thus, both stations were found to good for parking by commuting car users.*

f) How commuters rated the need for unavailable socio-economic facilities of benefit to them like shopping or recreation in the stations– *both stations registered a very low percentage that did not want socio-economic facilities to be developed, with ACRS at 25.9% and SCRS at 18.9% respectively (Tables 5.5(a) and 5.5(b)). This implies that the stations are unsatisfactory in their current status and therefore require these collaborative services to liven and enhance the commuter experience at the stations.*

g) Assessment of how the stations have effectively served the influence area – *the key 5km radius of influence area of the stations was the predominant source of commuters at over 75% in both cases (Figures 5.5(a) and 5.5(b)). It is therefore concluded that both stations were ideally well situated to effectively serve the influence area. The outcome of this measure is that it qualified the potential for re-development of idle land within the influence zone to provide more residential housing which shall impact positively the P&R stations in generating ridership numbers.*

In summary, ACRS at 46.6% and below average was rated as ***unsatisfactory*** in terms of the weighted performance encompassing all the seven criterion items while SCRS at 59.2% was rated as ***fair*** (Section 5.7). Thus, ACRS is not functioning well as a suburban P&R station. It is also noted that none of the criterion achieved very good or excellent rating (the desired measure of highest level of efficient performance) in both stations thus more attention targeting the criterion items assessed is required to boost performance of the stations as discussed elsewhere in the report.

Arising from the evaluated performance for the stations, some key observations and conclusions are further made regarding the various aspects assessed as follows:

- In terms of the station influence area, it is emphasized that future stations be cognizant of the existing surrounding land use within the critical radius of influence of up to 5km to inform on the ridership numbers expected and the nature of the facility to be adopted. For this study, it was evidential that Athi River Station could have simply served as a pick-and-drop station while Syokimau Station started well as a P&R station before development of the Nairobi Expressway. In this regard, the impact of emerging developments in the urban space pertaining land use and urban transportation needs to be well evaluated to just be sure that other existing facilities constituting major public investments do not suffer negatively. The commissioning of the recent Nairobi Urban Expressway and its impact on the existing P&R stations along the Mombasa Road Corridor such as Syokimau Station is a case in point. Cognizance is also made of the Mavoko ISUDP discussed in sub-chapter 3.4.1 which is likely to shape developments for the area in the coming future.
- The underlying reasons for the current low utilization levels of the P&R service were investigated with a bearing on ACRS with the same survey also extended to SCRS for comparison. In addressing this objective, understanding of commuters' preferences, car ownership statistics and convenience of the service to them were key in helping establish some facts on service utilization levels. Car use by commuters was found to be quite low at ACRS with the greatest number accessing the station by walking while convenience of the time schedule elicited substantial negative responses at ACRS than at SCRS. In particular, the morning train departure and arrival timings at ACRS all emerged as quite unpopular for commuters. Suggestions to introduce new schedules and shorten journey times by running modern and faster trains were advanced by respondents in the qualitative part of the survey.
- The ultimate objective of determining suitability of ACRS as a P&R station or otherwise was investigated and crucial findings made. Precisely, the survey produced a significant number of respondents who accessed the station by walking as well as those who needed a connector bus or PSV to access the station. This signifies that ACRS was not suitably placed to function as a P&R station. Additionally, the researcher's statements on land use changes and station area re-configuration to create shopping and recreational facilities which were evaluated on a Likert scale were significantly agreeable to the respondents as analysed in Tables 5.5(a) and 5.5(b). The characteristics of surrounding land use therefore have a direct bearing on decisions pertaining the location of the P&R station.

- Suburban P&R stations need to be located in areas with a low catchment of low to medium density housing of residential nature and characterized by limitations of access by walking, cycling or connector buses. This is coincidentally the classical case for Syokimau Station which is isolated on one side of the Mombasa Road transit corridor which has purely commercial and manufacturing establishments with residentials located some kilometres away. Implementing P&R schemes in locations with potential for high density mixed-use developments in the vicinity will deliver significant patronage by walking population in future and could make the park-and-ride concept fail in the long run. Moreover, a land use shift that supports transit-oriented development in appropriate locations and less effective feeder bus, walking and cycling options will also need to be factored so as not to water down the car user effect for the P&R concept.

In conclusion, the research findings made were also found to be largely consistent with some studies undertaken in the thematic area. The study by Ginn (2009) on application of P&R and TOD concepts in developing a new framework to maximise public transport usage established that reasonable access distance up to 5km within a TOD, presence of other facilities like convenience stores, cafes and safety and security are key in maximising patronage. Evans et al. (2003) on traveller response to transportation system changes found out that changes affecting train schedules and the travel time like faster means have transformational changes to travellers' response.

6.4 Study Recommendations

Based on the research summary of findings and conclusions documented here above, this study recommended some short-term and medium to long term measures and strategies for action by the transit infrastructure provider and operator, i.e. KRC. The short-term measures are proposed to be implemented within two (2) years in resolving the low levels of utilization of Athi River Station commuter train service as envisaged in the fourth objective of this study:

6.4.1 Short Term Measures

I. For Athi River commuter train, schedule morning departure time of 7.00am at the earliest and maintain the 5.50pm evening departure time from Nairobi Central Station.

II. Develop and introduce differentiated affordable fares for train trips to Athi River Station (at least 2 in each direction) considering peak and off-peak hours for increased patronage of the service.

III. Carry out media campaigns on the existence and use of commuter trains not only for Athi River area but also on the rest of Nairobi Metropolitan Area (NMA) rails to enlighten the urbanites.

IV. Obtain constant feedback from commuters on facility and service performance and make informed appropriate decisions for future sustainability.

6.4.2 Medium and Long-Term Strategies

The following medium-term and long-term strategies have been justified by the research findings and are highly recommended for Athi River Station. The same may be investigated to confirm applicability for other P&R stations in NMA. These are proposed in a period ranging from over two years to ten years.

I. Introduction of faster trains to and from Athi River Station (preferably DMU) to minimize journey time to less than one (1) hour on the maximum.

II. Introduction of railway connector buses in Nairobi suburbs railway stations where car affording commuter numbers is doubtful to boost the ridership numbers. The same should be enhanced at Nairobi Central Station with various buses circulating to key work zones like Upper Hill, Industrial Area, and Westlands among others in Nairobi City.

III. Review of the concept for Athi River Station and reconfiguration of the station area in light of the under-utilized parking area to create station plaza with mini shopping malls, restaurants, and recreational facilities as necessary like gymnasiums among others. This should also apply for other commuter rail stations in NMA without such facilities and where space allows.

IV. Collaboration with stakeholders in the station locality and in particular Machakos County Government and the adjacent landowners towards re-planning to transform and revitalize the station coverage and catchment zone. This should be done with the 5Km radius influence area in mind and as may be guided by the Mavoko ISUDP. Zoning and restriction measures that promote transit-oriented land use developments in the P&R facility environs are very beneficial for integration success. In the long run, this collaboration will translate to economic benefits to all.

V. KRC through its parent Ministry of Roads and Transport should engage the concerned Road Authorities and the County Governments to improve the road network connecting the stations within the 5Km radius zone of influence for ease of access and mobility by connector transport and passenger cars.

6.5 Suggested Areas for Further Research

The proposed areas for additional research from this study include:

a) Impacts of major land use and transport development undertakings on existing P&R stations.
b) Technological advancements that can be implemented to transform P&R stations in Nairobi Metropolitan Area (e.g., introduction of modern trains or overhauling of the railway).
c) Impacts of low or high parking fee in the CBD on the utilization of P&R stations.
d) Economic appraisal of P&R stations in Nairobi Metropolitan Area.

REFERENCES

Akrich, M. (2023). Actor Network Theory, Bruno Latour, and the CSI. *Journal of Social Studies of Science*. Vol. 53(2), 169–173.

Banister, D. (1999). *Transport Planning.* (2nd ed.). New York: Spon Press.

Bertalanffy, L. (1968). General System theory: *Foundations, Development, Applications*. New York: George Braziller.

Bensmaïa, R (2005). "Poststructuralism". In Kritzman, L. (ed.). *The Columbia History of Twentieth-Century French Thought*. Columbia University Press. pp. 92–93. ISBN 9780231107907.

Capra, F. (1997). *The web of life*. New York: Doubleday-Anchor Book.

Clayton, W., Ben-Elia, E., Parkhurst, G., & Ricci, M. (2014). Where to park? A behavioural comparison of bus park and ride and city center car park usage in Bath, UK. *Journal of Transport Geography*. Vol. 36, 124–133.

Constitution of Kenya 2010 4th Schedule (Kenya).

Deleuze, G., & Guattari, F. (1987). *A Thousand Plateaus.* Minneapolis: University of Minnesota Press.

Edwards, J. R., & Lambert, L. S. (2007). "Methods for Integrating Moderation and Mediation: A General Analytical Framework Using Moderated Path Analysis", Psychological Methods. *The IUP Journal of Business Strategy*. Vol. 14, (4). Retrieved from https://www.researchgate.net/publication/322930562.

Eric, M., & Ilona B. (2009). Exploring heterogeneity in park and ride preferences: a latent class mode. *Proceedings of the transportation research board (TRB) annual meeting*, Washington, DC, 11–15 January 2009. Transportation Research Board.

Evans J., & Pratt, R. (2003). *Traveller response to transportation system changes*. Washington, DC: Transportation Research Board.

Ginn, S. (2009). *The application of the park & ride and TOD concepts to develop a new framework that can maximise public transport patronage.* (Published master's thesis). Queensland University of Technology, Brisbane.

Hamer, P. (2010). Analyzing the effectiveness of park and ride as a generator of public transport mode shift. *Journal of Road & Transport Research*, Vol. 19(1), 51–61.

Hamsa, A.A.K., Akmal, N.A.S., Zolkpeli, Z.H., (2021). Evaluating Parking Characteristics of Park-and-Ride Facility at Gombak LRT Terminal Station. *Jurnal Kejuruteraan*, Vol. 33(4), 981-992.

Heggie, I.G., & Papoulias, D.B. (1976). *Operational Performance of Park and Ride: Objectives and Achievements in Oxford.* Working Paper No. 23 Transport Studies Unit, University of Oxford, Oxford.

How Oxford led the way to create Park and Rides. (2013, December 6). *Oxford Mail*. Oxford. Retrieved February 6, 2023 from: https://www.oxfordmail.co.uk/news/10859209.oxford-led-way-create-park-rides/.

Israel, G. D. (2012). *Determining sample size.* PEOD6. IFAS, University of Florida, Florida.

Jackson, M. (2003). *Systems Thinking: Creative Holism for Managers*, Chichester, West Sussex: John Wiley& Sons, Ltd.

Jackson, S. (2015). Toward an analytical and methodological understanding of actor-network. (PDF). *Journal of Arts and Humanities*. Vol. 4(2), 29-44.

Kaneko, M. (2014). *Intermodal Transfer Facility Planning*. A Lecture Presentation to JICA Participants on Comprehensive Urban Transportation Planning Training Programme, JICA Tokyo International Centre. Tokyo.

Kenya Railways Corporation Act (CAP 397) Revised Edition 2019 (Kenya).

Kenya Railways Corporation. (2023). *The Nairobi Commuter Rail*. Retrieved February 6, 2023 from: https://krc.co.ke/the-nairobi-commuter-rail/.

Kenya Roads Board. (2023). *Road Maintenance Accountability Index Report for the Financial Year 2021-2022.* Nairobi: Published by KRB.

Kothari, C.R. (2004). *Research Methodology: Methods and Techniques*. (2nd ed.). New Delhi: New Age International (P) Ltd.

Liao, F., & Bothe, W. (2015). An article on effects of land-use transport scenarios on travel patterns: A Multi-State Super-Network Application. *Transportation (2017)*. Vol. 44, 1–25.

Machakos County. (2020). *Mavoko Integrated Strategic Urban Development Plan covering the period 2020 to 2030*. Machakos: County Government of Machakos.

Maina, J.I. (2018). *Factors Influencing Usage of Rail Transport by Private Motorists at Park and Ride Station: A Case of Syokimau Railway Project in Nairobi* (Unpublished master's thesis). University of Nairobi. Nairobi.

Manns, J. (2010): Park and Ride - Politics, Policy and Planning. *Town and Country Planning Association quarterly review*. March 2010. 144-148.

Maxwell, J. A. (2012). *Qualitative Research Design: An interactive approach.* (3rd ed.). California: Sage.

Meyer, M.D., & Miller, E.J. (1984). *Urban Transport Planning*. New York: McGraw-Hill.

Meyer, M. D., & Miller, E.J. (2001). *Urban Transportation Planning: A decision-oriented*

approach. (2th ed.). New York: McGraw-Hill.

Meyer, M. D (2016). *Transportation Planning Handbook* (4th ed.). New Jersey. John Wiley & Sons, Inc.

Miles, M. B., & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook (2nd ed*.). Thousand Oaks: Sage Retrieved 8th June, 2014, from http://www.drjohnlatham/com/Conceptual_Framework.html.

Ministry of Transport. (2009). *Integrated National Transport Policy.* Nairobi: Government Printers.

Ministry of State for Planning, National Development and Vision 2030. (2012): *Sessional paper No.10 of 2012 On Kenya Vision 2030*. Nairobi: Government Printers.

Ministry of Transport, Infrastructure, Housing & Urban Development. (2018). *2nd Road Sector Investment Programme & Strategy; 2018 – 2022*. Nairobi: Government Printers

Mugenda, A. G., & Mugenda, O. M. (2003). Research Methods; *Qualitative and Quantitative Approaches*. Nairobi: Africa Centre for Technology Studies.

Mugenda, A. G., & Mugenda, O. M. (2012). *Research Methods Dictionar*y. Nairobi: Arts Press.

Muniesa, F. (2015). Actor-Network Theory. In James D. Wright (Ed.), *The International Encyclopaedia of Social and Behavioural Sciences*, (2nd ed.). Vol. 1, 80-84. Oxford: Elsevier.

Nachmias, C.F., & Nachmias, D. (1992). *Research Methods in Social Sciences*. (4th ed.). New York: St. Martins Press.

Nairobi City County. (2015). *Integrated Urban Development Master Plan for Nairobi City.* Nairobi: Nippon Koei Co. Ltd.

NaMATA. (2022). *Industry Discussion Document on Establishing the Line 2 BRT Bus Operating Company*, Nairobi: NaMATA.

Ngechu, M. (2004). *Understanding the research process and methods. An introduction*. Nairobi: Starbright Services.

Niira, K. (2014). *Development of Transportation Infrastructure and Support System of the Japanese National and Prefectural Governments*. A Lecture Presentation to JICA Participants on Comprehensive Urban Transportation Planning Training Programme, JICA Tokyo International Centre. Tokyo.

Noel, E.C. (1988). "Park-and-ride: alive, well, and expanding in the United States". *Journal of Urban Planning and Development*, Vol.114(1), 2–13.

Olson, L. (2003) *Factors that Influence Choice of Travel Mode in Major Urban Areas: The*

attractiveness of Park and Ride (Published master's thesis). Royal Institute of Technology, Stockholm.

Orodho, A. J. (2003). *Essentials of Educational and Social Science Research Methods.* Nairobi: Mazola Publishers.

Owen, W. (1964) *Strategy for Mobility*. Washington D.C.: Brookings Institutions.

Parkhurst, G., & Richardson, J., (2002). Modal Integration of Bus and Car in UK local transport policy: The case for strategic environmental assessment. *Journal of Transport Geography*. Vol.10 (3), 195-206.

Pickett, M.W., & Gray, S.M. (1996). *The effectiveness of bus-based Park & Ride.* TRL Report 207.Transport Research Laboratory, Crowthorne.

Polit, D. F., & Hungler, B. P. (1999). *Nursing research: principles and methods*. Philadelphia: JB Lippincott Company.

Queensland Government. (2009). *South East Queensland Regional Plan 2009–2031*. Retrieved Retrieved February 18, 2023 from: https://www.ipswich.qld.gov.au/__data/assets/pdf_file/0005/7916/seqregional-plan-2009.pdf.

Rukwaro, R. (2016). *Proposal Writing in Research*. Nairobi: Applied Research & Training Services.

Runkel, M. (1993) Park and ride: Development and Perspective. 50th International Congress Sydney, *International Commission on Traffic and Urban Planning*. Brussel. International Union of Public Transport (IUPT).

Shirgaokar, M., & Deakin, E. (2005). Study of Park-and-Ride Facilities and their Use in the San Francisco Bay Area of California. *Journal of the Transportation Research Board.* No. 1927, 46–54.

Sinayev, A., Peters, E., Tusler, M., & Fraenkel, L. (2015). Presenting Numeric Information with Percentages and Descriptive Risk Labels: A Randomized Trial. *International journal of the Society for Medical Decision Making*. Vol.35(8), 937-947

Spillar, R.J. (1997). *P&R planning and design guidelines.* New York: Parsons Brinckerhoff Inc.

Steer Davies Gleave Company. (2006). *Study on the Prices and Quality of Rail Passenger Services*. Retrieved March 6, 2023 from: https://transport.ec.europa.eu/system/files/2016-09/2016-04-price-quality-rail-pax-services-final-report.pdf

Taylor, N. (1998). *Urban Planning Theory Since 1945*. London: SAGE Publications.

Park and ride "is ruining rural land". (2005, June 8). *The Guardian.* London. Retrieved January 6

2023 from:
https://www.theguardian.com/society/2005/jun/08/environment.transportintheuk.

Vincent, M. (2007). *Park and ride: Characteristics and demand forecasting*. Research Report No. 328. Land Transport New Zealand, Wellington.

Waddell, P. (2011). Integrated land use and transportation planning and modelling: Addressing challenges in research and practice. *Transport Review.* Vol.31(2), 209‑229.

Wiseman, N., Bonham, J., Mackintosh, M., Straschko, O., & Xu, H., (2012). "Park and ride: An Adelaide case study." *Road & Transport Research:* A Journal of Australian and New Zealand Research and Practice. Vol. 21(1):39-52.

Zamanzadeh, V., Ghahramanian, A., Rassouli, M., Abbaszadeh, A., Alavi-Majd, H., & Nikanfar, A. R. (2015). Design and Implementation Content Validity Study: Development of an instrument for measuring Patient-Centered Communication. *Journal of caring sciences, 4(2)*, 165–178. https://doi.org/10.15171/jcs.2015.017.

APPENDICES

APPENDIX 1: RAILWAY COMMUTERS' QUESTIONNAIRE

RESEARCH TOPIC: PERFORMANCE OF PARK & RIDE STATIONS IN NAIROBI METROPOLITAN AREA: *A Case Evaluation of Athi River and Syokimau Commuter Railway Stations*

Name of Researcher: *Patrick Mutua* **Registration No.** *W50/38882/2020*

Study Programme: *Master of Urban Management*

Institution: *University of Nairobi - School of Built Environment*

Introduction to Respondents:

This questionnaire is designed to seek your opinion and views on the research topic given above and information provided will be used for academic purposes only. Anonymity of respondents shall be upheld in the survey.

Thanks in advance for your valuable time and cooperation in aiding this research.

Section A: General Information

A1. Gender of the Respondent

☐ Male ☐ Female

A2. Age of the Respondent

☐ Below 25 Years ☐ 25 – 34 Years ☐ 35 – 44 Years

☐ 45 – 54 Years ☐ Above 55 Years

A3. For how long have you been using the commuter train?

☐ Less than 1 Year ☐ 1 – 2 Years ☐ > 2 – 5 Years

☐ > 5 – 10 Years

Section B: Station Influence Area, Transport and Commuter Preferences

B1. Where do you live?

☐ Kitengela ☐ Athi River ☐ Mlolongo

☐ Syokimau/Katani ☐ Embakasi _____

(Others - Specify) ……

B2. Approximately, how far is your place of residence from the Station?

☐ Less than 1Km ☐ 1Km – 3 Km ☐ >3km up to 5Km

☐ More than 5Km

B3. How often in a week do you use train service? Indicate the number of days from Monday to Friday _____

B4. If you don't use the train service daily, what are your reasons for omitting the service in other days of the week?

_____

_____

_____

B5. On a scale of 1 to 5, rate the reasons you prefer using the train service (Where 1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

	Reasons for preferring the train service	**1**	**2**	**3**	**4**	**5**
1	To avoid traffic jams					
2	To save on travel cost and time					
3	The station parking cost is less than the parking fee in Nairobi CBD					
4	The train service is safe and secure					

B6. Do you own a car?

☐ Yes ☐ No

B7. If yes in B6 above, what makes you not to use your car to access the station? (Tick any as applicable)

☐ I can walk to the station

☐ I prefer boda-boda because it is cheaper

☐ I can use PSVs (matatu or bus) for access to the station

☐ The parking fee at the station is unaffordable

Any other reason_____

B8. If you use the Park and Ride Service, rate on a scale of 1 to 5, the extent of satisfaction to the following statements: (where 1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

	Statement	**1**	**2**	**3**	**4**	**5**
1	Parking fee is affordable					
2	Payment mode is convenient					
3	Parking facility is accessible					
4	Cars are secure in the parking					

5	Persons with disability can use it conveniently					

B9. Suggest ways in which you think Kenya Railways can use to improve on the Park and Ride service

_____
_____
_____
_____

B10. On a scale of 1 to 5, please indicate the extent to which you disagree/agree with the following statements (Where 1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

	Statement	**1**	**2**	**3**	**4**	**5**
1	The train departure/arrival schedule time is convenient					
2	My residential area has no available public transport means (matatu, bus) to take passengers to the station					
3	Introducing a Railway Connector Bus or PSV in my area can increase the number passengers to the train station					

B11. Indicate your preferred train departure and arrival timings as follows?

a) Morning:
Home area departure ……Arrival in Nairobi CBD ……

b) Evening:
Nairobi CBD departure …… ….Arrival at home area station……

Section C: Land Use Factors and Station Area Re-configuration

On a scale of 1 to 5 where 1 = Strongly Disagree (SD); 2 = Disagree (D); 3 = Neutral (N); 4 = Agree (A) and 5 = Strongly Agree (SA), please indicate the extent to which you disagree/agree with the following statements regarding new land uses within the stations:

	Statement	**1**	**2**	**3**	**4**	**5**
1	If there were affordable houses near the station, I would prefer to reside there in for my access convenience					
2	Kenya Railways should develop shopping premises/mini malls within the station area to allow commuters to shop for basic items on their way home in the evening					

3	Recreational facilities like landscaped mini parks with benches or a fitness gym are necessary to liven or energize the commuter experience at the station					

APPENDIX II: QUESTIONNAIRE FOR THE RAILWAY OPERATOR (KRC OFFICIALS

RESEARCH PROJECT TOPIC - PERFORMANCE OF PARK & RIDE STATIONS IN NAIROBI METROPOLITAN AREA: ***A Case Evaluation of Athi River and Syokimau Commuter Railway Stations***

Name of Researcher: *Patrick Mutua* **Registration No.** *W50/38882/2020*

Study Programme: *Master of Urban Management*

Institution: *University of Nairobi - School of Built Environment*

Introduction to Respondents:

This is academic research being carried out with the aim of evaluating the Performance of Park and Ride Stations in Nairobi Metropolitan Area with a focus on Athi River and Syokimau Commuter Railway Stations.

This questionnaire therefore seeks your opinion and views on the study area and information provided will be used for academic purposes only treated with utmost confidentiality.

Part A: Questionnaire for KRC Officials at the Railway Stations

1. Approximately how many cars are parked at the station in day? …….
2. What is the daily parking fee?……..
3. Have car owners at any given time complained about the car parking fee charged at the station and if yes was the parking fee rate revised/reviewed?
   ……..
4. Based on your experience at the station, which means of transport do most commuters use to access the station?
   ……..
5. In your opinion, why do you think the station parking facility is under-utilised from the number of cars observed to be parked at the station?
   ……..

   ……..
6. What do you think should be done to improve the parking utilization at the station?
   ……..

Part B: Questionnaire for KRC Officials at the Head Quarters

(NB This questionnaire is to be administered to technical offices of Graduate and above and at least 5 years of experience with KRC).

---

1. What is the daily average number of commuters using each of the stations?

   Syokimau……Athi River……..

2. What is the peak design capacity in car numbers for the parking areas at the stations?
   Syokimau……Athi River……..

3. On average, how many cars are parked by commuters at the stations each day?
   Syokimau……Athi River……..

4. What informed KRC on the choice of P&R concept rather than pick-or-drop concept for Athi River station?

   …….

   …….

   …….

5. Is KRC aware of the low utilization rate of the parking facility at Athi River Stations and if yes, what measures have been taken to address the usage of the parking space at Athi River Stations?
   ……

   ……

   ……

6. Based on thriving Park and Ride stations across the world and available space, there is need to reconfigure the current stations' land use and create station malls and /or recreational facilities like gyms to liven and energize the stations for attraction of more commuters? Is there any initiative by KRC towards this and if yes, at what stage is it in?
   ……

   ……

   ……

7. "Transit Oriented Development" is one of the strategic ways that KRC should considered in boosting commuter numbers and effective utilization of the stations? Does KRC consider development of high-density residential housing near the stations and if yes how could this be achieved?

……

……..……..

……

APPENDIX III: FIELD SURVEY & OBSERVATION CHECKLIST

RESEARCH PROJECT TOPIC - PERFORMANCE OF PARK & RIDE STATIONS IN NAIROBI METROPOLITAN AREA: ***A Case Evaluation of Athi River and Syokimau Commuter Railway Stations***

Name of Researcher: *Patrick Mutua* **Registration No.** *W50/38882/2020*

Study Programme: *Master of Urban Management*

Institution: *University of Nairobi - School of Built Environment*

Part A: Field Survey/Observation within the Station

1. Number of parking slots provided……..
2. Number of Cars in the parking bays……...
3. Means of Transport being used to access the station

   ……

4. Number of wagons on each train trip……

   ……

Part B: Field Survey/Observation outside the Station

1. Access Roads and Drainage Condition

   ……

   ……

   ……

2. Visual observation on the character of developments within 1Km radius of the stations (old, dilapidated housing / new housing/poor quality housing/informal structures/manufacturing establishments etc)

   ……

   ……

   ……

……

3. Common commercial activities…….

   ……

   ……

4. Distance to nearest modest residential houses and their type (Bungalows, maisonettes, high rise flats)
   ……

   ……

5. Average rents payable in residential zones (for Bungalows, maisonettes, or high-rise flats)
   ……

   ……

6. Overall environmental outlook and quality of the neighbourhood

   ……

   ……

APPENDIX IV: INTRODUCTION LETTERS TO KENYA RAILWAYS

A. UNIVERSITY LETTER

UNIVERSITY OF NAIROBI
Facultyof Built Environment and Design
DEPARTMENT OF ARCHITECTURE
E- mail: architecture@uonbi.ac.ke

P.O. BOX 30197,
Nairobi, Kenya
Telephone: 020-4913519
Telegrams: Varsity

Our Ref: UON/FBED/Arch/38882/20

Date: 9th February, 2023

TO WHOM IT MAY CONCERN

RE: PATRICK MUTUA REG. NO. W50/38882/2020

This is to confirm that the above named is a bona fide student pursuing Master of Urban Management degree in the Department of Architecture, University of Nairobi. He is undertaking a project entitled *"Performance of Park and Ride Stations in Nairobi Metropolitan Area: A Case Evaluation of Athi River and Syokimau Commuter Railway Stations"*.

Mr. Mutua wishes to collect data for his project. We are thus requesting you to give him some of your valuable time and respond positively to his enquiries, provision of drawings, maps, etc as may be required. This is for academic purposes only.

Any assistance accorded to him will be highly appreciated.

Yours sincerely,

CHAIRMAN
DEPARTMENT OF ARCHITECTURE
UNIVERSITY OF NAIROBI

Arch. Musau Kimeu
CHAIRMAN,
DEPARTMENT OF ARCHITECTURE

B. RESEARCHER'S LETTER TO KRC FOR SUPPORT

Ref.: UoN/MUM/pmm-001 16th February 2023

THE MANAGING DIRECTOR
KENYA RAILWAYS CORPORATION
NAIROBI.

(ATTENTION GENERAL MANAGER, BUSINESS & OPERATIONS)

Dear Sir,

RE: UNIVERSITY OF NAIROBI: MASTER OF URBAN MANAGEMENT
Research Project on Performance of Park & Ride Stations in Nairobi Metropolitan Area (Case Study of Athi River & Syokimau Stations)

Please refer to the attached letter from the University of Nairobi regarding my postgraduate studies in Urban Management. Towards completion of the Masters programme, I am undertaking a Research Project on the Performance of Park and Ride Stations in Kenya's Nairobi Metropolitan Area with a specific focus on Athi River and Syokimau Commuter Railway Stations.

Towards this end, I endeavour to float Questionnaires to Commuters using these two Stations to pick data and information that shall be analysed and necessary inferences made for appropriate recommendations. Additionally, I also plan to hold some brief interviews with a Technical KRC officer at the Infrastructure Development Department and with at least one officer in each of the Railway Stations as well. All information obtained is to be used for academic purposes only.

I look forward to your assistance and support to accomplish the mission. Any additional information that may be availed by KRC on the study thematic area shall be highly appreciated.

Yours Sincerely,

Patrick Mutua
MUM Student, UoN