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FACTORS MOTIVATING SUSTAINABLE TRANSPORT BEHAVIOUR

A Case of Gautrain Passengers

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MUS-SEEC

Declaration

I, Lindsay Laurie (2734443), am a student enrolled for the degree of Master of Urban Studies – Sustainable and Energy Efficient Cities in the 2023 academic year. I hereby declare the following:

I understand that plagiarism (the use of someone else's works without their permission and / or without acknowledging the original source) is a legal offense which the University of the Witwatersrand may take disciplinary action on. The report I am submitting for assessment is my own unaided work except for where I have referenced otherwise. This report was written exclusively for fulfilment of the program named above, and it has not been submitted elsewhere for accreditation or publication.



Lindsay Laurie

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Finally, I remember my Creator, who designed this temporary home with care and beauty. In my imitation of Your example, grant me humility, grace, and discernment to know my role. Your will over mine.

Abstract

This study blends insights from transport studies and psychology to compare how human transportation needs are met by public and private modes. It advocates for considering these needs in public transportation to promote sustainable urban behaviours.

The researcher purposefully sampled and interviewed a subset of ten Gautrain passengers who also have access to private transport to understand their commuting experiences on both modes. While this sampling limited the generalisability of the findings, it was crucial for specifically understanding how to motivate private commuters to use public modes.

The analysis revealed key differences and similarities in how transport needs are experienced, impacted, and understood by both modes. Notably, the need for competency was important in both public and private modes, suggesting it as perhaps the most strategic and delicate transport need to address, enhance, and maintain. The Gautrain was better able to meet this critical need by reducing the mental load of commuting, compared to driving, which was more likely to be stress-inducing. Reliability, due to inaccessibility, was a key area of deficiency for the Gautrain, which produced car-dependency among middle-class commuters.

The study concludes with possible solutions for how the Gautrain could better design and advertise itself with respect to transport needs and emphasises the impact that relational dynamics between transport needs can cause. Enhancing public transportation with human-centric considerations could motivate behavioural shifts towards it, and if this shift draws in otherwise car-dependent commuters, cities could become more sustainable.

Keywords: Sustainable Transport, Motivation, Captive / Choice Passenger

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List of Acronyms

BRT – Bus Rapid Transit

CBD – Central Business District

CO_2 - Carbon Dioxide

DoE – Department of Energy

GMA – Gautrain Management Agency

GRRIN – Gauteng Rapid Rail Integrated Network

HTN - Hierarchy of Transport Needs

MTR – Metro Rail Transit

PRASA - Passenger Rail Agency of South Africa

PT – Public Transport/Transportation

SA – South Africa

SAAA – South African Automobile Association

SD – Sustainable Development

SDG - Sustainable Development Goal(s)

SDT – Self Determination Theory

ZAR – South African Rand

Chapter 1: Introduction and Background

1.1: Introduction

Sustainable transportation has been recognised for its vital role in alleviating environmental threats. As illustrated by Figure 1, 81% of the energy input into the global transportation sector is rejected in the form of heat (Lawrence Livermore National Laboratory, 2011). Within passenger transport specifically, Pereira, Carvalho & Jucá (2015) estimate that only about 25% of the energy put into cars is converted into motion. Cities can strive towards environmental competitiveness by reducing private car dependency and increasing public transportation (PT) ridership across all social groups. Peñalosa (2013:0 minutes 26 seconds) advocates for this concept in his TED Talk: "An advanced city is not one where the poor use cars, but rather one where even the rich use public transport." This quote alludes to the too-common perspective that PT is an inferior choice taken by the poor, but the idea that it could instead be a competitive market choice anchors this research. The adoption of such a perspective has the potential to benefit both environmental and social sustainability.

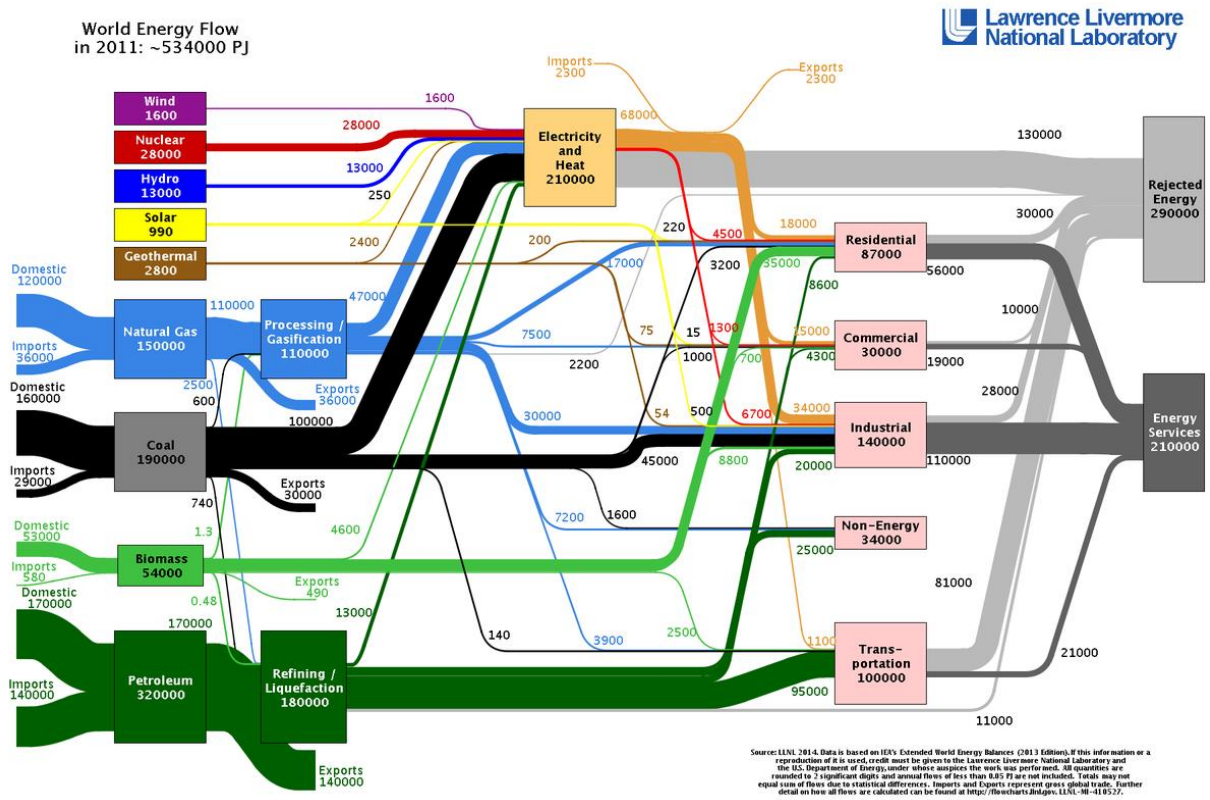


Figure 1: World Energy Flow Chart. By percentage, the transportation sector is the least energy efficient sector, rejecting about 81% of the energy put into it. (Lawrence Livermore National Laboratory, 2011).

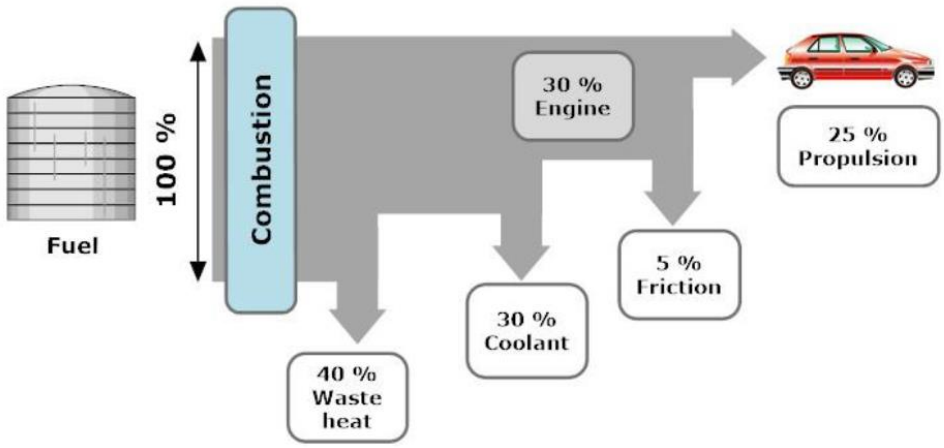


Figure 2: Typical Energy Flow of an Internal Combustion Engine (Pereira et al., 2015). Note that on average, only about 25% of the inputted energy gets converted into useful motion

1.1.1: Problem Statement

In many places, public transportation is the less favoured mode of transport, despite it generally being recognised as having more environmentally sustainable potential than private transport (Ritchie & Roser, 2023). This stigmatization is discussed further in Section 2.3; however, the fact that PT is reluctantly chosen remains the central issue of this research. Of those who do use PT, it is overwhelmingly the working class who lack financial choice. Financial consideration is important because car ownership rates are highest among wealthier South Africans (Mtembu & Krygsman, 2020), making them a commuting group that poses both a high environmental risk and opportunity.

Recognising this socioeconomic stigmatisation, the Gautrain became South Africa's first high-speed rail service, with notable efforts to market towards the middle class and rebrand public transportation with dignity, albeit not without controversy (see Section 1.2). However, even if distinguished, the Gautrain has only returned to 40% of pre-pandemic levels (Gautrain Management Agency, 2022:11), whereas sales of private cars have returned to pre-pandemic levels (CEIC Data, 2024). This suggests that what motivates an individual to choose a particular transport mode is more complex than just money or the esteem that may come with wealth. These other influences on commuting modes are later named and defined as transport needs in Section 2.4.

Finally, economic development has often grown in correlation with rising CO_2 levels, and despite the recent challenges facing the South African Rand, there are reasons to consider South Africa a leading economy, especially at the continental level. It was the first African BRICS nation recognised globally for its political and economic potential, and it remains a destination for many migrants from surrounding nations in search of employment. If the preference for private over public transport persists, combined with growing financial access, it could set South Africa on a path towards a future where masses of individual cars collectively choke the air to death by a thousand cuts. This future becomes less theoretical and more probable if, once wealthy enough, commuters choose private cars, as CEIC Data (2024) suggests South Africans are doing.

1.1.2: Aims

On a local level, a core motivation of this study is to encourage a perspective that highlights the potential of public transport over private transport. Drawing insights from Transport Studies and Behavioural Psychology, it aims to understand commuters' transportation needs and encourage PT agencies to design systems that cater to these needs. By doing so, PT can become more people-centred, thereby improving rider retention and attraction. The potential for reducing a city's

transportation carbon footprint is particularly significant when shifting commuters from private cars to PT. Therefore, the researcher is particularly focused on understanding how to make PT competitive for those with access to private cars.

On a larger scale, the researcher aims to contribute to the conversation on how emerging nations can develop in a more advanced way than First World nations have previously done. Emerging economies like South Africa are held to higher standards of consideration for people and the planet, as embodied by the United Nations' Sustainable Development Goals (SDGs). If South Africa intends to be recognised for how its economy grows, or if it wishes to avoid accusations of archaic development practices, it must adopt sustainable practices. Car dependency is just one threat to social and environmental sustainability; therefore, understanding the components that contribute to it will be valuable for creating efforts to move away from it.

1.1.3: Research Questions

The main question of this research revolves around how public transportation can be promoted as a competitive alternative to private cars and motivate commuters to choose it.

The field of Psychology, however, has established that people often behave to meet needs before attaining the privilege of choice. Thus, identifying and defining commuter transport needs becomes the first sub-question. This question is largely explored in Chapter 2.

The second sub-question applies and localises the transport needs to Gauteng Province by comparing how private cars and the Gautrain do and do not meet the established transport needs. This provides insight into the competitive edge and limitations of each mode from the middle class's perspective, the primary sample group. This question was largely answered in the fieldwork stage and extensively discussed in Chapter 4.

The final sub-question calls for action from transportation agencies to implement strategies that could make public transportation more accommodating to commuting needs and more attractive as a commuter choice. This sub-question is largely answered in Sections 4.6 and 5.1.

Overall, the main question and three sub-questions are as follows:

Main Question: How can public transportation be understood as a competitive alternative to the private car, especially for middle-class commuters?

1. What kinds of transport needs do people have, and which will be explored in this research?
2. How does the Gautrain meet these transport needs compared to private transport?
3. What strategies can transportation planners explore to better address human transportation needs?

1.2: Background on the Gautrain

The PT system of focus is the Gautrain: an interprovincial high-speed rail line named after Gauteng province, where it is situated. The Gautrain's service currently spans ten stops — often at key economic destinations — across three lines. Referring to Figure 3, the Airport Express Route and East/West Commuter Line were completed in 2010, while the North/South Commuter Line was completed in 2011. The latter line is the longest stretch, at 80 km (50 miles), and notably connects the economic hub (Johannesburg) and political capital (Tshwane/Pretoria) of South Africa. At top speed, the Gautrain travels at 160 km (100 miles) per hour, with the longest trip from Park to Hatfield station taking 42 minutes. On-site feeder buses, parking lots, and shuttles (at select stations), as well as integration with other local PT entities' services, support the last- and first-mile journey.

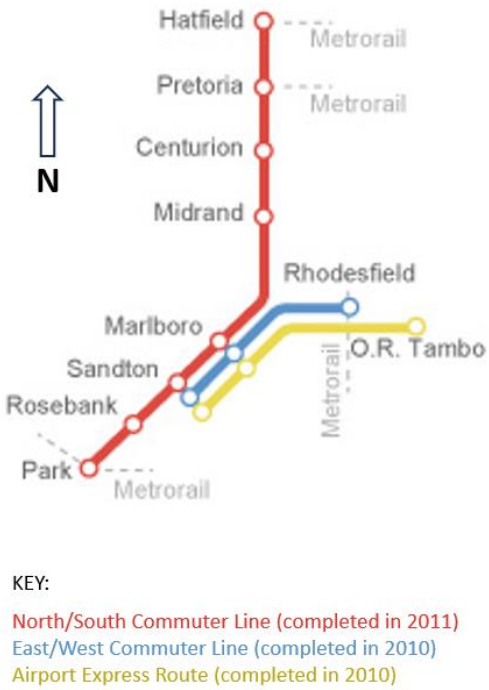


Figure 3: The Current Gautrain Routes (Gautrain Management Agency, undated)

The Gautrain is unique among other PT services in that it is based on a Public-Private Partnership. The public entity is the Gauteng Provincial Government, while Bombela Concession Company is the private partner. Privatisation does not disqualify the Gautrain from being considered a form of PT, as similar ownership structures can be found on an international scale. For example, the privatisation of British Rail, JR-East in Japan, and the local Kombi Taxi service are all examples of PT services that have been at least partially privatised. While debatable in terms of accessibility (Section 1.2.1), the research considers the Gautrain public from the passenger's perspective, as the experience of using it more closely aligns with features of PT, such as set routes and schedules, service fares, and freedom from vehicle liability. The Gautrain Management Agency (GMA) was established in 2006 to govern and oversee operations, ensuring they are in alignment with the province's primary economic objectives. In their 2019 brochure, the GMA announced their GRRIN (Gauteng Rapid Rail Integrated Network) expansion plan (Figure 4). This extension aligns with the province's goals for a holistic transport network, economic growth, and environmental sustainability. The expansion project is currently under feasibility studies and is expected to roll out in phases over a 20-year timeframe. With this foundation set, the following sections discuss the services, reputation, and function of the Gautrain in the context of this research.

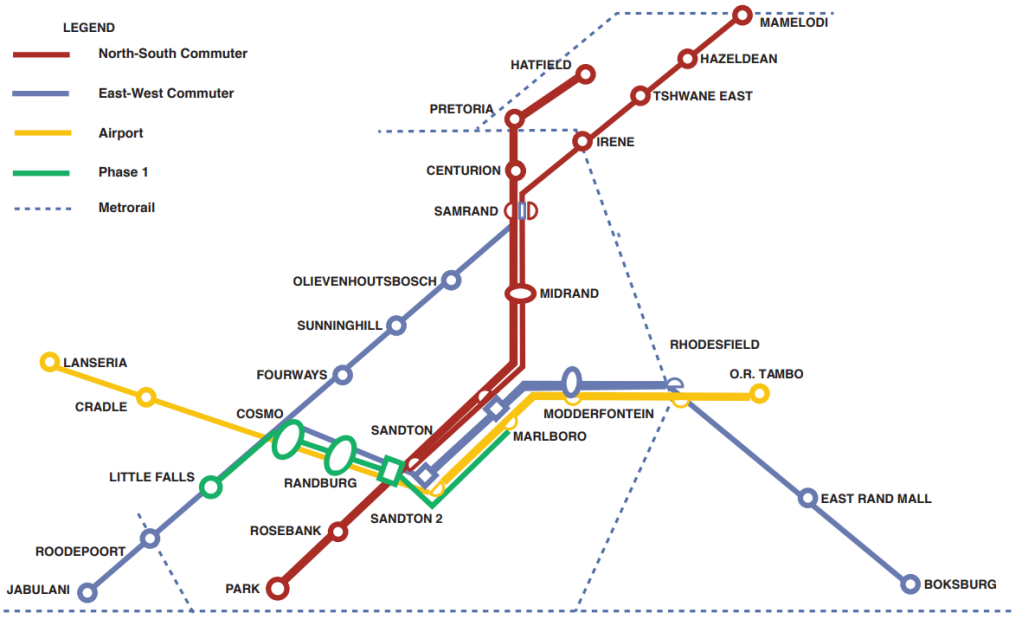


Figure 4: The GMA's GRRIN Expansion Plan (Gautrain Management Agency, 2019)

1.2.1: Identity & Controversy

Brand identity is contextual. While the Gautrain may appear like any high-speed rail service to developed nations, it represents cutting-edge transportation in its context. It prides itself on being safer, cleaner, and more reliable than other provincial modes which have struggled with these standards. Safety is particularly attractive in South Africa due to the nation's high crime rates.

A key target audience of the GMA are individuals who would otherwise drive a private car, often middle-class commuters. By attracting this demographic, the Gautrain aims to alleviate traffic along the congested N1 highway between Tshwane (Pretoria) and Johannesburg, leading to reduced driving accidents, noise, and air pollution associated with private cars. However, attracting otherwise car commuters has also contributed to a point of criticism of Gautrain who some consider it an elitist form of transport. Despite being theoretically accessible to everyone, its pricing and limited station locations, often in affluent suburbs or business centres, make it financially and physically inaccessible, especially those from working-class backgrounds in townships. Critics argue the Gautrain project was a politically driven project aimed at showcasing South Africa as a global leader for the 2010 World Cup. Twenty billion ZAR was allocated to the Gautrain project, but despite serving at least 2 million passengers every weekday, only 4.67 billion ZAR was allocated to all other provincial forms of PT (Van Der Westhuizen, 2007:338). This stresses social injustices when public funds are disproportionately allocated away from projects that would help the average working-class to benefit the affluent tourist or middle-class.

Socioeconomic controversy has surrounded the Gautrain since its inception and remains a challenge today. In a 2019 report, GMA defends itself as having a positive influence that notably provides economic opportunities and reshapes perceptions of public and rail transport (Gautrain Management Agency, 2019). The Gautrain created 35,000 direct jobs during the construction phase and 10,900 jobs in continued operations (ibid: 10). The GRRIN expansion is expected to generate even more jobs. Furthermore, the history of PT in South Africa has often been associated with negative connotations such as violence and overcrowding. The GMA defends itself then as a positive redefining of what PT *could* be.

1.2.2: Environmental Intention

Given the focus of this research, it is crucial to discuss the environmental impact of the Gautrain. While trains theoretically reduce carbon footprints compared to private cars, practical considerations raise doubts about whether the Gautrain achieves this. Public transport's environmental sustainability depends on reaching a critical mass of ridership to offset its relatively high energy inputs. However, Gautrain ridership levels have been low, especially since the COVID-19 outbreak, with the GMA reporting ridership at 40% of pre-pandemic levels (Gautrain Management Agency, 2022:11). Additionally, despite being electric, the Gautrain is powered by the national grid (supplied by Eskom), which primarily relies on fossil fuels for electricity generation. Stations and parking lots could potentially be retrofitted with solar panels, but they are not currently equipped as such (Partner, 2020). The GMA regards green hydrogen with immense potential for future adaptation (Creamer, 2019), but the current setup shifts rather than reduces carbon emissions. While the Gautrain has potential for future environmental competitiveness, given the factors of grid dependency and low ridership, it is difficult to argue that it has a significant impact at present. Nonetheless, the Gautrain encourages human behaviour patterns that favour public over private transport, which is a positive shift for any city's carbon levels. Thus, it is more the ideology and motivation for sustainable transportation that the GMA represents that qualifies it as a sustainable mode in the context of this research.

1.2.3: The Gautrain's Function in this Research

Though controversial and imperfect, the Gautrain sufficiently serves to explore the research questions and support the overarching motivation: to promote public transport as a competitive alternative to private car use. Demographics that can speak to both public and private transport were particularly valuable for approaching this research practically. Since the Gautrain is the local public transport service specifically aimed at attracting car commuters (as evidenced by its extensive provision of on-site parking facilities), it offers the most direct and efficient means to reach the target sample group.

1.3: Key Terms

The following terms, defined below, are critical for understanding the concepts explored throughout this research. Each term is followed by a definition of how it is used in this study to establish a common starting point for both the report and its readers.

- Sustainable Development: Meeting the needs of the present without compromising the ability of future generations to meet their own needs. This includes balancing environmental, social, and economic growth. For further details, see Section 2.1.
- Sustainable Transportation: Building upon the concept of sustainable development, sustainable transportation aims to move people, goods, and services in socially, environmentally, and economically responsible ways. This research specifically focuses on the movement of people and operates on the premise that public transportation, when optimised, has more potential than private transport to support sustainable commuting (Ritchie & Roser, 2023).
- Human Transport Need: The conditional requirements people have that must be met while in transit. Given that people are conscious beings with psychological needs, this research borrows insights from the field of Psychology to explore how these needs can be applied to commuter transport, with further discussion in Chapter 2.
- Motivation: The reasons behind an individual's actions or behaviours. This research is specifically concerned with the reasons commuters choose different modes of transport, namely the private car and the Gautrain.
- Captive Passenger: A commuter who relies on a particular mode of transport primarily because other options are not accessible. For more on this, see Section 2.4.5.

- Choice Passenger: A commuter who uses a particular mode of transport despite having other available options. For more on this, see Section 2.4.5.

1.4: Chapter Summary

This introductory chapter presents the key problem and the questions the researcher aims to explore. The two primary options for commuter transport are public and private modes. While both have their respective advantages and disadvantages, the research is primarily motivated by environmental sustainability, which has greater potential to be achieved through public transport. The question of how to promote pro-environmental transport choices is introduced. The research also begins to localise the study by focusing on Gauteng, acknowledging that while the Gautrain is a controversial form of transit, it is strategically important for reaching the target demographic—those with access to both public and private transport. Finally, key terms as defined in this research are outlined to anchor the remainder of the report.

Chapter 2: Literature Review

Research gains credibility when it aligns with pre-existing theories and studies. This chapter examines the challenges of applying sustainability principles within local contexts. Drawing on insights from psychology and transport research, four key studies and theories inform the humanitarian approach to understanding human transport needs. Together, these studies define a set of transport needs (Table 2) that form the foundation for the researcher's exploration and analysis.

2.1: The Implications of Sustainable Development on Transport

It could be argued that the earliest thinkings of sustainable development (SD) began in 1833 with mathematician William Foster Lloyd (1794–1852). Lloyd described a scenario that was later rediscovered, named, and popularised by ecologist Garrett Hardin in his 1968 essay The Tragedy of the Commons. The scenario is as follows:

> 'Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy. As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, 'What is the utility to me of adding one more animal to my herd?' This utility has one negative and one positive component.
>
> 1. The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly + 1.
> 2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any decision-making herdsman is only a fraction of -1'
>
> (Hardin, 1968: 162)

The Tragedy underscores the human tendency to prioritise personal gain at the expense of the collective, often leading to the abuse of public goods. A notable example is transboundary air pollution, where the benefits of productivity are enjoyed by one nation, but the costs are borne globally. For instance, China's manufacturing sector threatens both its own domestic air quality and that of neighbouring Korea, while only China reaps the rewards of economic development. Similarly, South Africa is the largest transboundary air polluter in Southern Africa, infringing on Swaziland's air quality, especially when accounting for population size (Du *et al.,* 2020). Likewise, the exclusive benefits of convenience enjoyed by drivers often come at the expense of collective air quality.

While the concepts of sustainable development (SD) have existed for some time, formal recognition, strategies, and practices are relatively recent. The first Earth Day, held in 1970, was followed by the Stockholm Conference in 1972, which marked the first global acknowledgment of ecological challenges as public issues requiring international cooperation and policy responses. The 1987 Brundtland Commission report was another pivotal moment, providing the most widely accepted definition of sustainable development: 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987:39). Sustainability thus has an ethical dimension, requiring consideration not only of individual and current needs, but also of community and future needs.

Sustainable development (SD) depends on responsible resource management and growth, a process that often involves compromises, contradictions, and, at times, symbiotic overlaps. Purvis, Mao, and Robinson (2019:5) describe this as 'the balancing of trade-offs between seemingly equally desirable goals'. The three 'pillars' of environmental, economic, and social longevity support the overarching concept of sustainable development (ibid). These pillars are often visualised as three intersecting or concentric circles, or as literal pillars (Figure 5).

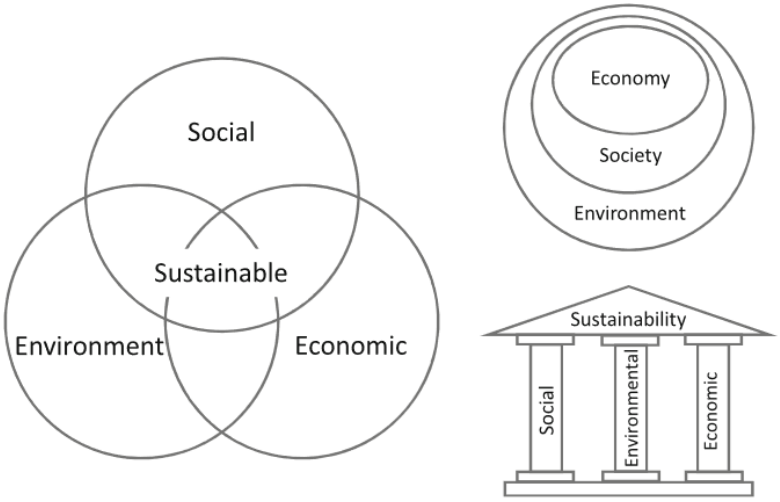


Figure 5: Common Visual Depictions of Sustainable Development (Purvis et al., 2019)

These pillars also inform the United Nations' Sustainable Development Goals (SDGs), as illustrated in Figure 6. For example:

- Environmental sustainability focuses on the preservation of natural resources and wildlife, which is addressed by SDGs 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land).
- Economic sustainability is concerned with raising standards of living, influencing SDGs 1 (No Poverty), 8 (Decent Work and Economic Growth), and 9 (Industry, Innovation, and Infrastructure).
- Social sustainability is focused on individuals' ability to reach their full potential, as reflected in SDGs 3 (Good Health and Wellbeing), 5 (Gender Equality), and 16 (Peace, Justice, and Strong Institutions).

This spectrum of goals sometimes collaborates, but at other times competes, making sustainable development (SD) a complex and slow endeavour, despite its noble objectives (Swilling & Annecke, 2012). It is akin to planning dinner for a large party, which requires significantly more time, effort, and coordination to accommodate the dietary preferences, budgets, and schedules of multiple individuals, compared to planning for a single person.



Figure 6: The United Nation's Sustainable Development Goals (The United Nations, undated)

The role of sustainable transportation is to serve as a means of achieving sustainable development, and therefore it should be rooted in the same three pillars. Such transportation systems must consider the social pillar by being accessible to all people, the economic pillar by promoting the mobility of goods and services, and the environmental pillar by minimising ecological impacts. In this research, public transportation (PT) is considered to have greater sustainable potential than private transport, as the latter is both socioeconomically exclusive (Section 2.3.4) and environmentally irresponsible (Section 2.3). When optimised, public transportation has the potential to offer mobility benefits to a larger portion of the population, thus promoting social sustainability. In contrast, maximised car ownership—where everyone owns and uses their own vehicle—limits mobility due to congestion and requires more environmental resources than nature can regenerate. Public transportation, at full potential, presents a scenario where everyone has access to some mobility, rather than a few having it all while the rest are excluded, which aligns with the situation described in the Tragedy of the Commons.

2.2: Environmental Responsibility

The Paris Agreement of 2015 established a goal to limit global temperature rise to no more than 2°C above pre-industrial levels by 2030. At the subsequent COP28 conference in 2023, this target was revised to 1.5°C, although the strategies for achieving this remain vague. While there is broad agreement on the ambition of this goal, the allocation of responsibility has been a controversial issue, particularly when concepts like climate justice come into play. This is often due to the disproportionate impact of climate change on already disadvantaged groups (Islam & Winkel, 2017). Historically, countries that were the first to industrialise—mostly Western nations—have contributed the most to cumulative CO_2 emissions (Ritchie, 2019a), as shown in Figure 7.

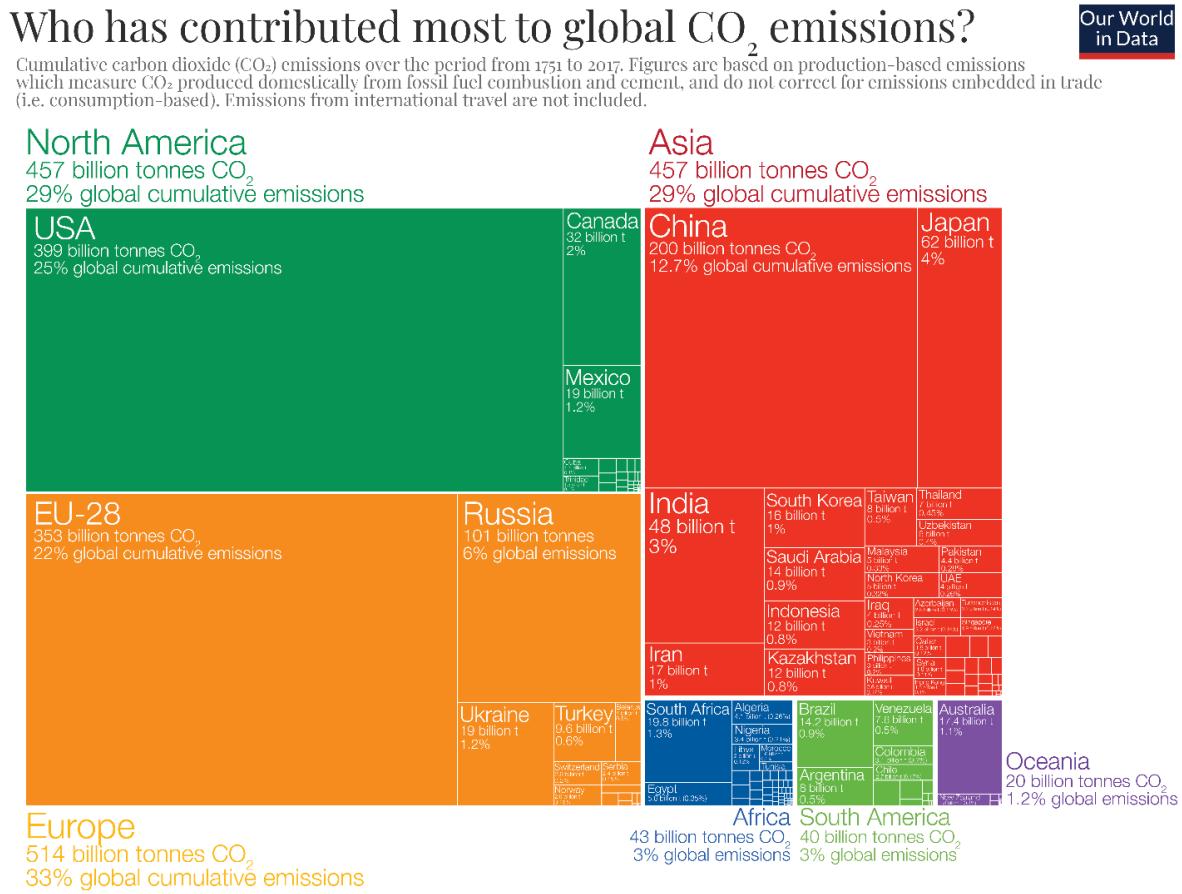


Figure 7: Cumulative CO_2 Emissions by Continent from 1751-2017. Note Western countries as have contributed to most historical emissions (Ritchie, 2019a)

However, as shown in Figure 8, there has been a notable shift in recent decades, with Asian nations—primarily China and India—now occupying the top spots as the fastest-developing and largest greenhouse gas emitters to date (Ritchie, 2019b).

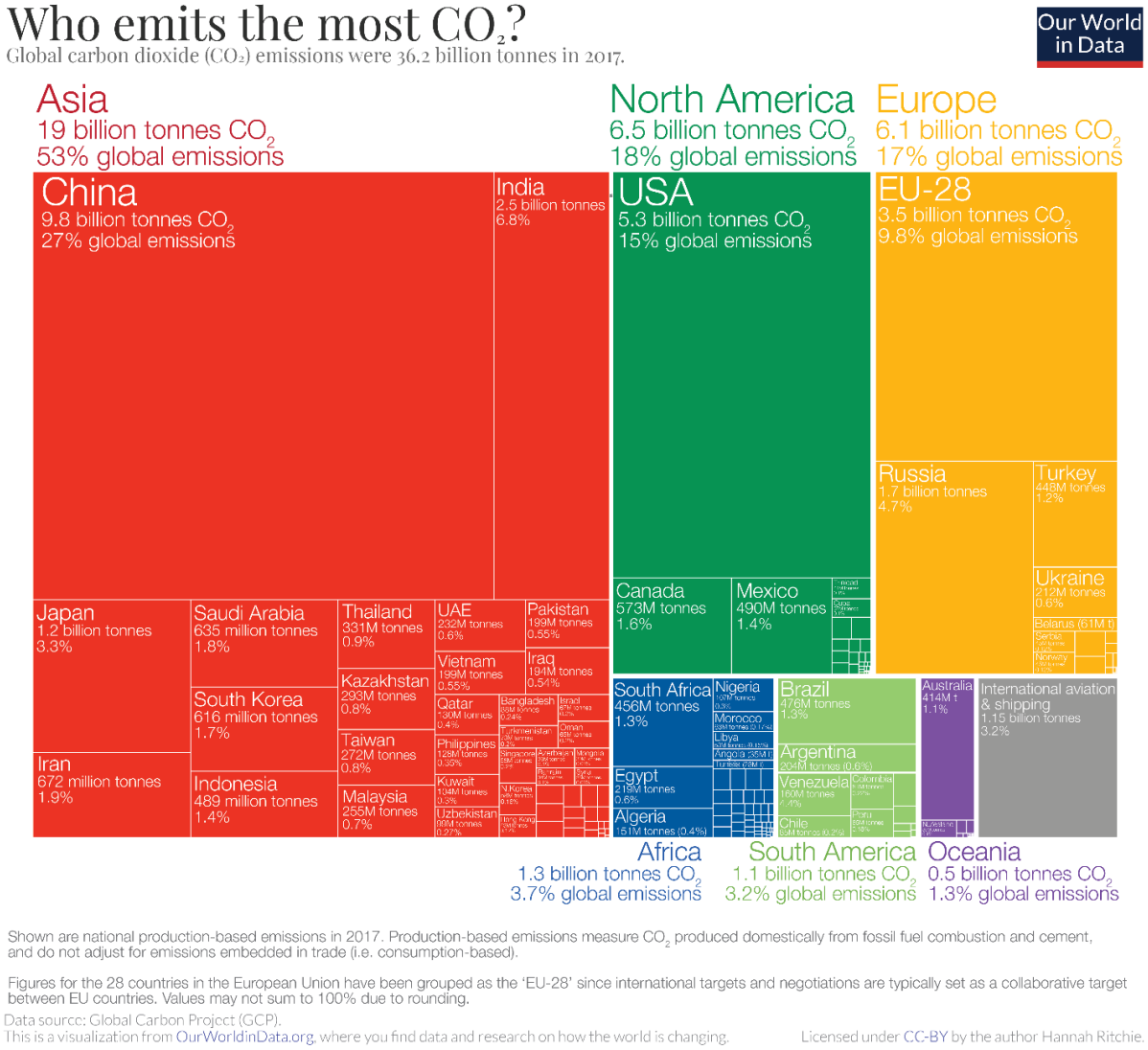


Figure 8: Current CO_2 Emissions by Country. Note that today, the largest contributing continent is now Asia where manufacturing has boomed (Ritchie, 2019b)

The shift in CO_2 emissions generally correlates with the timing of a country's industrial and economic boom, which underpins an ongoing international dispute over climate responsibility. While leaders advocating for global warming mitigation emphasize the need for a collective, global effort and urge all countries to prioritise environmental concerns, developing nations argue that:

> "Western emissions are lifestyle emissions (i.e., from luxury cars), whereas in developing countries, they are survival emissions (i.e., from food production). Some accuse wealthy nations of hypocrisy—having enriched themselves without ecological constraints during their industrial revolutions, yet now expecting developing nations to forgo industrialisation and remain impoverished" (Kurzgesagt, 2020: 95 seconds).

Countries yet to develop may be reluctant to adopt environmentally sustainable practices, especially when they have historically contributed little to the climate crisis. In contrast, high-GDP countries disproportionately account for global carbon emissions. The top 10% of global GDP earners contribute over 33% of the world's greenhouse gas emissions, while the bottom 50% contribute only 15% (Hubacek *et al.*, 2017). Within any given country—whether wealthy or poor—those with higher incomes tend to lead more extravagant lifestyles that generate more CO_2 emissions. These disparities

raise issues of climate justice, particularly when the 2°C Paris Agreement target is not met, as developing nations, especially those near the equator, will bear the brunt of the consequences despite their relatively low carbon footprints (King & Harrington, 2018).

The debate over responsibility is complex. Some argue that Western nations should bear a greater share of environmental accountability due to their historical emissions, while others contend that developing nations cannot afford to follow the carbon-intensive path of the West if future generations are to have a viable planet.

This research advocates the importance of individual responsibility, recognising that while large entities like car manufacturers may contribute more pollution than a single driver, the collective impact of individuals can still pose a significant environmental threat—often described as "choking the air to death with a thousand cuts." While acknowledging the disparities in CO_2 contributions, the study argues that focusing on assigning blame detracts from the central issue of sustainable action (Mark, 2019). No individual, country, or institution should be exempt from this responsibility. Therefore, the disparities in CO_2 emissions are primarily used in this research to strategically identify the focus group with the greatest potential for impact, rather than to excuse or condone one group over another.

Compared to bus or taxi riders, Gautrain passengers are more likely to have a choice in their mode of transport, as the system was specifically designed to appeal to a socioeconomic class that would otherwise opt for private cars. For individuals who have this choice, there is also a responsibility to make environmentally conscious decisions when possible. Likewise, transportation agencies have a duty to make sustainable transport options the more attractive choice. By recognising personal responsibility—whether at the individual, organisational, or national level—we can shift the focus from debate to action.

2.3: Local and Historical Challenges to Sustainable Transport

Gauteng is South Africa’s smallest province by land area, yet it is the largest by population. Known for its wealth, Gauteng is home to both Johannesburg, the 'City of Gold,' and Sandton, often referred to as the 'Richest Square Mile.' The province's transformation began in 1886 when gold was discovered in the nearby Witwatersrand, turning the region into a lucrative asset. The demand for freight systems to export precious metals spurred the development of the first rail network, which was initially centered around the mining industry (Sey, 2008). As wealth and job opportunities grew, so did immigration to Gauteng, fueling urban development and the need for passenger transport systems within its expanding cities. At its peak, the South African rail system was the 11th largest in the world, spanning 22,298 km (Mampane, 2021:6), as shown in Figure 9. The rail system is managed by three entities: Transnet Freight Rail (TFR), PRASA, and the Gautrain Management Agency (GMA), with the latter two responsible for commuter services.



Figure 9: A Map of South Africa's Combined Rail Infrastructure (Htonl, 2012)

The South African Yearbook recognizes rail as the ideal backbone for the country's transport strategy, citing its potential to "reduce the impact on road infrastructure, roadside emissions, and improve efficiencies in the broader transport value chain" (ibid: 8). Ritchie and Roser (2023) illustrate, through Figure 10, that shifting urban commuter transport from private vehicles to mass transit can significantly reduce CO_2 emissions. Diesel cars, for instance, emit about 1.7 times more CO_2 than even the least energy-efficient form of public transit, such as buses. In South Africa, over 90% of emissions from transportation come from diesel cars (World Wildlife Fund, 2016), underscoring the potential for emissions reduction in road transport. While the plan to promote mass public transport (PT) seems promising on paper, in practice, PT in Gauteng has been plagued by a reputation for violence, neglect, and theft. The social and historical factors contributing to these challenges are explored further in Section 2.3.2. The subsequent subsections within Section 2.3 highlight some of the key challenges and competing needs in South Africa that have contributed to the stigmatization of PT. These sections do not attempt to provide an exhaustive list of all factors, as the issue is multifaceted. Instead, the researcher aims to acknowledge this complexity and offer insights from diverse perspectives to help understand the underlying causes.

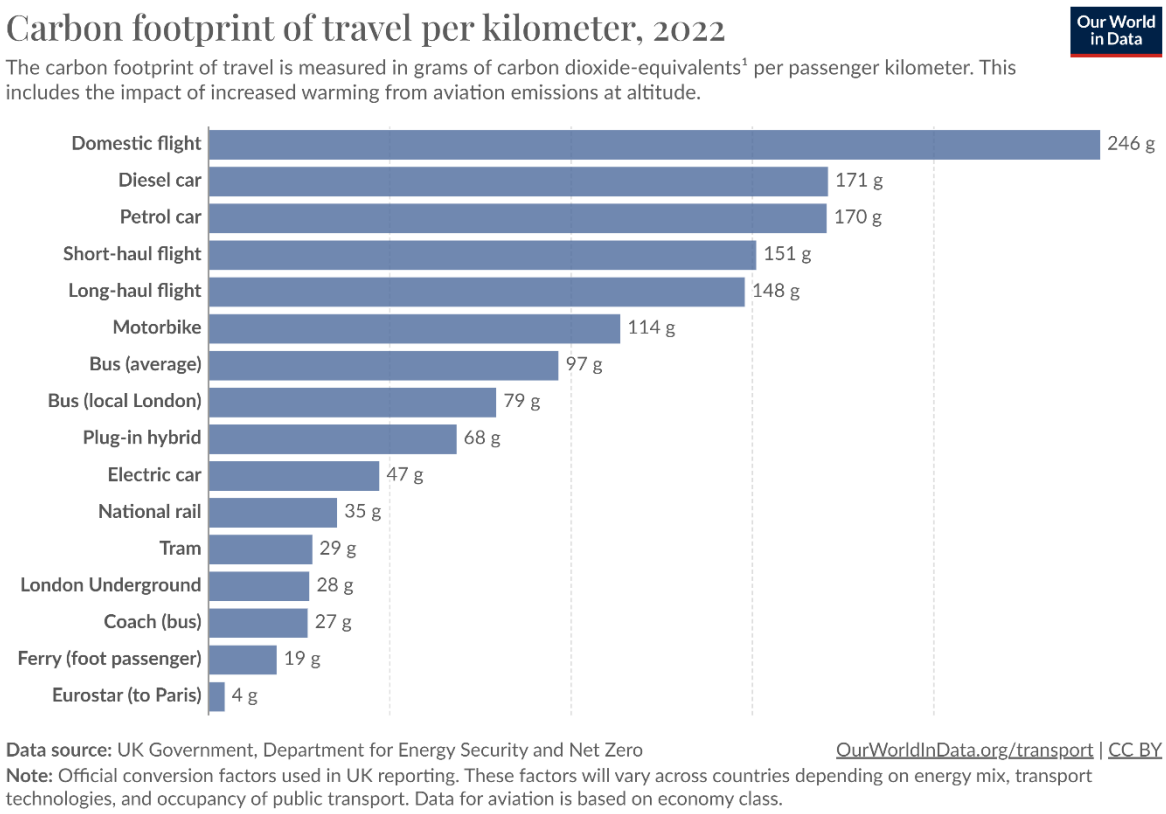


Figure 1 O: Carbon Impact by Various Modes of Transport (Ritchie & Roser, 2023)

2.3.1: Population Distribution and Land Use

Public transport becomes more efficient when it serves a sufficient critical mass, which is typically achieved in areas with higher population density. While Gauteng is densely populated, the metropolitan area spans a wide expanse, with population clusters located in isolated nodes, separated by large gaps (Figure 11). Despite the geographic isolation of these nodes, they are not socially or economically isolated. People frequently travel between these nodes for business, school, and leisure, creating a dynamic of social interdependence that significantly influences commuting patterns.

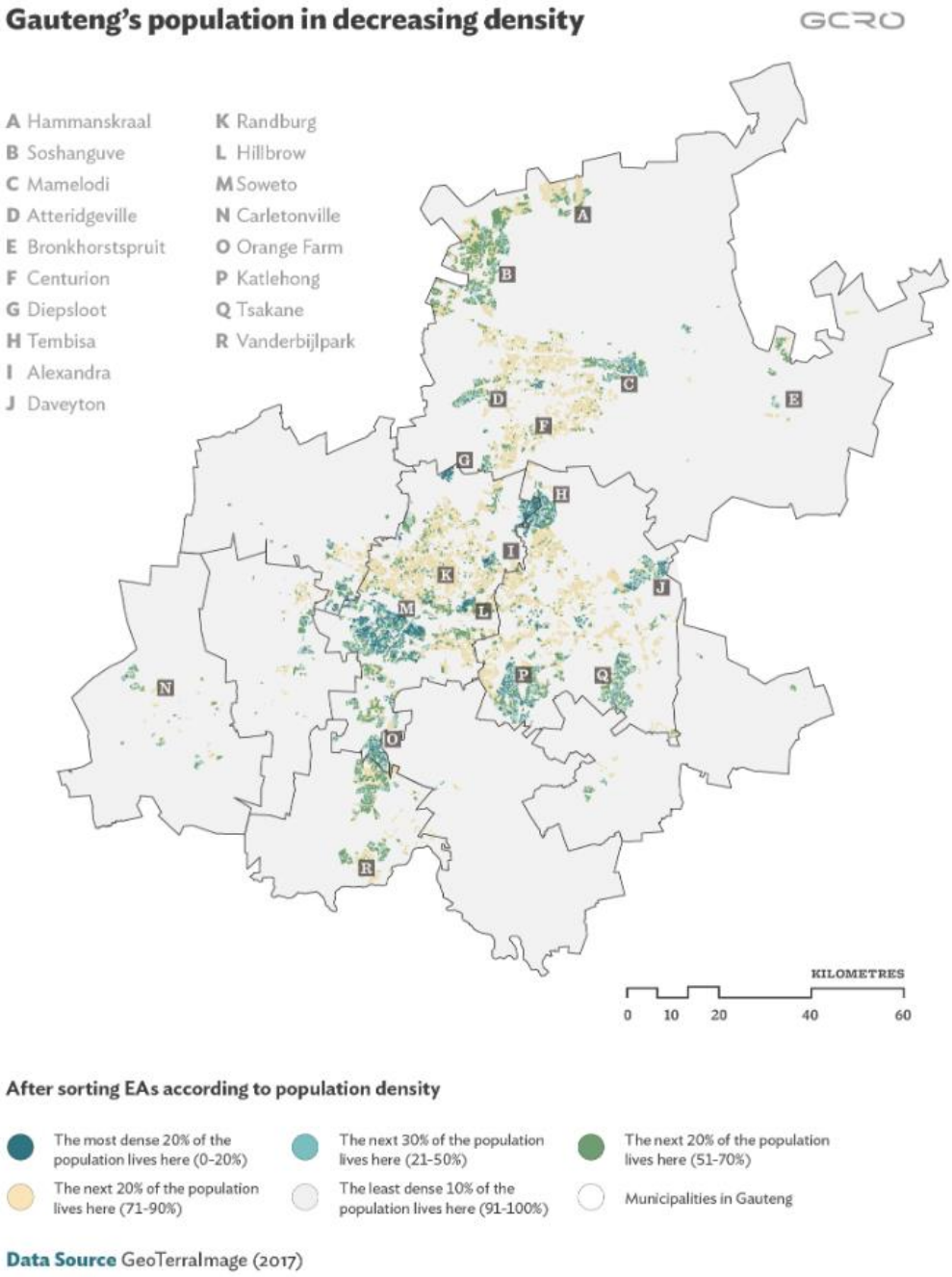


Figure 1 1: Major Population Densities in Gauteng Province (Parker & Hamann, 2020)

Figure 12 highlights the unique distribution of the local population compared to eight other global metropolitan areas. Unlike other cities, which typically have a single, dense population mass, Johannesburg has multiple comparable population centers, each separated by significant gaps. This results in a relatively sprawled metropolitan area.

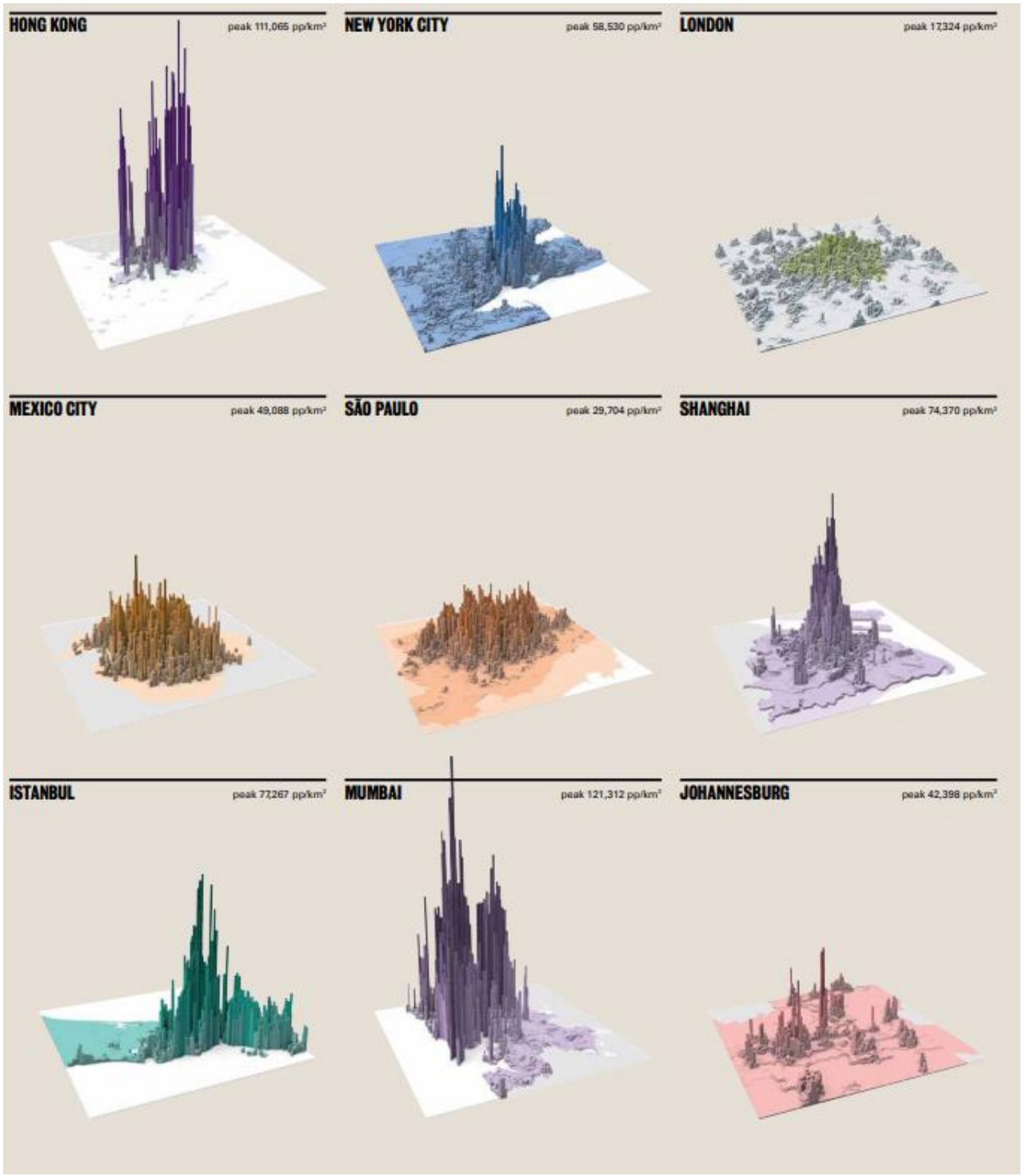


Figure 12: Density Distribution of Nine International Cities. Note how Johannesburg's pattern of sprawl leaves gaps of lower population and underdevelopment (Brandmueller et al., 2011)

The distribution of population density can make the development of a comprehensive transit network more challenging, as infrastructure must extend across widely dispersed nodes. Abozeid and AboElatta (2021) identify two main travel patterns, each with distinct challenges and advantages. As illustrated in Figure 13, monocentric (or agglomerated) cities feature a central business district (CBD) around which development tends to concentrate. This configuration optimizes proximity, making the sharing of services, resources, and knowledge more efficient and enhancing productivity. However, such cities also face intense competition for land, driving up prices due to limited availability (Harris,

2014). Geographical constraints, as seen in mountainous island nations like Hong Kong, often induce higher population density.

Conversely, polycentric cities, like Johannesburg, feature multiple centres of development that interact with one another. Countries with ample landmass, such as Australia, Canada, and the United States, are well-positioned to accommodate polycentric urban forms. While polycentric cities offer more affordable land options, they require urban infrastructure and services to span greater distances, which typically results in higher upfront costs (Harris, 2014). As a result, these cities often lead to higher car dependency (Rodrigue, 2020).

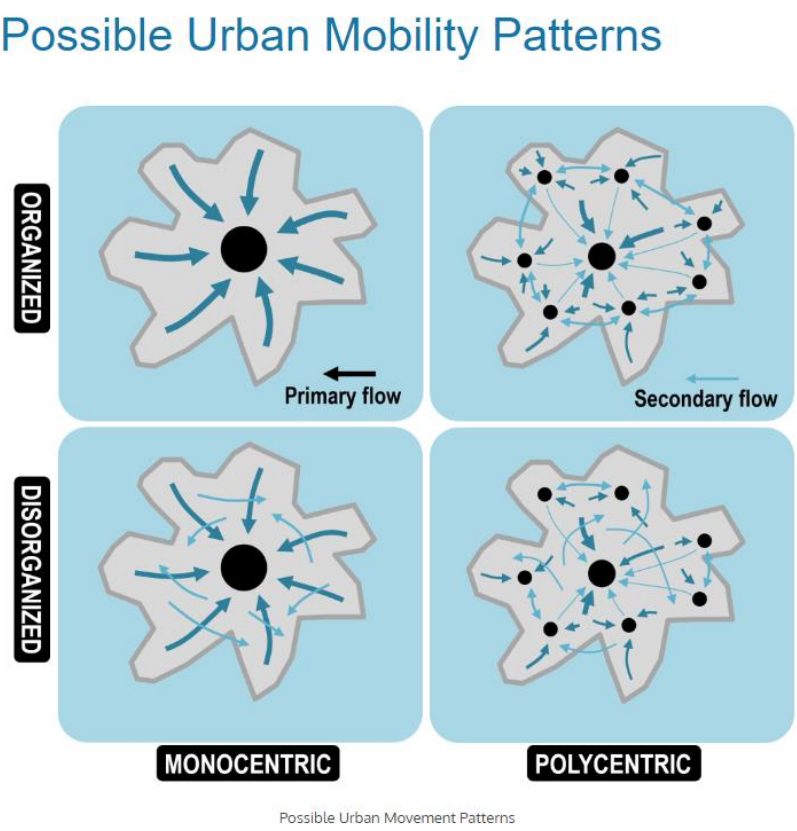


Figure 1 3: Mobility Patterns of Monocentric and Polycentric Cities. Note that polycentric cities (like Johannesburg) simply have a higher diversity and quantity of commuting routes. mobility patterns requiring primary and secondary routes (Rodrigue, 2020)

While monocentric development patterns provide a strong foundation for public transportation (PT) systems, Johannesburg has historically followed a polycentric pattern. The Johannesburg metropolitan area is characterized by several hubs, including the Johannesburg CBD, Tshwane, Ekurhuleni, Sandton, and Midrand (Low, 2018; Parker & Hamann, 2020). The apartheid era further compounded this by legally enforcing the physical separation of ethnic groups, which contributed to urban sprawl. Additionally, employment and residential areas were segregated, creating larger land gaps and further dispersing population centres (Parker & Hamann, 2020). As a result, Gauteng's population distribution leads to more diverse travel patterns that require a broader range of transportation options. Without sufficient coverage, these expansive travel patterns make PT an unviable option, even for commuters who would prefer to use it.

2.3.2: Social Challenges

In 2008, the City of Johannesburg Department of Transport, in collaboration with James Sey, published *The People Shall Move! A People's History of Transport in the Apartheid Era*. The book commemorates

the social history, challenges, and progress of both public and private transport during apartheid and post-apartheid South Africa. It was first made available at the Apartheid Museum and has since been distributed to a select number of public libraries throughout Johannesburg. The insights from this book have significantly informed this section of the research.

Trains first supported colonial South Africa's mining industry and were integral to an extensive transport network across Sub-Saharan Africa. The first passenger train, the Rand Tram (Figure 14), introduced in 1890, primarily transported laborers to mining sites. However, from its inception, the rail system was deeply influenced by the colonial system, with trains being racially segregated. This set the stage for future unrest, as the rail network became a symbol of both economic exploitation and social division. Alongside physical land gaps (Section 2.3.1), rail tracks were also used as buffers between racial groups. Despite higher demand, fewer and lower-quality train cars were allocated to Black passengers. These trains quickly became sites of political violence and unrest, much like segregated buses in the United States.

In 1952, the introduction of the Group Areas Act forcibly relocated Black populations to the urban outskirts, lengthening their commutes and exacerbating the problem of urban sprawl. The already strained train services for non-White commuters were described as a "powder keg on the verge of explosion" (Sey, 2008:28). The starkly contrasting passenger experiences between racial groups further entrenched the divisions in South African society, setting the stage for future political struggles over transportation and racial equality.

> ‘All one needs to be is strong enough to push even the women aside to get in the crowded train. If the coach is already packed, well, I sit on the windowsill with my feet hanging out. But it is cold in winter, so I prefer to sit in the couplings between the coaches’ (Isaac Mogale in Sey, 2008:28).

By the 1970s, automobiles had become widely accessible due to mass production, and while many sought to escape the unsafe and overcrowded trains, it was primarily the affluent populations, with the financial means to do so, who could make the switch. As a result, road transport emerged as the primary competitor to public transportation (PT), leading to a sharp decline in investment in rail infrastructure by the 1980s. Trains, which had long been a focal point of racial and political tension, remained controversial sites in the struggle against apartheid until the country’s transition to democracy in 1994.

In the post-apartheid era, the once-vital rail services, now heavily disinvested, became associated with lower-class transport, while the more affluent increasingly turned to the comfort and perceived safety of private cars. Chronic disinvestment, coupled with rampant property theft and labor strikes, left only the most desperate passengers using the dilapidated rail system (Onderwater & Kishoon, 2017). Nonetheless, as evidenced by the overcrowding issues reported by the Passenger Rail Agency of South Africa (PRASA) (Figure 15), there remained significant demand for rail services despite their decline.

The COVID-19 pandemic ultimately exacerbated these challenges, becoming the final blow for services like PRASA, which was forced to shut down temporarily. Today, rail transport is the least used mode of public transport in Gauteng Province (Statistics South Africa, 2022). However, this is not due to a lack of demand; rather, it is a consequence of the deteriorating quality of service. Despite the poor conditions and strained resources, PRASA trains continued to attract ridership because they met a practical need at an affordable price. Only recently has PRASA begun to revitalize its operations, and as it moves forward, it faces a complex array of civil and historical challenges.

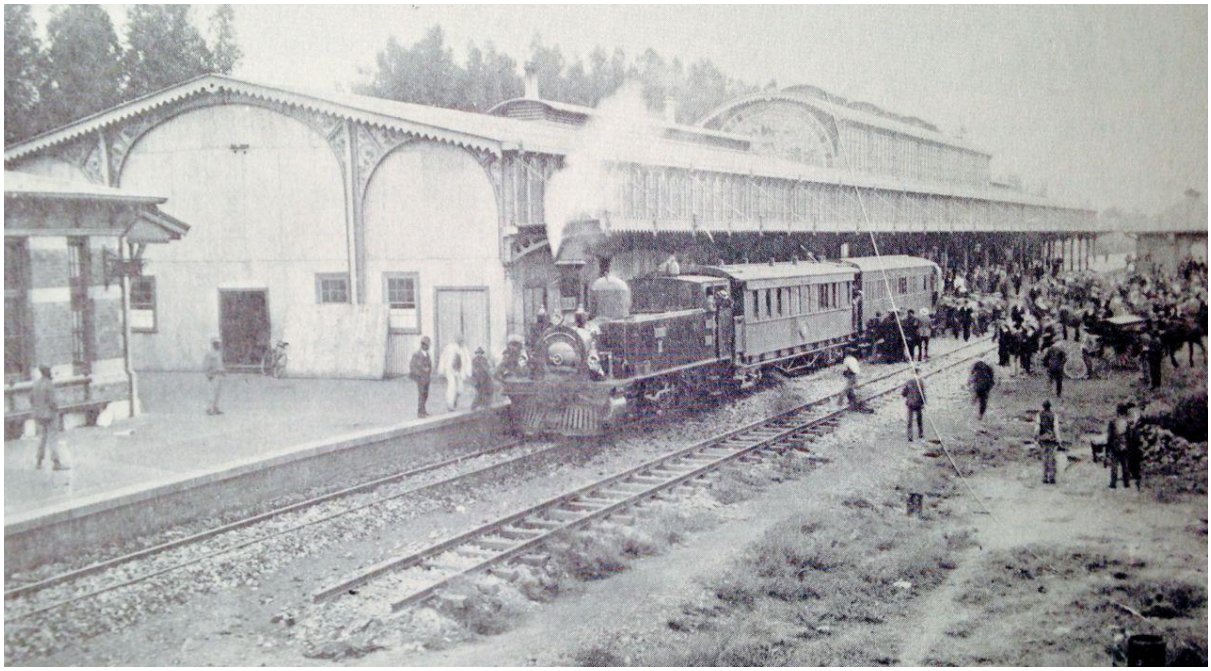


Figure 1 4: The Rand Tram at Park Station in 1897 (Nederlansche Zuid-Afrikaansche Spoorweg-Maatschappij, 1897)



Figure 1 5: Passengers Hanging onto the Outside of a PRASA Metrorail Train in Johannesburg (Michael Bega, 2014)

2.3.3: Economic Viability

The most effective and viable environmentally sustainable projects must align with South Africa's highest priority: economic development. While the planet is facing environmental degradation, South Africa's economy is also in distress. The country grapples with an alarming unemployment rate of 32% (Statistics South Africa, 2023), and the national currency, the Rand, struggles with international competitiveness. For years, allegations of corruption have eroded public trust and confidence, further

hindering much-needed investment in the economy (Government Communications, 2019). The COVID-19 pandemic has only intensified the financial challenges, making the issue of unemployment an urgent priority for the government (Government Communications, 2022). While the South African Department of Energy (DoE) acknowledges the importance of sustainable development, they highlight a significant gap in the economic viability of green projects, stating:

> 'There are still significant barriers to further improving energy efficiency, including the *economic downturn* and *decreases in commodity prices*, which is reportedly encouraging industry and mining to focus on increasing throughput. *Market failures*, such as energy service companies that do not have the capacity to adopt *innovative financing* and technology solutions, the *high costs* of energy efficient appliances, and the negative incentive of *high borrowing rates*, reduce the uptake of energy efficient solutions' (DoE, 2016:9, researcher's emphasis)

Ecologically sustainable initiatives are more likely to gain widespread adoption if they are financially viable, and they become even more attractive if they also contribute to economic productivity. However, in the transportation sector, this can often feel like a distant goal, as most global public transport systems rely heavily on government subsidies. Public transport is considered a civic right, making it a public responsibility for cities to provide these services. As a result, cities may allocate enough funding to keep services operational but often fall short of investing in improvements. With limited financial resources, public transport systems struggle to offer a competitive service that can attract and retain ridership. As ridership remains low, the financial challenges only intensify, creating a cycle that is difficult to break.

In the energy sector, coal continues to compete with sustainable alternatives. While much of South Africa is electrified, coal remains the dominant source for electricity generation. In 2008, when coal supplies became constrained, load shedding was introduced as a measure to reduce consumption (Eskom, 2012). However, this approach has not only curtailed energy use but also further strained South Africa's economy by reducing productivity across various sectors.

Planning strategies must reconcile environmental and economic objectives, both of which are integral to sustainable development (Section 2.1). Winkler *et al*. (2002) argue that, despite higher initial costs, energy-efficient technologies ultimately save money through lower operational and maintenance expenses. The concept of time is crucial in this affordability debate, as it aligns with sustainability's goal of ensuring benefits across generations. Winkler *et al*. (2002) suggest that subsidies should be directed towards reducing the financial gap of energy-efficient solutions, making them more accessible in the long term.

2.3.4: Personal Status

Wealth is a key factor, particularly as it correlates with car ownership. Various measures of wealth provide insights into the economic stability of individuals, organizations, or nations. For instance, the United Kingdom's Office for National Statistics uses a Wealth Assessment Survey that categorizes wealth into financial, property, pensions, and physical assets (Office for National Statistics, 2018). While cars immediately depreciate after purchase, they are still considered part of an individual's physical wealth, with banks often accepting them as collateral for loans. Socially, wealth is frequently judged by personal possessions, and car ownership is a prominent indicator. In a study conducted in Latin America, Córdova (2009: 3) notes that the absence of a vehicle tends to have a negative impact on an individual's economic status, stating: "It can be observed that the factor scores for 'no vehicle,' as expected, have a negative sign, indicating that an individual in a household without a car ranks lower in terms of economic status than one with a vehicle." Across cultural borders and income levels, car ownership is universally associated with financial flexibility and is often seen as a socially desirable asset.

Conversely, public transportation (PT) is often stigmatized as the mode of transport for poorer populations who lack alternatives. The very existence of advocacy for public transport highlights this social stigma. For example, former Bogotá mayor Enrique Peñalosa addressed this issue in his 2013 TED talk, as discussed in Section 1.1. Even when PT is recognized for its service, reliance on it is often seen as something to be overcome, with car ownership viewed as a natural social progression. The use of PT by public figures tends to attract media attention, as private chauffeurs and pilots are now considered symbols of success. For instance, when members of the Royal Family use PT, it is celebrated as a gesture of relatability to ordinary citizens (Ash, 2023). While such advocacy is positive, it inadvertently reinforces the social assumption that PT is inferior and unfit for individuals of high status. In South Africa, local public transport services such as the Rea Vaya buses, Kombi taxis, and Metrorail trains are similarly stigmatized as belonging to the lower class, in contrast to the more elite perception of the Gautrain, as outlined in Section 1.2.1.

Car ownership is often seen as a symbol of upward mobility for the working class, while it is assumed to be a given for the middle class and above. As a result, middle-class individuals who choose public transportation (PT) may be considered somewhat countercultural. This study posits that their less car-dependent travel habits are more environmentally sustainable and seeks to explore the motivations behind such behaviours. While acknowledging that transportation choices alone are not the sole indicator of a sustainable lifestyle, the research also recognizes that external factors can limit individuals' ability to choose alternative transportation options. The goal of this study is to identify the factors that enable sustainable transport choices and to understand the motivations behind them. By uncovering these influences, the research aims to promote PT among middle-class South Africans, making sustainable mobility a social norm across all socioeconomic groups and contributing to the broader sustainable development (SD) of urban areas.

2.4 Psychological Motivations Towards Human (Transit) Needs

Sustainable development, as defined by the Brundtland Commission, aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. This definition prompts questions about what constitutes a human need, how these needs are fulfilled, and the extent to which they can be met in a sustainable manner. These questions have been extensively explored in psychology, particularly through theories of human behaviour. This study specifically focuses on environmentally sustainable transportation behaviour.

This section examines four key studies—two from psychology and two from transportation research—to identify and understand the transport-related needs that influence commuter behaviour. From psychology, Maslow's (1943) Theory of Human Motivation and Ryan & Deci's (2000) Self-Determination Theory are explored. Maslow's theory addresses the hierarchical order in which human needs must be fulfilled, while Self-Determination Theory focuses on the intrinsic motivations behind need fulfilment. From transportation, Allen, Muñoz, and Ortúzar's (2019) Hierarchy of Transit Needs and Onderwater & Kishoon's (2017) study on the socioeconomic impact of transport needs provide further insights. Together, these studies inform the identification of fifteen key transport needs, summarized in Section 2.4.7.

2.4.1: Maslow's Theory on Human Motivation

Abraham Maslow's theory of human motivation is widely recognised and has been applied in various sectors, including marketing to enhance customer satisfaction and business management to improve employee performance (Bridgman, Cummings & Ballard, 2019). This section provides a foundational understanding of Maslow's hierarchical framework, which is essential for the subsequent exploration of its application to PT.

Maslow introduced his original theory in 1943, comprising five human needs. Although Maslow himself did not favour it, the widely accepted representation of his theory is depicted in a pyramid

structure, as shown in Figure 16. Additionally, Maslow categorised the needs into deficiency and growth categories. For deficiency needs, motivation and the attainment of a need are inversely proportional, whereas for growth needs, they are directly proportional. This means that deficiency needs, when unsatisfied, motivate actions to fulfil them, but as the needs are met, motivation gradually decreases. An everyday example is feeling motivated to cook when hungry; however, once nutritional satisfaction is achieved, the motivation to continue cooking diminishes. In contrast, growth needs cannot be fully satisfied, and progress in meeting them further motivates action. Maslow placed the need for self-actualisation in this category because he believed it had infinite potential for satisfaction and would never be fully attained.

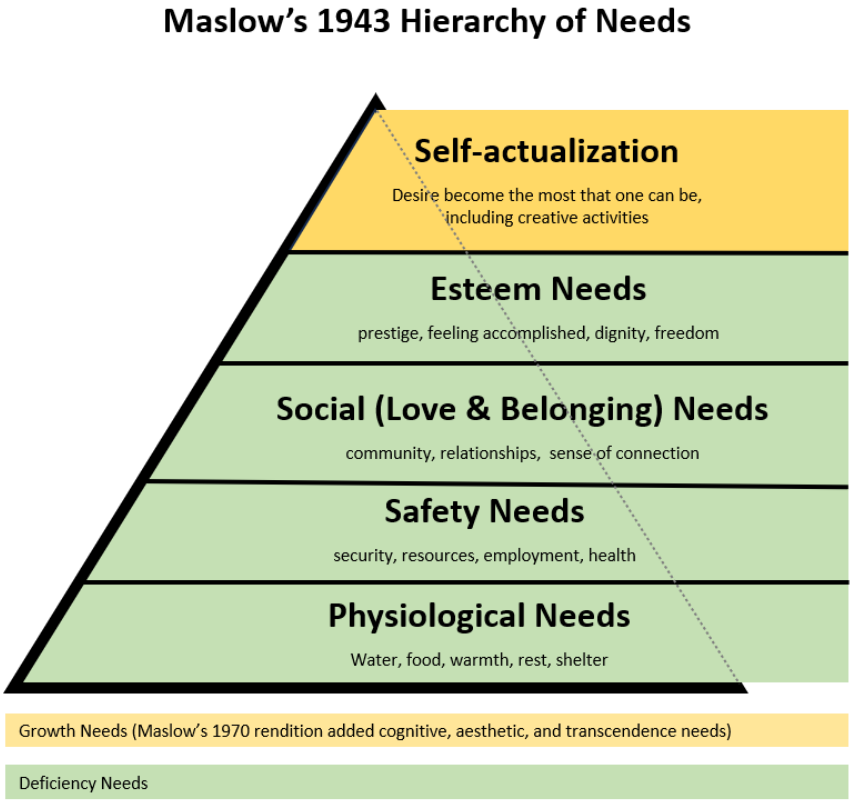


Figure 16: A Pyramid Model of Maslow's Hierarchy created by the Researcher informed by a series of figures from (Mcleod, 2018)

Maslow's theory is distinctive for establishing a sequential relationship among human needs. Like climbing a mountain, progression through the hierarchy begins from the bottom up, with higher needs becoming attainable only after lower ones are met. This hierarchy can guide city leaders in prioritising transportation investments to retain and attract ridership (Allen *et al.*, 2019). The order implies that people are primarily functional, which is a unique and controversial (Section 2.4.6) aspect of Maslow's theory. Interestingly, this chronology aligns with typical developmental stages throughout life, and the following section demonstrates how transportation can directly or indirectly impact some of these needs. For example:

1. Physiological needs are essential for basic survival and the maintenance of bodily functions. These needs begin at birth and are epitomised by colloquial sayings such as 'all babies do is eat, sleep, and poop'.
2. Safety needs relate to protecting one's physical body from environmental harm, which depends on an individual's ability to recognise sources of danger. Maslow argued that a child's

discomfort with new situations is an expression of this need. When faced with unfamiliar people, places, or things, babies may cling to their parents (think “stranger danger”), which validates the parents’ role as protectors. In transportation, perceived safety can either attract or repel ridership.

3. Social (love and belonging) needs arise from the human (and some animal) instinct to affiliate with others who are similar. One distinctive way this need is realised is through the natural development of communication skills, which become tools for interacting within a community. Non-verbal communication develops first, followed by verbal communication, which notably accelerates in the toddler stage. Transportation can help or hinder individuals in reaching social outlets; the perceived sense of community within stations and vehicles can impact the commuting experience.
4. Esteem needs stem from receiving recognition at two levels: from the self and from others. Maslow refers to the former as a high form of esteem and the latter as a low form. This need is most evident in adolescence, when self-awareness and the evaluation of one’s subjective worth become prominent concerns. As discussed in Section 2.3.4, different modes of transportation may be associated with varying levels of cultural or social prestige, which can influence an individual's attraction to them.

2.4.2: Hierarchy of Transit Needs

Inspired by Maslow’s theory, Allen *et al*. (2019) investigated the relevance of hierarchical thinking to PT. They acknowledged that factors such as sociodemographics, location, and mode of transport could influence the order of needs. The researchers specifically focused on Bus Rapid Transit (BRT) systems in four Latin American cities: Santiago de Chile, Mexico City, and two undisclosed Brazilian cities (referred to as B1 and B2). Through statistical analysis of customer satisfaction surveys, they confirmed that the Hierarchy of Transport Needs (HTN), depicted in Figure 17 below, is applicable to three of the Latin American cities studied. They noted that the city which deviated from their hierarchy had also been particularly unsatisfactory in terms of comfort and safety.



Figure 17: Hierarchy of Transport Needs. (Allen et al., 2019)

Similar to Maslow’s hierarchy, transport needs are ideally fulfilled in a bottom-up sequence. However, Allen *et al*. (2019) argue that this hierarchy is not strictly linear and must be considered in conjunction with the dimension of time for a more comprehensive understanding. They present the Dynamic Transit Development graph alongside the hierarchy (Figure 18). The x-axis represents the developmental timeline of a transportation entity, with less developed stages on the left and more developed stages on the right. While the baseline hierarchy order is evident in the overall timeline, it may appear differently at specific moments. For example, at moment B, safety may seem more important than reliability. Allen *et al*. observed this in Mexico City, which placed a lower overall importance on reliability, attributing this to the city having already "fulfilled the reliability domain, and as such, users can now develop higher-order needs" (2019:88). This suggests that Mexico City’s PT system may be at a more advanced developmental stage. Therefore, if a city's PT system does not

precisely follow Allen *et al.*'s hierarchy, it does not necessarily mean the hierarchy is inapplicable. For instance, it may be unclear whether, in Johannesburg's BRT system, the Rea Vaya, the need for safety or reliability is more crucial. However, before concluding that Johannesburg has a different baseline hierarchy, it is essential to verify that reliability has not been sufficiently satisfied. Allen *et al*. (2019) assert that reliability is the baseline transport need because it directly impacts an individual's ability to access essential survival needs, such as employment, housing, and food. They defend this stance by observing that individuals will travel even in unsafe conditions. By identifying what riders are willing to sacrifice, the study confirmed the existence of an order.

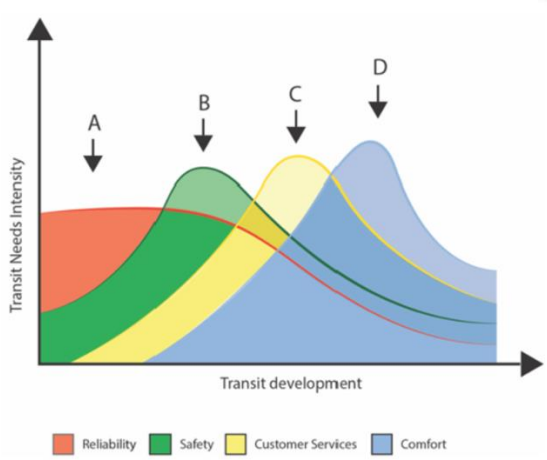


Figure 1 8: Dynamic Transit Development showing once a lower need is met, its salience becomes less relevant. (Allen et al., 2019)

Needs that, when unmet, result in the most customer dissatisfaction are prioritised before those that do not generate as much dissatisfaction. Kano *et al. (*1984), in Allen *et al*. (2019), delineate these into three levels of service needs: basic, performance, and hedonistic services, as outlined in Table 1.

Table 1: Levels of Customer Service Applied to Public Transport

Level of Service/Need	Relation to Customer Satisfaction as per Kano et al. (1984)	Function in Transport as per Allen, Muñoz & Ortúzar (2019:76)	Examples
Basic	These attributes are of compliance and viewed as doing the bare minimum when provided. They do not generate additional satisfaction when met, but the lack of them can generate dissatisfaction.	These transport needs directly correlate with the basic reason for the existence of public transportation: to move people from point A to point B in a reliable way.	Needs related reliability such as availability and dependability
Performance	These are considered performance attributes, and satisfaction correlates proportional to the variety and quality of these services	Allen, Muñoz & Ortúzar consider services that contribute to passenger safety the primary type of performance needs. Passengers do not expect the service for basic performance, but the provision directly impacts perceived quality and passenger satisfaction.	Staff, cameras, covered waiting areas
Hedonistic	Once a customer is already generally satisfied with a product or service, the provision of these additional attributes can boost satisfaction and brand loyalty	These are accessory attributes that are not seen as essential but when provided, make the ridership experience more enjoyable	Customer service, comfort (real and perceived), aesthetics

Like Maslow's hierarchy, higher tiers of needs are of little significance if baseline needs are not fulfilled. Hedonistic needs matter little if basic and performance needs are lacking. For instance, a transportation service may offer exceptional customer service (a hedonistic need), but if it is consistently unreliable (a basic need), customers will be overall unsatisfied. Conversely, if a service is reliable, customers may still be satisfied even if the customer service is subpar.

Allen *et al.* (2019) add that transportation needs are not always fixed at a certain level; they can change over time or vary by location. For example, automatic gears may be considered a performance need in a country where most cars have automatic transmissions, but a hedonistic attribute in countries where manual cars are more common. Likewise, before the internet age, getting live location updates of a vehicle would have been considered a hedonistic feature, but in the current digital age, it may be viewed as a performance need, depending on the context.

2.4.3: Exceptions and Limitations to Hierarchical Thinking

Despite its widespread acceptance, the concept of a hierarchical order of human needs is not without exceptions and debates. Even among those who acknowledge hierarchical thinking, there is disagreement over the order of needs and its applicability across different cultural contexts, life stages, and generational variations. Maslow himself recognised several exceptions and cautioned against rigid adherence to hierarchical thinking (1943:12). For example, one exception he noted was individuals whose need for self-actualisation is realised despite lacking physiological needs, such as "starving artists." Another exception involves individuals who have coped without a particular need for so long, such as those experiencing chronic unemployment, that the aspiration to pursue it is suppressed, lost, or never realised. Individuals accustomed to their need for safety being unsatisfied each time they take public transportation may question why Allen *et al.* consider comfort a transportation need.

Additionally, while the triangle became a popular and easy-to-remember pictorial mnemonic, it was not Maslow's preferred representation, nor has it been received without criticism. Maslow (1943) argued that a person strives to fulfil higher-level needs only after a lower-level need is sufficiently satisfied. This implies that individuals without the material wealth to meet basic physiological needs

cannot consider or achieve higher-level needs, which has elitist implications (Comincioli & Masoodian, 2020). However, Maslow never intended for each type of human need to exist in isolation, as the triangle suggests. He also argued that most behaviour is "multi-motivated" (1943:15), simultaneously addressing several needs at once. Bridgman *et al*. (2019:85) therefore advocate for a ladder model (Figure 19) introduced by Lidwell *et al*. (2003) as a more accurate representation of Maslow's theory, one that avoids the pyramid's implication that each level of need "must be addressed separately before these are transcended and higher levels moved up to."

Moreover, while the triangular representation of Maslow's hierarchy has become popular, it was not his preferred depiction and has faced criticism. Maslow (1943) suggested that individuals strive to fulfil higher-level needs only after lower-level ones are sufficiently satisfied. This implies that those lacking the material means to meet basic physiological needs cannot progress to higher needs, which has elitist implications (Comincioli & Masoodian, 2020). However, Maslow never intended for each type of human need to exist in isolation, as implied by the triangular diagram. He acknowledged that most behaviour is "multi-motivated" (1943:15), with individuals simultaneously addressing several needs at once. Bridgman et al. (2019:85) therefore advocate for a ladder model introduced by Lidwell *et al*. (2003) as a more accurate representation of Maslow's theory.

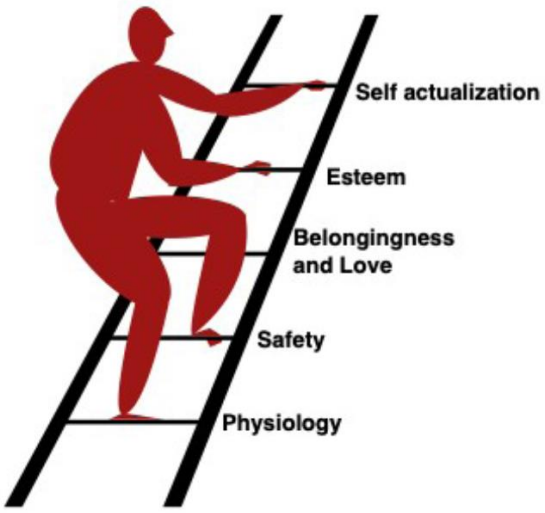


Figure 19: A Lesser-known Ladder Depiction of Maslow's Hierarchy. Notice how the person has limbs in several at once suggesting the pursuit of several needs at the same time is possible. This concept is a limitation of the triangular model. (Comincioli & Masoodian, 2020)

The reality that numerous needs can be pursued simultaneously suggests a non-linear and complex approach to how human needs are attained. These complexities make it unrealistic to establish a strict order for the attainment of transport needs without also acknowledging numerous exceptions and limitations. Therefore, the researcher will not attempt to do so. How these complexities impact the researcher's methodology is further expounded in Section 3.6.

2.4.4: Self Determination Theory (SDT)

Another relevant theory on motivation is Self-Determination Theory (SDT), developed by Ryan and Deci in 2000. The theory largely categorises motivation based on whether the desired outcome

originates from the joy of the action itself (intrinsic) or if the action is a means to a separate outcome (extrinsic). It is the difference between driving for the joy of it versus commuting by car to avoid the dangers associated with public transport (PT). Ryan and Deci (2000) further break extrinsic motivation into four variations, as demonstrated in Figure 20.

There are two relevant sub-theories of SDT, the first of which is Organismic Integration Theory, which describes who has the authority to initiate each kind of motivation: the outside world (external) or the self (internal). When the justification for an action 'emanates from a sense of self' (Ryan & Deci, 2000:60), it is internalised. The relationship, with transportation-specific examples, is summarised in the following Figure 20.

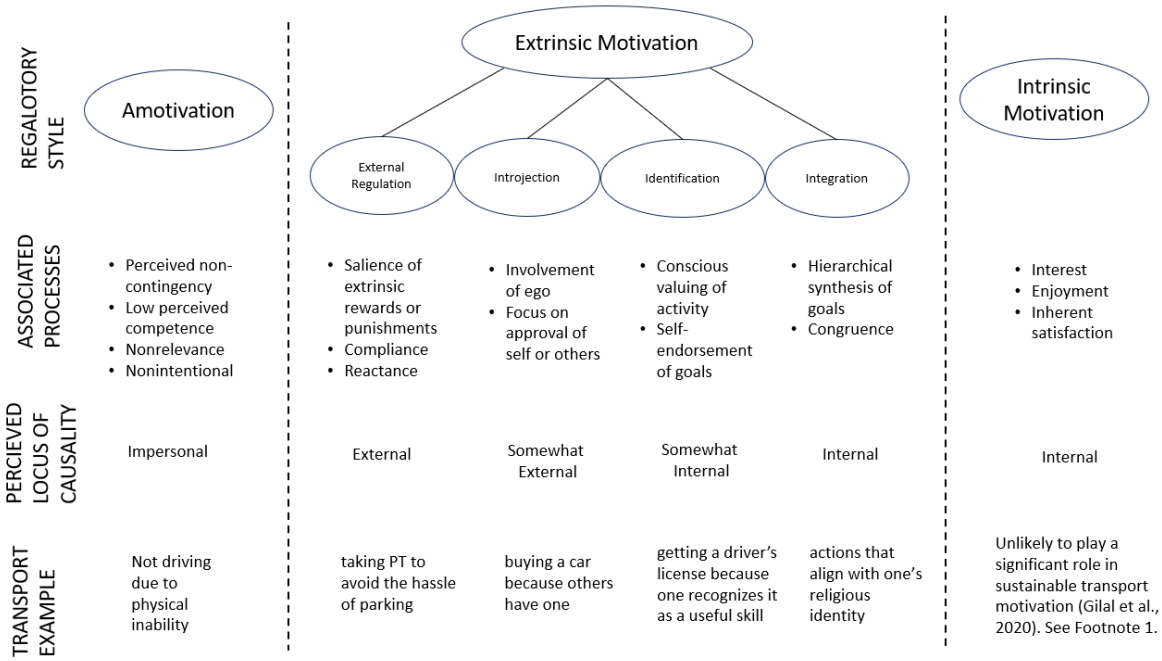


Figure 20: Types of Motivation in Self-Determination Theory (Ryan & Deci, 2000) with examples in the context of transportation

The second sub-theory of SDT is Basic Psychological Need Theory (BPNT), which posits three innate human needs that facilitate growth when an individual is faced with a seemingly difficult task (Burgueño *et al*., 2020). These are the needs for autonomy (having choices and the freedom to act on them), competency (the ability to effectively interact with one's environment and receive expected outcomes), and relatedness (feeling connected to other individuals or communities while engaging in a task). Some relevant studies of SDT in the context of sustainability and transportation, along with their findings and implications, are outlined below:

- A study on the adoption of healthy eating habits in South African townships found that those who received "support from friends or family and who [felt] competent" were more likely to eat healthily (De Man *et al*., 2020:2), validating the need for relatedness and competency. The same study found that guilt and social pressure, driven by introjected motivation, stalled the adoption of healthy eating habits (ibid). Applied to transportation, this suggests that blaming and shaming car users for their emission levels is unlikely to support behavioural change.
- Another study on Canadian students focused on their motivation towards pro-environmental behaviours, specifically taking public transport (PT). It found that increasing competence encouraged users' perseverance through difficult but environmentally beneficial tasks (Aitken, Pelletier & Baxter, 2016).
- Finally, a study conducted in Pakistan found that in persuading the middle class to buy green products, extrinsic motivation had a more immediate impact than intrinsic motivation (Gilal

et al., 2020). For this reason, the researcher hypothesises that External Regulation and Introjected motivation will similarly play the strongest role in participants' transport choices. This alludes to the importance of designing and maintaining spaces that encourage responsible behaviour, which city developers, designers, and managers directly influence.

SDT offers a scientific explanation of human motivation, and its application spans various sectors concerned with motivating human choice, such as marketing, politics, and parenting. This research focuses on how SDT can guide public behaviour towards more sustainable transport habits.

2.4.5: Transit Needs of Captive and Choice Passengers

Onderwater and Kishoon's (2017) study explores how socioeconomics can influence the order in which individuals pursue their transport needs, in a setting similar to this research. They compared Gauteng's captive and choice rail passengers, using Metrorail and Gautrain passengers as sample groups for each target group, respectively. A captive passenger in the transportation context is someone who uses the service because they have no other options, while a choice passenger has mobility options but chooses to use public transport (PT) for other identified benefits (Onderwater & Kishoon, 2017; Guerra, 2022). Often, choice passengers have access to a private vehicle, but it should not be assumed that those who own cars do so purely by choice. For example, in car-dependent countries like the United States, there are areas with little to no public transport, necessitating car ownership and creating a population of captive car-owners. The focus of this study is on choice riders, comparing the ways in which the Gautrain and private car meet transport needs.

Onderwater and Kishoon's (2017) study is based on the idea that all passengers have three "budgets" when considering transportation needs: time, cost, and effort. While the latter two budgets can be replenished through employment and leisure, time remains fixed. Although all passengers aim to minimise expenditures across all three budgets, when faced with trade-offs, captive and choice passengers tend to prioritise different budgets. Captive passengers are primarily concerned with the cost variable, while choice passengers are more inclined to spend money if it saves time.

Intolerance for delays is particularly pronounced among airport commuters, where the risk of delays is higher. Therefore, lines to airports must be reliable, or else the transit authority may face more intense complaints. The study found no significant differences in how the effort budget was perceived between captive and choice riders, noting that effort is generally treated as a constant (Onderwater & Kishoon, 2017).

Captive passengers are often dependent on the service due to a lack of options. Financial inaccessibility was the most cited reason among Metrorail commuters when asked why they used the service, but a lack of a driver's licence or physical inability to drive were also mentioned (Onderwater & Kishoon, 2017). Captive riders may have higher ridership loyalty, but their relationship with the service is often more strained, as their perceived loyalty stems primarily from the fact that changes to their commute are unrealistic.

The study also identified other differences between captive and choice riders, particularly in the types of trips each group makes and the loyalty of each group. Overall, both captive and choice riders commute primarily for practical reasons such as work or school, but captive passengers are less likely to make leisure trips. The researchers suggest this is due to the additional strain on the time, cost, and effort budgets, which may already be limited. Additionally, choice passengers are more likely to have inconsistent or occasional travel patterns. For example, there is a group of Gautrain commuters who form part of the GMA's target market, using the airport express service exclusively, and a private car for all other trips. These passengers can be more difficult to plan for, as their loyalty is less tolerant of inconveniences when they have other transport options. Captive riders, on the other hand, tend to exhibit higher levels of perceived loyalty, especially when changing to other transport modes is

unrealistic. South Africa is already a large economic leader on the African continent, in in light of this, Onderwater & Kishoon add:

> 'As economic wealth increases, car ownership will also increase, and more people will become Choice Users, and less PT Captives. This can result in a reduction of PT patronage. To assess this impact, it is recommended to split population growth in income groups, for non-car users, to determine the number of Captives/Choice Users respectively' (Onderwater & Kishoon, 2017:631)

The researcher also argues that, in a democratic context, the humanitarian approach should be to foster choice ridership, rather than trapping captive riders into public transport (PT). However, she acknowledges that the reality is far from this ideal. Across all modes of PT in the country, captive riders constitute the majority of PT patronage, with the most notable percentage served by Kombi Taxis. While the focus on choice riders may not address the needs of the current majority, the researcher justifies its value as a proactive approach to planning. Rather than waiting for most citizens to become wealthy enough to own a car and then responding to the issues of car-dependency, she suggests a preventative planning strategy to make PT more desirable than private car use. This approach could reduce some of the health and environmental issues associated with private car use before they even emerge, and, in the long term, save future energy and resources. While there may be several viable strategies, this research explores the human-centric approach of meeting basic needs through the design of transport systems.

2.4.6: The Limitation of Transportation's Role in Meeting Human Needs

Finally, the researcher emphasises the limited role transportation plays in an individual's overall well-being. While urban and transportation planners have a direct responsibility to meet transportation needs, they have only an indirect role in addressing an individual's psychological needs. Transportation serves as a means to attain other goals, rather than an end in itself (Onderwater & Kishoon, 2017; Allen *et al*., 2019).

Although transportation entities are not explicitly tasked with meeting human psychological needs, the researcher argues that transportation systems should not create barriers to fulfilling those needs. For example, while it is not the responsibility of public transport to provide food, if individuals cannot access a grocery store due to transportation limitations, the system can be considered unsustainable.

2.4.7: Summary of Transportation Needs

At this point, the researcher has introduced four relevant studies that have informed her understanding of what constitutes a transportation need. Table 2 summarises the composite list of transportation needs explored in this research. However, it should be noted that these original fifteen needs have yet to be confirmed in terms of their specific applicability to commuter transport. This evaluation was carried out during the fieldwork stage and is discussed in Chapter 4.

Table 2: List of Transport Needs Explored in this Research and the Theories/Studies that Informed It

(Type of) Transport Need	Theory/Study
Physiological	Theory of Human Motivation (Maslow, 1943)
Safety	
Social	
Esteem	
Self-Actualization	
Reliability	Hierarchy of Transport Needs (Allen, Muñoz & Ortúzar, 2019)
Safety	
Customer Services	
Comfort	
Autonomy	Self-Determination Theory (Ryan & Deci, 2000)
Competence	
Relatedness	
Time	Captive & Choice Ridership (Onderwater & Kishoon, 2017)
Cost	
Effort	

Two studies—Onderwater & Kishoon (2017) and Allen *et al*. (2019)—come directly from the field of transport studies, while the other two—Maslow (1943) and Ryan & Deci (2000)—borrow insights from psychology to explore their transferability to transportation. It is important to stress that these fifteen needs are not meant to be all-inclusive. Other human needs could arguably apply to transportation, but in order to keep the study within a manageable scope, the researcher had to limit the scope. These needs are widely accepted and supported by respected studies, thus serving as a baseline set of transportation needs to be further explored and discussed.

2.5: Chapter Summary

In this literature review, the researcher discussed some of the earliest theories related to sustainable development, beginning with Hardin's Tragedy of the Commons (1833) and moving into the United Nations' formalisation of the concept in 1987, where the pillars of social, economic, and environmental sustainability were established. Given the controversial trajectory of global development, a discussion on environmental responsibility followed, cautioning against fixating on the notion of fault to the extent that it distracts from the need for collective responsibility. This discussion was pivotal in grounding the research's focus on the wealthier class, which the researcher argues is strategically important for influencing the travel behaviours of everyday commuters.

While the goals of sustainable development are theoretically aggregable, achieving them through public transportation faces significant resistance. The chapter also explored localized issues such as car-dependent land use, social stigmatization, and status competition, which often make using public transport seem more like an act of desperation than a desirable choice. The literature review suggests limitations to the notion that individuals have a true choice in their commuting mode, as the physical transit network and spatial planning factors can often motivate or supersede personal preferences.

Lastly, the chapter outlined the existing studies from which the researcher derived a list of transport needs, which are carried into the remainder of this study. Four studies—two from transport studies and two from psychology—were referenced to inform the interdisciplinary research questions previously introduced. These transport needs are summarised in Table 2. While all are referred to as

'needs', the literature suggests that commuters may be willing to sacrifice some but not others. This indicates that some of these could be better understood as transport wants or 'hedonistic' needs (Kano *et al*., 1984), while uncompromisable needs are likely to be 'basic' needs (Maslow, 1943). The researcher theorises that commuters consider a mode of transport viable when it meets their basic transport needs and competitive when it meets their hedonistic transport needs. The continuation of this research aims to delineate which transport needs are experienced as basic, and which as hedonistic.

Chapter 3: Research Methodology

3.1: Introduction

Research methodology plays a crucial role in shaping the conclusions a researcher can draw, encompassing the procedures for data collection, organisation, and analysis. Just as there are multiple approaches to solving a problem, there are many combinations of methodologies that can lead to valid conclusions. However, no methodology is without its limitations. Therefore, this chapter not only defends the chosen methodologies but also acknowledges their constraints. Finally, because the methodologies are designed to answer the research questions, it is useful to revisit Section 1.1.3, where these questions are first introduced.

3.2: Qualitative Study

Scholars generally categorise research into two broad types: quantitative and qualitative. Quantitative studies typically involve large sample sizes and closed-ended questions, generating substantial amounts of numerical data that are ideal for statistical analysis. In contrast, qualitative research gathers data through open-ended questions, uncovering individual experiences and perspectives via narratives. Qualitative data aims to extract meaning from these narratives, and the smaller sample size allows researchers to account for context and subjectivity in participant responses (Streefkerk, 2019).

The researcher chose a qualitative approach as the most appropriate for investigating her primary research question, which centres on motivation. Given the complexity of motivation, the researcher anticipated nuanced responses and cited Sandler and Tsitolovsky (2008: 177), who describe motivation as the "most ambivalent" aspect of neuroscience, influenced by a range of objective and subjective factors. To allow for a deeper exploration of these nuances, the researcher opted for open-ended questions, avoiding the limitations of closed-format responses such as true/false, multiple-choice, or numerical scales. However, while the qualitative approach offers richer insights, a trade-off is the smaller sample size, which may limit the transferability of the findings. This limitation is discussed further in Section 3.3.2.

3.2.1: Case-Comparative Study

Within the qualitative approach, this research is specifically comparative: it examines the similarities and differences between at least two entities in relation to at least one object of investigation (Esser & Vliegenthart, 2017:2). In this study, the two entities are commuting by private car and commuting by Gautrain, and the objects of investigation are several transport needs.

The researcher specifically considers this study a case-comparison, as it focuses on one form of public transport (the Gautrain) in depth, rather than comparing several forms of public transport equally. However, this research is not a pure case study, as it primarily examines the Gautrain in relation to transport needs. Pure case studies, according to Mihas (2023), require an in-depth exploration of a subject through multiple data collection methods, perspectives, and angles to form a comprehensive understanding, which is beyond the scope of this research.

One benefit of comparative studies is that they reveal nuances and complexities, presenting a more nuanced view rather than over-generalizing or reducing the data to a binary of "black and white" (Esser & Vliegenthart, 2017:2). In other words, comparing two entities can highlight how they may be more alike or different than is commonly assumed. A potential limitation of comparative studies arises when the researcher fails to define the boundaries or establish a common standard of evaluation for comparison, leading to a situation where entities are compared without a consistent frame of reference—comparing "apples to oranges." To mitigate this, the researcher followed Esser and Vliegenthart's (2017) four parameters for comparative studies, ensuring a structured and

methodologically sound approach. Table 3 outlines these guidelines, along with their application to the context of this research.

Table 3: Parameters for a Mature Comparison Applied to this Research (Esser & Vliegenthart, 2017).

Parameter - as per Esser & Vliegenthart (2017:4)	Applicability to this Research
The purpose of the comparison must be explicated early in the project, and it should be a defining component of the research design	By comparing the private car to PT, the researcher aims to better understand how to motivate middle class transport behavior towards more sustainable modes
Second, the macro-level units of comparison must be clearly delineated, irrespective of how the boundaries are defined.	The geographical and historical context for both transport modes being evaluated are within the same scope: within Gauteng province, South Africa in 2023.
Third, the objects of analysis should be compared with respect to at least one common, functionally equivalent dimension.	The common dimension of comparison is that the same set of individuals were asked about both ridership experiences. This approach eliminates variances from sample group bias.
Fourth, the objects of analysis must be compared on the basis of a common theoretical framework and must draw on equivalent conceptualizations and methods rather than be analyzed separately	Objects of analysis for evaluating the car-commuting and train-riding experiences are both measured by the same set of theories about human transport needs. Ideas from the four studies intoroduced in the Literature Review were explored in both transport modal contexts.

3.3: Sampling

Sampling is the process of recruiting qualified participants for research. In this study, snowball sampling—a form of non-probability sampling—is primarily used to identify a subset of hybrid Gautrain passengers who also drive private cars. This section defines the target sample group, outlines the methods used to locate participants, and provides an overview of the sample group's characteristics. Given that sampling limitations proved to be the most complex aspect of the study, their implications and the potential consequences are also discussed in this section.

3.3.1: Characterising the Sample Size

The sample group of interest consisted of middle-class (or above) choice Gautrain passengers, selected for their strategic influence as discussed in Sections 1.1.2 and 2.2. The criteria for classifying participants as choice and middle-class were based on two key factors. Choice passengers included individuals who currently had access to a private car, had previously had access, or shared a car, as long as this access was synchronous with their use of the Gautrain.

The definition of middle-class was relatively straightforward, as the Gautrain predominantly targets higher-income groups. However, participants also verbally verified their middle-class status through self-identification.

Rather than using quantifiable tax income ranges to define middle-class status, the researcher opted for a more flexible approach to avoid potential non-responses and because precise income data was not deemed essential for this study. The researcher recognizes that omitting income brackets could be seen as a limitation, but also acknowledges that applying tax income data could be misleading. For example, early-career adults with modest incomes might still be classified as middle-class due to shared household resources, such as living with relatives. Since the research focuses on the lifestyle implications of being middle-class, allowing participants to self-identify was deemed sufficient for the context of this study.

The demographic characteristics of the sample group are summarized in Table 4 below.

Table 4: Demographic Breakdown of Participants in this Research

Participant	Gender	Socioeconomic Class (Self-Identified)	Age	Highest Qualification	Ethnicity	Living With	Number of Dependents	Employment Status	Primary Mode taken to Main Occupation (Inferred)
A	M	Upper	65	PhD	--	Independent	0	Retired	Private Car
B	F	Middle	31	Honour	Black	Family	0	Fulltime emp.	Private Car
C	M	Middle	24	Honour	Coloured	Family	0	Fulltime emp.	Gautrain
D	M	Middle	64	Bachelor	White	Partner	0	Self-employed	Gautrain
E	M	Middle	51	Bachelor	Black	Family	3	Fulltime emp.	Private Car
F	M	Working	23	Honour	Black	Family	0	Fulltime student	Private Car
G	M	Middle	64	Bachelor	White	Family	1	Fulltime emp.	Gautrain
H	F	Working	22	Bachelor	Black	Family	0	Part Time Employed	Private Car
I	F	Middle	37	Master	Black	Family	2	Fulltime emp.	Private Car
J	F	Middle	25	Bachelor	Arab	Family	0	Fulltime emp.	Private Car
Average (if applicable)			40.6				0.6		

It is important to note that two participants (F and H) identified as working-class, a detail the researcher only realized after the interviews had been conducted. This oversight occurred partly because, for online interviews, participants typically completed the Demographic Questionnaire (Appendix B), which includes questions about socioeconomic status, after the interview. In hindsight, the researcher recognizes the need to verbally confirm participants' socioeconomic status before proceeding with the interview. Nevertheless, the researcher decided to include these two participants' insights, as their comments still provided valuable perspectives on transportation needs. As a result, 80% of the ten participants fully met the criteria for the intended sample group.

Additionally, the researcher did not initially anticipate the insights that could be inferred from the frequency of Gautrain use, which was recorded in the questionnaire. From this, the researcher inferred the contents of the far-right column in Table 4. While all participants used a hybrid mode of transport (private car and Gautrain), 70% of participants primarily used cars, suggesting that the Gautrain, even when utilized, served as a supplementary option. This finding aligns with market segmentation research conducted by Catalyst for the Gautrain Management Agency (GMA), which found that 64% of Gautrain users use another mode of transport as their primary mode (GMA, 2014:13). The researcher cross-referenced these findings to support the validity of her inference.

Regarding the potentially limited sample size (ten participants), the researcher referred to Alyavina, Nikitas, and Tchouamou Njoya (2020), who recommend a minimum of five participants as a baseline for semi-structured interviews. Data saturation, which occurs when consistent patterns of meaning emerge across participants, is considered more valuable in qualitative research than meeting a strict sample size threshold (Saunders *et al*., 2018).

3.3.2: Non-probability Sampling

This research used Streefkerk's (2019) framework distinguishing between probability and non-probability sampling to classify the sampling method employed in this study (see Table 5). The characteristics most applicable to this research are highlighted in green.

Table 5: Distinctives of Nonprobability and Probability Sampling as Defined by Streefkerk (2019) by which the researcher used to define her sampling method.

Non-Probability Sampling	Probability Sampling	Characteristic of this Research
Sample selection based on subjective judgement of the researcher	The sample is selected at random	selection was exclusive as participants who met the middle-class Gautrain choice passenger criteria were included, but others were not
Not everyone has a chance to participate	Everyone in the population has an equal chance of getting selected	Gautrain passengers with access to a private car were more likely to be pursued by the researcher
The research does not consider sampling bias	Used when sampling bias has to be reduced	The research question systematically and strategically makes certain Gautrain passengers more likely to participate
Useful when the population has similar traits	Useful when the population is diverse	This is subjective depending on what the individual constitutes as diverse. Gautrain passengers could be argued as socioeconomically homogenous but also racially diverse.
The sample does not accurately represent the population	used to create an accurate sample	The sample does not accurately represent the general population as outlined in Section 3.3.2 and 3.3.3.
Finding respondents is easy	Finding respondents is not easy	Finding respondents was hard because hybrid Gautrain/private car commuters are a niche subset

Non-probability sampling was the most fitting description for this study, as the research aimed to gain an in-depth understanding of a specific subgroup—hybrid Gautrain/private car commuters. One of the key advantages of selecting a targeted and consistent sample group was that it provided a common standard for comparison (see Section 3.2.1) and enabled the researcher to maintain a manageable scope of investigation. However, this choice also limited the generalizability of the findings, meaning that patterns identified among choice Gautrain passengers may not be easily transferable to other transit modes. While the researcher argues that non-probability sampling is essential for addressing her research motivations, it is not without its limitations.

3.3.3: Recruiting Methods

Finding qualified candidates posed a significant challenge in this research. Initially, the researcher attempted quota sampling (Etikan, 2017) and sought to optimize this approach by positioning herself at Gautrain parking lots, which would allow her to filter for Gautrain passengers who also drove. However, this strategy was discouraged by station security, and securing formal permission from the Gautrain Management Agency (GMA) proved unexpectedly difficult (Section 3.5). As a result, the researcher shifted to asking random passengers on the Gautrain if they had access to a private vehicle, inviting those who met the criteria to participate. This alternative method, however, was time-consuming, inefficient, and luck-dependent, ultimately resulting in only two participants being recruited through this approach.

The researcher then reverted to snowball sampling, a form of network sampling in which existing participants are asked to recommend other qualifying participants that the researcher could contact (Etikan, 2017). While snowball sampling helped locate more participants, Etikan (2017) cautions about its limitations, noting that "the choice of the whole sample balances on the choice of individuals from the beginning of the stage, belonging to a particular clique or having ample biases" (p. 216). For example, as shown in Table 4, all participants were educated to at least an undergraduate level. The researcher attributes this in part to the exclusion of legal minors (18 years and younger) but primarily to the snowball sampling process, which originated within academic connections.

3.4: Research Procedure

The researcher began by observing Gautrain ridership to gain experiential insights, which informed the subsequent interview stage. Additionally, she attended the Southern African Transportation Conference (July 2023) and the Transport Month Conference (October 2023), where she engaged with industry professionals and academics, including representatives from the GMA, to further guide her research. Between September 24 and November 8, 2023, ten participants were interviewed, with 70% opting for online interviews. The interviews were structured using the Interview Guide (Appendix A), which was developed based on insights from the Literature Review. Each participant also completed a Demographic Questionnaire (Appendix B).

Although the researcher initially aimed to obtain data directly from the GMA, this proved more challenging than anticipated (see Section 3.6).

Ethically, the researcher prioritized participant safety and data integrity throughout the study. The interview questions (Appendix A) posed no risks beyond those encountered in everyday life, and measures such as using aliases were implemented to ensure anonymity. Participants were also given the option to exclude certain information, and all demographic questions were voluntary. All participants were over 18 years old and consented to audio recording. The recordings were stored securely and deleted at the end of the research term.

Prior to each interview, participants were provided with an information sheet and consent form (Appendix C). The research was approved by the University's Ethics Board.

Interviews were transcribed using Microsoft Word's transcription tool, with corrections made for any computer-generated errors. Key responses were highlighted, and codes were developed to identify relevant themes and overlaps. These codes then informed the researcher's conclusions.

3.5: Analysis Methods

Once data have been collected, it must be organised and analysed to derive meaningful insights. These processes are essential, particularly when working with primary data, as they directly influence the quality and validity of the research findings. The primary method of analysis used in this research was thematic analysis, framed within a deductive approach. This section reviews key literature on the definition, applications, and limitations of these methodologies. It also provides a practical explanation of how these analytical methods were applied in the context of this study, along with a justification for their use.

3.5.1: Thematic Analysis

Thematic analysis identifies patterns of meaning, both explicit and implicit, in qualitative data common across various epistemologies (Mihas, 2023). This form of analysis aims to gain insight into how a particular topic is understood, experienced, or discussed (ibid.). The researcher found examples of its use in both transport studies (Alyavina *et al*., 2020) and psychology (Braun & Clarke, 2012).

Braun and Clarke (2012) formalised thematic analysis through a systematic framework for coding qualitative data into themes. Codes are labels for features of repeated meaning that are relevant to the research question. In the context of this study, the researcher's codes were informed by the transportation needs compiled in Table 2. These codes also serve as section headings throughout Chapter 4.

Thematic analysis was chosen as the methodology for this study because it allows for the exploration of natural patterns related to transportation needs. It is also flexible, which makes it accessible to a variety of fields and levels of research experience. However, critically, it could also be argued to be unstructured, with much room for subjectivity. The personal interpretation, framework, and sample set the researcher includes or excludes all create potential for biases and subjectivity (Mihas, 2023). In their application of the methodology to transportation, Alyavina *et al*. (2020) attempt to limit biases by first independently coding their interview transcripts, and then coming together to compare and compile a list of agreed-upon codes/themes.

3.5.2: Deductive Analysis

Thematic analysis can be approached inductively or deductively. Codes from an inductive approach are derived from the content of the data itself, while deductive codes are inspired by concepts the researcher imposes onto the data (Braun & Clarke, 2012). Whereas the former allows themes to emerge from the data itself, the latter seeks themes through an existing theoretical framework (Dawadi, 2020). For example, interpreting the world through a religious framework could arguably be a deductive way of understanding the data (or experiences) of life.

Deductive analysis often results in generalising the data, and those generalisations become stronger when supported by a larger dataset. Analysis often begins with identifying the codes or themes in the literature review stage (Dawadi, 2020), which is true of this research. The codes for this research included transport needs as well as concepts such as intrinsic and extrinsic motivation, captive and choice riders, and human needs existing in a hierarchy, all of which were introduced in the literature review.

It is unsurprising that a limitation of deductive analysis is that it confines the interpretation of data to a specific perspective, thereby making the results subjective to confirmation bias. For example, in the context of this research, it might be argued that by analysing transport needs through psychology, the

researcher imposes the idea that the two sectors have anything to do with each other. The researcher, however, justifies the overlap of these fields because:

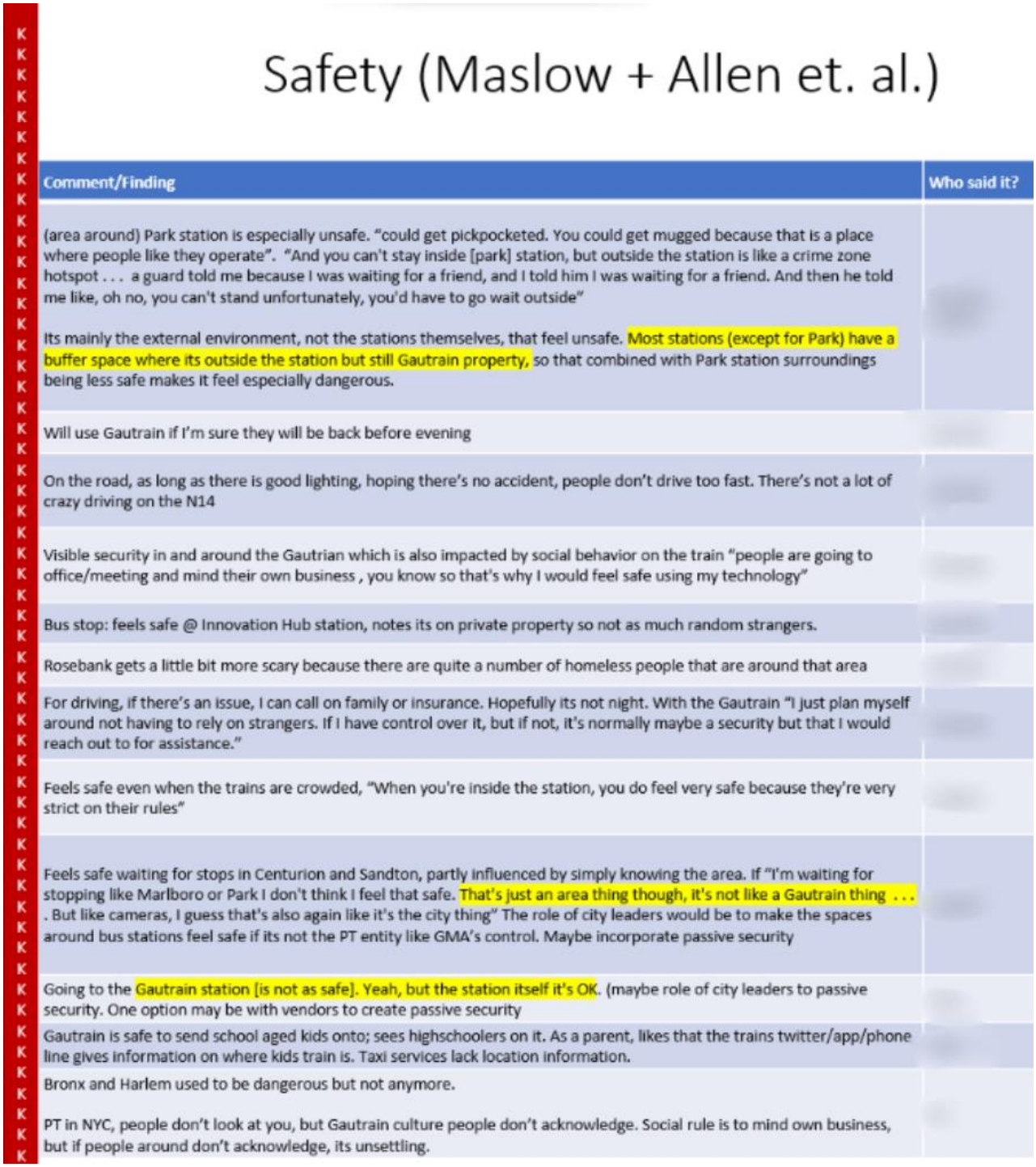
1. The main clientele of PT is people.
2. People have needs, and they will behave in such ways to meet those needs.
3. Psychology is a field that speaks on human needs and behaviour.

Therefore, while psychology is not the *only* framework through which to examine human transportation needs, it is a *valid* one. It is important to reiterate that this research is intended to be a study in sustainable urban development. Given the significant amount of environmental change rooted in human behaviour, considering the issue in relation to human behaviour became a strategic approach. When people in cities are motivated to make green choices, it benefits the sustainability of the larger city in which they live. The researcher does not argue that this approach is the only or the best framework for considering all the components of a well-rounded transportation system. In fact, she would argue that transportation is an interdisciplinary field, and the diversity of perspectives through which it is examined adds strength to a deeper understanding of it.

Finally, while most studies are dominated by one form of reasoning, they often incorporate elements of both deductive and inductive analysis (Braun & Clarke, 2012). Thus, while this research is primarily deductive, it also incorporates elements of inductive analysis (Section 3.4.3) to ensure a comprehensive and nuanced understanding of the data.

3.5.3: Analysis Practically Applied to This Research

This section demonstrates how thematic and deductive analysis were applied in this research. The analysis began by organising each participant's transcript into codes (Braun & Clarke, 2012). As this research is motivated by human transport needs, it was natural to code accordingly. The researcher created a compiled document, dedicating a section to each coded transport need, and organised responses accordingly. Figure 21 provides an example of participant responses coded under the transport need of 'safety'.



Safety (Maslow + Allen et. al.)

Comment/Finding	Who said it?
(area around) Park station is especially unsafe. "could get pickpocketed. You could get mugged because that is a place where people like they operate". "And you can't stay inside [park] station, but outside the station is like a crime zone hotspot . . . a guard told me because I was waiting for a friend, and I told him I was waiting for a friend. And then he told me like, oh no, you can't stand unfortunately, you'd have to go wait outside"	
Its mainly the external environment, not the stations themselves, that feel unsafe. Most stations (except for Park) have a buffer space where its outside the station but still Gautrain property, so that combined with Park station surroundings being less safe makes it feel especially dangerous.	
Will use Gautrain if I'm sure they will be back before evening	
On the road, as long as there is good lighting, hoping there's no accident, people don't drive too fast. There's not a lot of crazy driving on the N14	
Visible security in and around the Gautrian which is also impacted by social behavior on the train "people are going to office/meeting and mind their own business , you know so that's why I would feel safe using my technology"	
Bus stop: feels safe @ Innovation Hub station, notes its on private property so not as much random strangers.	
Rosebank gets a little bit more scary because there are quite a number of homeless people that are around that area	
For driving, if there's an issue, I can call on family or insurance. Hopefully its not night. With the Gautrain "I just plan myself around not having to rely on strangers. If I have control over it, but if not, it's normally maybe a security but that I would reach out to for assistance."	
Feels safe even when the trains are crowded, "When you're inside the station, you do feel very safe because they're very strict on their rules"	
Feels safe waiting for stops in Centurion and Sandton, partly influenced by simply knowing the area. If "I'm waiting for stopping like Marlboro or Park I don't think I feel that safe. That's just an area thing though, it's not like a Gautrain thing . . . . But like cameras, I guess that's also again like it's the city thing" The role of city leaders would be to make the spaces around bus stations feel safe if its not the PT entity like GMA's control. Maybe incorporate passive security	
Going to the Gautrain station [is not as safe]. Yeah, but the station itself it's OK. (maybe role of city leaders to passive security. One option may be with vendors to create passive security	
Gautrain is safe to send school aged kids onto; sees highschoolers on it. As a parent, likes that the trains twitter/app/phone line gives information on where kids train is. Taxi services lack location information.	
Bronx and Harlem used to be dangerous but not anymore. PT in NYC, people don't look at you, but Gautrain culture people don't acknowledge. Social rule is to mind own business, but if people around don't acknowledge, its unsettling.	

Figure 2 1: A Sample Coded Response Document for the Transport Need of safety. Portions highlighted in yellow were comments that stuck out to the researcher. Note: names were included so the researcher could connect the response to the correct participant's context, but they have been burred for privacy considerations. (Laurie, 2024)

While conducting the interviews, the researcher noticed that participants often discussed transport needs in relation to one another. Alyavina *et al*. found a similar trend in their application of thematic analysis to transport behaviour, stating:

> 'During the theme identification process, it became obvious that, although some extracts belong to the same theme, they interpret different, at times contradicting, theme dimensions. Moreover, as on occasion the extracts matched more than one theme, some of the themes also appear logically interlinked.' (Alyavina *et al*. 2020: 369)

The researcher inferred that transport needs do not act in isolation but in relation to one another. Therefore, the researcher also looked for patterns of overlap between individual transport needs. A systematic approach was created to aid in identifying relational connections. This procedure involved some deconstruction and reconstruction of the previously coded responses. Deconstruction encouraged the researcher to interpret quotes independently of the original transport need they were in response to, thus reducing potential bias. Reconstruction revealed the ways in which transport needs interacted with each other. Figure 22 provides a step-by-step demonstration:

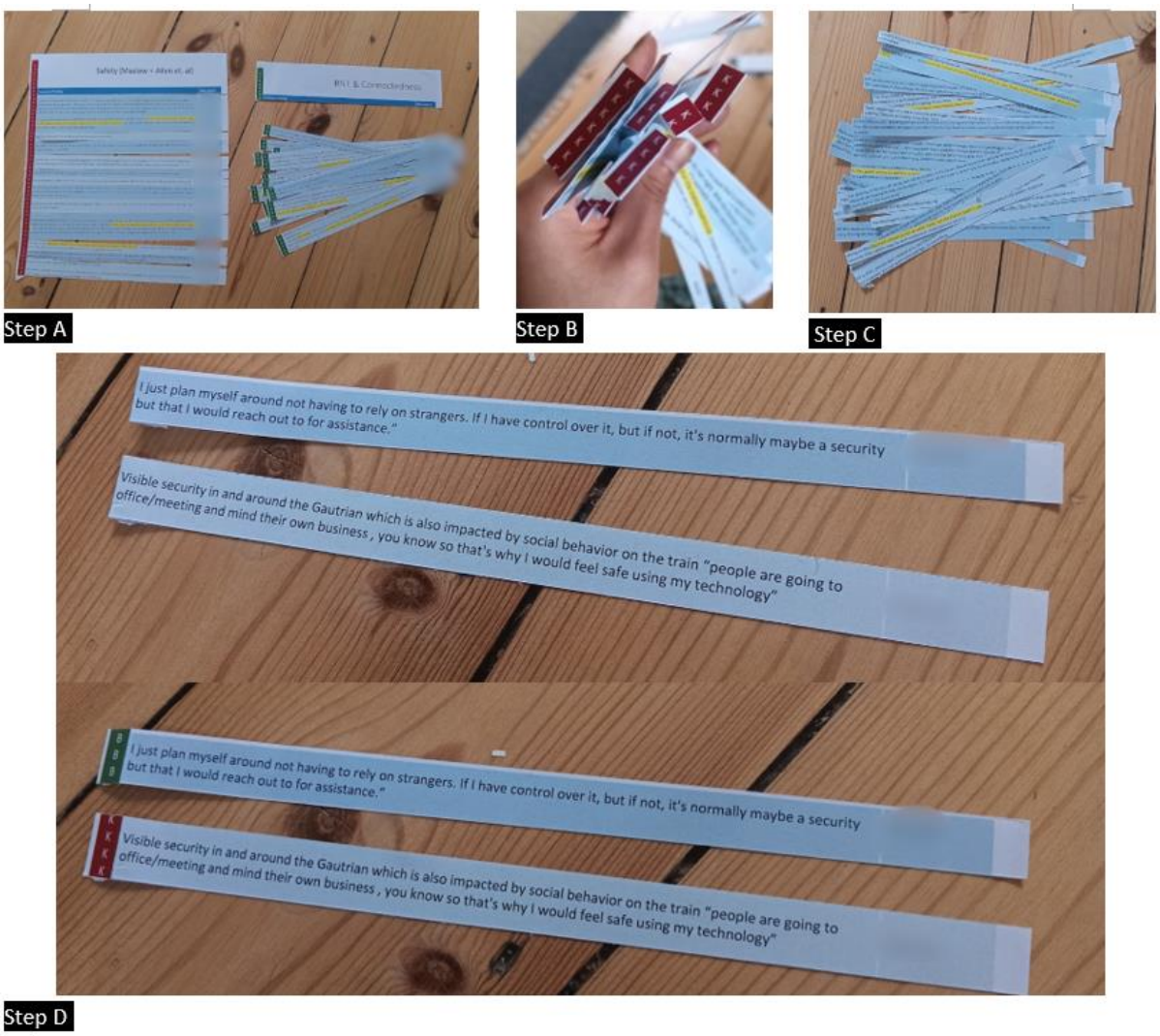


Figure 22: A Step-by-step Visual Demonstration of How the Researcher Found Relational Connections Between Transport Needs. Each response with the same coding was compiled into one document and an identifier was attached to the left-hand margin (the red and green vertical stripe in Step A). They were cut into individual responses but with the identifier intact (Step A, right). The identifier was folded back (Step B) to remove previously assigned codes, creating a pile of responses with the only the content of the responses (Step C). The researcher reread and re-grouped responses by similar meaning in content. For example, the researcher grouped these two responses (Step D top) as similar in meaning because they both talked about how social surroundings impacted the perception of safety. However, the top quote was in response to when the researcher asked about social needs while the bottom was in response to a question about safety. Thus, the researcher inferred that the safety and social transport needs are related to each other. (Laurie, 2024)

The above procedure incorporates inductive analysis. Codes established through thematic analysis form the backdrop to the vocabularies used in Chapter 4.

3.6: Methodological Limitations & Clarifications

Despite her intentions, the researcher faced obstacles that led her to modify aspects of her original thinking and approach. This section discusses these alterations and the ways in which they impacted the final research product.

Firstly, while writing Section 2.4.6,, the researcher learned that not only is there considerable debate about whether human needs exist in a hierarchy, but also about what that order is and how applicable it is across different contexts. Even in cases where an order is agreed upon, needs are unlikely to be attained in a linear pattern. Thus, if the researcher were to suggest an order for the attainment of transport needs, an exhaustive list of exceptions and limitations would also need to follow. However, there is less debate regarding the legitimacy of the needs themselves. Recall also that this research is qualitative in nature; the researcher is more interested in the question of why and how a given transport need is applicable. Attempting to soundly suggest an order would have required a quantitative approach and a much larger sample size, which the researcher did not have access to. For these reasons, the researcher does not attempt to argue for an order to the transport needs explored in this study; she simply suggests that the needs themselves could be relevant to transportation.

Secondly, the researcher intended for the information gathered from participant interviews to inform questions she would later ask the GMA. She also aimed to gather additional primary data from the GMA regarding the population of people who arrived at each station by private transportation, which could have provided insight into the degree of car-dependency between areas within Gauteng. However, securing an interview and obtaining the dataset proved to be more difficult and time-consuming due to a series of scheduling challenges, as outlined:

> The researcher contacted the GMA on 14 July 2023, seeking their participation. The GMA required Ethics Clearance (Appendix E) from the University before proceeding, which was granted on 19 September. Following this, the GMA scheduled a screening interview for 6 October. They then requested a second screening with the CEO and four GMA staff members. Delays occurred, partly due to scheduling conflicts among multiple participants and partly due to the GMA's CEO transitioning at the time. The second screening was rescheduled for 30 November. After this, the GMA required the researcher to complete their organisational contract (which also required the CEO's collaboration). On 6 December, the researcher received a market analysis, which was useful for cross-referencing her findings. However, the crucial data on car passengers was missing, and obtaining such data required the involvement of GMA staff who had not participated in either of the previous screenings. A third interview was planned for 15 December with the appropriate department but was cancelled due to a medical emergency. The holiday break caused further delays. To circumvent further scheduling issues, the researcher proposed an online survey with the interview questions she intended to ask (Appendix D) to her main contact at the GMA. On 22 January 2024, they agreed to distribute the survey among the relevant individuals and departments within the GMA. However, by 9 February, no responses had been received, and the researcher could not afford any further delays.

While there is little reason to suggest that the researcher's experience with the GMA was typical, the overall process proved to be largely out of her control. Despite these alterations, the researcher believes that the data and conclusions she was able to obtain still provide valuable insight into how transport planning could be approached.

3.7: Chapter Summary

This chapter introduces and defends the research frameworks and procedures used during the fieldwork stage. Motivated by the qualitative research questions outlined in Section 1.1.3, a case-comparative approach allowed the research to explore the experiential differences between the two

transport modes of interest—the Gautrain and private cars—through the perspectives of individuals with access to both. Due to the small scale of this hybrid group, intentional (non-probability) sampling was necessary to identify suitable participants. Snowball sampling was primarily employed to achieve a manageable sample size.

Thematic analysis was applied to extract meaning from the collected data. The transport-related themes established in the literature review formed the initial codes for the analysis, but inductive methods were also employed to enrich the findings and enhance the quality of the analysis.

Finally, the chapter addresses the limitations of the study, particularly the restricted generalisability of the findings and the inability to involve the GMA to the desired extent. Despite these constraints, the fieldwork yielded valuable insights into how transport needs are experienced across the two modal options of interest. These findings are presented in the next chapter.

Chapter 4: Findings & Discussion

4.1: Introduction

Recall that Table 2 from the Literature Review established ten baseline needs. This chapter follows up by discussing how the researcher found those needs to be experienced by the sample. The organisation of this chapter mirrors Section 2.4 of the Literature Review, where the needs identified by Maslow were first introduced, followed by those from Allen *et al*., Ryan & Deci, and Onderwater & Kishoon. In the same order, this discussion reintroduces those needs to evaluate their applicability to the Gautrain and private car from the sample's perspective. The chapter concludes with suggestions on how transportation entities could better meet human transit needs, which form the third and final sub-question of this research.

4.2: Maslow's Theory of Motivation

This section builds upon the understanding of human needs established in Section 2.4.1, exploring their applicability to the context of transportation. It is important to note, however, that participants provided limited commentary on what Maslow refers to as physiological and self-actualisation needs when discussing transportation. As a result, these needs are not discussed independently but may be integrated into the discussion of other needs.

4.2.1: Safety Needs

Safety is transferable to the transportation context and is often described in terms of social or environmental aspects. This section defines and compares the salience of safety as experienced by Gautrain passengers and drivers and explores its impact on transport choice.

All participants reported feeling secure as Gautrain passengers, with some highlighting safety as a distinctive feature not commonly found in other local public transport (PT) systems. When passengers felt unsafe, "it [was] mainly the external environment, not the stations themselves," notes Participant C. From this, the researcher inferred that there could be a cognitive association between the Gautrain and factors beyond its jurisdiction. To investigate how the built environment impacts this cognitive association, a basic remote analysis of the surroundings of Gautrain stations was conducted using Google Maps. This analysis revealed two general station designs, which the researcher refers to as Open and Closed designs. These design features are depicted below in Figures 23 and 24 and are comparatively analysed afterwards.

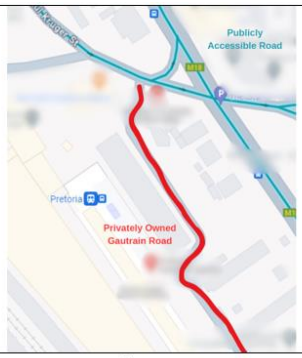
		
Stations have a private driveway (Red) owned by the Gautrain (Pretoria Station)	Fences surround the station (Centurion Station)	The land immediately adjacent has a relatively lower infrastructure density (Midrand Station)

Figure 2 3: Features of a Closed Station Design. (Google Maps, 2024)



Figure 24: Typical Features of an Open layout station. (Google Maps, 2024)

Closed stations feature buffering elements and resemble residential suburbia, as seen in Figure 23. The researcher believes these features act as visual cues that help passengers cognitively disassociate anything (whether positive or negative) beyond these buffering elements from the Gautrain. In contrast, open-layout stations face tighter land constraints, which limit the possibility of such buffering features. Referring to Figure 24, these might include:

- Access roads to the station that are public, and the station building is not fenced off (1)
- Higher-density buildings in proximity (2)
- Open space outside the station with publicly visible seating (3)

In open station layouts, it is less obvious what is considered Gautrain property versus other adjacent areas. As a result, unsafe events that occur near Gautrain property may still be cognitively associated with the Gautrain. Some participant quotes suggest an associative rather than a direct connection to Gautrain in relation to safety, including:

> "Going to the Gautrain station [is not as safe], but the station itself is OK" (Participant J)
>
> "If I'm waiting at a stop like Marlboro or Park, I don't think I feel that safe. *That's just an area thing though, it's not like a Gautrain thing*. . . *Outside [Park] station* it is like a crime zone hotspot. You could get pickpocket or mugged because that's where they operate" (Participant C, researcher's emphasis)
>
> "Rosebank gets a little bit [scarier] because there are quite a number of homeless people that are *around that area."* (Participant B, researcher's emphasis)

In dense environments, especially, the atmosphere from one place easily carries to another; thus, the GMA cannot assume exclusive control over its reputation in open stations. However, closed-off infrastructure designs can be elitist and hostile. Efforts to create cohesively safe atmospheres with surrounding entities could be especially impactful in open stations.

The latter two quotes also allude to a difference in how threats to safety are understood, which the research thematically coded as social or environmental threats. As passengers, participants feared social threats like robbery or assault. Participant C notably points out Marlboro and Park stations, which are located near informal settlements and degrading central business districts, respectively. In contrast, drivers were more concerned about environmental threats such as bad weather or poor road conditions.

While safety concerns as Gautrain passengers provided insight into participants' trust in others (overlapping with social needs Section 4.2.2), safety concerns as drivers offered more insight into how capable participants felt (overlapping most acutely with the need for competency, Section 4.4.3).

Social safety is more relevant for Gautrain passengers because, unlike drivers, who can prevent unsafe individuals or threats from entering their vehicle, passengers depend on the GMA to ensure social safety. The Gautrain has achieved exceptional social safety, which is particularly notable given the persistent crime threats; however, this achievement has not come without sacrifices to passenger freedoms, as demonstrated by their rules (Figure 25).



Figure 25: Gautrain Rules for Passengers (SRP Austin Photography, 2010)

Evaluating the rules provides insight into the type of social safety climate the GMA aims to foster. These inferences are exclusively the researcher's own and do not represent the opinions of any participants or the GMA.

- **No firearms or dangerous weapons:** This rule directly limits interactions involving civil violence and overtly protects the physical safety of passengers.
- **No informal trading:** This rule limits economic interactions between people and helps maintain a fast and practical pace within the station. Passengers are less likely to linger or socialise with merchants if there are no attractions like these.

- **No helmets, hoodies, or balaclavas; no soiled clothing:** The ban on head coverings likely aids in facial recognition by security cameras, while the restriction on soiled clothing seems to target homeless individuals.
- **No disturbance of peace (loud music, shouting):** This rule limits social interactions with street artists and activists, particularly those making public proclamations of potentially controversial ideas, which, if intensified, could lead to civil unrest, such as protests.
- **No begging, loitering, or gambling:** This rule removes the potential for passengers to interact (whether positively or negatively) with those in financial instability or using the stations as shelters.

Social encounters within the Gautrain system are typically free of homeless individuals, merchants, or activists. However, these rules would be ineffective without proper enforcement, and Gautrain security guards have set an exceptional standard in this regard. Participants noted that, whereas security guards in other contexts may provide only the impression of safety, Gautrain guards are very strict about enforcing the rules. Some participants criticised the rules and their rigidness for contributing to a sterile environment, but overall, they appreciated the guards' contribution to creating a safer and cleaner environment.

4.2.2: Social and Relatedness Needs

Social needs seemed to be less applicable to transportation than the researcher initially anticipated. However, they did influence other transport needs. Additionally, recall that Maslow's social need and Ryan & Deci's relatedness need both centre around humans needing one another. As such, they are treated as synonymous and discussed together to avoid redundancy.

Occasionally, as drivers, participants ran errands with household members, and as passengers, they engaged in brief conversations with strangers. However, the norm was generally to travel alone. Furthermore, 90% of participants expressed little expectation, desire, or need for a change in the social environment. Connecting back to the literature review, there are at least three hypotheses for why social needs had little salience in the context of transportation:

1. In Maslow's terminology, social needs have perhaps been denied long enough in the commuting context for participants to have learned to cope without them. People have been conditioned to loneliness and the concept of receiving social connection through commuting is foreign.
2. In Allen *et al.'s* terms, social needs are perhaps hedonistic that may add a pleasant bonus to the transport experience, are not seen as necessary. Social company perhaps plays little to no influence on an individual's transportation choice but simply adds enjoyment if attained.
3. Lastly, social needs perhaps have little to no applicability to the transportation context. While both Maslow's Theory on Motivation and Self Determination Theory say that social needs are relevant for all individuals, neither argues for its relevance to all life activities. Transportation may simply be a means to meet social needs in other ways.

Participants expressed a wide range of views regarding social needs, suggesting that any of the above hypotheses could be valid. For example, Participant H sometimes enjoyed people-watching and conversing on the Gautrain, but at other times, viewed commuting as "me time," a chance to disconnect from the stresses of work and home. Conversely, Participant A desired more social engagement on the Gautrain, expressing concerns that the "mind your own business" mentality leads to indifferent strangers who they did not trust to intervene in an emergency. However, this indifference positively affected Participant C's sense of safety through anonymity: the fact that nobody paid attention to those around them made it less likely for anyone to be violated.

Overall, the researcher found participants' social experiences and desires to be highly diverse, suggesting that exploring social needs in the commuting context could be a valuable area for future study.

Transport modes also influence the quality and nature of interactions participants had. On the Gautrain, participants often described having polite but superficial interactions with strangers, in contrast to the more varied and personalized interactions they had with individuals in their social circle while driving. Participants also noted that, while driving, they could select personalized music tailored to their passengers' tastes. Those with families felt more capable of meeting their loved ones' needs — such as grocery shopping or dropping off children at school — by private car rather than by Gautrain.

Participant A commented on how the scale of movement on the Gautrain could affect the depth and quality of social interactions compared to other forms of public transport. For example, while a bus operates within a relatively small area, moving in increments of blocks, the Gautrain travels between neighbourhoods, increasing the social distance between strangers. On a bus, passengers may live in the same neighbourhood, shop at the same local grocery store, or send their children to the same school. However, the Gautrain attracts passengers from a larger geographical area, reducing the likelihood that any two passengers will have even surface-level similarities.

Overall, the Gautrain offers a more anonymous experience, while the private car offers more opportunities for personalization. The degree of anonymity is influenced by the scale of travel, and attitudes towards anonymity varied between individuals.

4.2.3: Esteem

Esteem, in the context of transportation, refers to the need to feel dignified about one’s mode of transport. This section presents the overall finding that esteem needs are sufficiently satisfied for both Gautrain passengers and drivers, while also acknowledging the limitations of this finding due to the sampling method.

Since esteem is partly validated by one's social circles, the researcher first asked participants about the most popular transport modes in their communities. Eighty percent reported that private cars were the most common mode, but no participant expressed feelings of social isolation or the need to justify their choice of the Gautrain. Furthermore, participants did not feel excluded from social activities, as they could drive to locations inaccessible by the Gautrain. The researcher suspects that this freedom to choose one's mode of transport plays a crucial role in maintaining esteem when using the Gautrain. However, it is important to reiterate the limitations of this finding due to the sampling method (see Section 3.3.2). The sample consisted of relatively privileged individuals with access to cars, and as such, the researcher cannot definitively conclude whether the Gautrain independently fulfils esteem needs, or if this is supplemented by car ownership. Captive Gautrain passengers may have provided a more comprehensive evaluation of this.

However, it can be inferred that being a choice rider inherently contributes to a level of esteem, which is important for promoting public transport as a desirable option rather than a necessity. Secondary data provided by the GMA from a market segmentation analysis found that, out of 275 non-Gautrain users, 90% expressed interest in trying the service (Catalyst, 2014). The scale of this curiosity suggests that the Gautrain has a certain level of baseline desirability, reputability, or esteem, as non-Gautrain users would likely not be motivated to try a service they have never used if it lacked these qualities. Despite the sampling limitation, there are compelling reasons to suggest that the Gautrain meets esteem needs.

Regarding private transportation, Maslow's esteem needs overlap with social needs through external validation, which can be understood as a form of introjected motivation (Ryan & Deci, 2000), as demonstrated by the following participant's narrative:

> Lerato[1] was one of the first and few to move out of her township, attain higher education, and own a car. These feats would be honourable in most contexts, but they were heightened in her case as a Black Female who achieved these when the odds of Apartheid were stacked up against her. Her car was a good one too, not just a hunk of metal. It attracted curiosity and admiration. From close friends to mere acquaintances, people invited her to parties for the simple exchange of looking cool on the commute over, a win-win for both parties. She loved driving: the freedom, dignity, and access that came with the package. But with many things that seem to fade with young adult life, so did her attitude toward driving. Schedules got busy, friends moved, and the vehicle that once represented youthful adventures became a functional tool for mundane tasks. In the career stage of her life, Lerato remembers coming home from work exhausted, angry, and on the verge of tears from wasting her evening in bumper-to-bumper congestion. Where driving once gave her quality time and memories, now the task seemed to rob her of those very things.

This narrative highlights a common theme: while cars boost an individual's esteem, the effect is often fleeting. Young adult participants generally had neutral to positive attitudes toward driving, but older participants expressed a sense of weariness or dissatisfaction with it. Although older demographics are not a significant ridership or target group for the Gautrain, this finding suggests that it may be easier to encourage this age group to move away from private car use.

Overall, the researcher found that the Gautrain fulfilled esteem needs, but this conclusion may be influenced by the sampling method, which could have created an echo chamber. Private cars, on the other hand, generally met or even exceeded esteem needs, though this satisfaction was often short-lived.

4.3: Hierarchy of Transit Needs

This section focuses on the five transport needs identified by Allen *et al*. (2019), whose study was introduced in Section 2.4.2. These needs are reliability, safety, customer service, and comfort. Reliability was considered a basic need, essential for passenger tolerance, while safety was viewed as a performance need that increased in importance in proportion to the quality of service. The remaining two needs—customer service and comfort—are hedonistic, enhancing satisfaction when available, but not essential for baseline satisfaction. This section discusses three of these needs (since safety has already been covered in Section 4.2.1), focusing on how participants felt these needs were met by both the Gautrain and private car.

4.3.1: Reliability

Allen *et al*. (2019) consider reliability a baseline transit need (Section 2.4.2) that commuters are willing to compromise on for the sake of other factors. Reliability is a practical need, centred around the ability to arrive at one's destination using a particular mode of transport. While seemingly straightforward, the researcher found that reliability encompasses three key components:

- The desired destination is accessible by said transport mode
- The transport mode promises to get passengers to the destination in a timely manner
- The transport mode follows through on its promise

[1] For the participant's privacy, this is a pseudonym.

This section explores how participants perceived the reliability of each transport mode based on the three criteria outlined earlier. Overall, participants indicated that the private car was more reliable than the Gautrain.

The Gautrain meets Criterion C for reliability but falls short in Criterion A. Participants often described this as the service not offering a wide range of destinations, but those it does serve, it delivers on consistently. The Gautrain's ability to meet Criterion A is constrained by its rail infrastructure, which is limited in scope. As mentioned in Section 1.2, Gautrain tracks cover only 80 km, and because the trains cannot operate on roads, the destinations it serves (thus fulfilling Criterion B) are restricted to this 80 km stretch. While the GRRIN expansion will enhance accessibility, as it stands, only a handful of destinations are physically accessible via the Gautrain. However, this limitation also contributes to the Gautrain's reliability when compared to road-dependent modes. As the only vehicle on the tracks, it operates independently of traffic, which can make driving, as well as other forms of local public transport (buses, Kombi taxis, etc.), especially during rush hour, unpredictable and often frustratingly slow. When a destination is accessible by both rail and road, commuting by Gautrain is more precise, and the train's reputation for punctuality further enhances its reliability.

In contrast, the private car, despite being less favoured in other aspects (Section 4.4.1), could reliably take participants to a much wider range of locations, thus fulfilling both Criteria A and B more comprehensively. The private car supports a broader range of life activities, including occupational (e.g., work), personal (e.g., grocery shopping), and occasional (e.g., recreational) trips. Although participants used both the private car and the Gautrain, they remained largely car-dependent (Table 4). The primary use of the Gautrain was for occasional trips (e.g., conferences, sporting events, airports), rather than for daily commuting.

Regardless of mode, both transport systems became unreliable when vehicles broke down, though the extent of the failure varied. For example, Participant J began using the Gautrain because their car had broken down and remained in the shop for months, making their private vehicle unreliable. While this was a rare occurrence, Participant C recalled an instance when a magnet malfunction caused the train to not show up. They noted that had they been driving, they would have been able to rely on their car to guarantee their arrival, even if delayed. However, with the Gautrain, they were fully dependent on the service to ensure arrival.

4.3.2: Customer Service

Customer service is the first hedonistic need in Allen *et al.*'s hierarchy (2019). When considering the private car, the concept of "customer service" expanded to include inanimate services, as well as human interactions. In both contexts, customer service contributed to the need for competency (Section 4.4.3), and while it was sufficiently met for Gautrain passengers, the responses regarding private car usage were more varied, making it difficult to identify a general trend.

On the Gautrain, customer service is provided by both human staff and inanimate services. Staff are stationed throughout the facilities, including stations, parking lots, and onboard trains. Participants described the staff as approachable, helpful, and professional, and the researcher observed that staff were alert and attentive to their surroundings. Issues with customer service arose when participants felt the enforced rules were overly controlling, which conflicted with passengers' need for autonomy (Section 4.4.2). Beyond human staff, participants also mentioned non-human forms of customer service, such as clear signage, audio announcements, and self-service ticketing machines. The Gautrain app, which provides live updates on train arrivals, was also highly valued, helping participants plan their journeys effectively. All of these human and inanimate services contributed to a sense of competency (Section 4.4.3) for passengers, allowing them to navigate the system with confidence.

For drivers, human customer service was more limited, leading to greater reliance on inanimate services. Human support typically came in the form of roadside assistance through one's insurance

policy, or occasionally from a kind stranger. Inanimate services, such as GPS systems, road signage, and overhead lighting, were also cited as important forms of customer service. However, the extent to which participants felt adequately supported varied, depending on factors such as their individual skill level, the complexity of the route, and the traffic conditions at the time.

Overall, customer service was an important and sufficiently met need for Gautrain passengers, contributing positively to their sense of competency. For drivers, customer service options were more limited, and the adequacy of these services varied widely between participants.

4.3.3: Comfort

Regarding comfort, the researcher found that one could argue both for and against the private car as well as the Gautrain, depending on the frame of reference through which comfort is understood.

When comparing the internal environment, participants favoured the private car for its comfort, mainly due to the customizable features that are lacking on the Gautrain. Features such as music selection, seat adjustments, and temperature control were highlighted. The ability to eat and drink in one's own car was also seen as enhancing comfort, whereas this is prohibited on the Gautrain. Some participants perceived the rule as limiting comfort and autonomy. Additionally, travelling by car allowed for more relaxed or personal conversations without the concern of disturbing strangers. These features exclusive to the car made public transport services, such as the Gautrain, comparatively less comfortable. Participant C mentioned that driving becomes uncomfortable when prolonged, particularly due to the inability to stand up and stretch, a feature available on the Gautrain. The congestion between Johannesburg and Pretoria often extends travel times significantly, making the trip uncomfortably long and slow, despite the short distance between the two cities.

When comparing the headspace of passengers, the Gautrain is generally perceived as more comfortable than a private car. Most participants described driving as a more stressful activity, requiring heightened focus and skill. Even though drivers may have the freedom to eat or choose their own music, they often do so in stressful surroundings. In contrast, on the Gautrain, passengers can ignore external stressors, allowing for a range of comfortable activities, such as reading, napping, or knitting, which would be unsafe while driving. The longest Gautrain journey is around 45 minutes on the North/South line, minimising any potential discomfort, as it is short-lived. While most participants could always find a seat on the Gautrain, one participant encountered instances where the train was too full, forcing them to stand, a situation that would never occur in a private vehicle, thus impacting comfort levels.

Overall, despite the internal environment of a private car often exceeding the Gautrain in comfort, stress-inducing factors outside a car can counter those benefits. The researcher cannot soundly defend one mode as objectively more comfortable, but both were sufficiently comfortable for the participants.

4.4: Self Determination Theory

Recall from Section 2.4.4 that Ryan and Deci's Self-Determination Theory (2000) categorises motivation for various behaviours as either intrinsic or extrinsic, with the latter more often dictating human behaviour. Additionally, people need three types of support to feel motivated: autonomy, competence, and relatedness. In this section, the researcher first evaluates the degree of attachment participants had to driving, and then continues the comparative pattern of discussing the private vehicle and the Gautrain in relation to the respective transport needs. Since the need for relatedness has already been discussed in Section 4.2.2, only the remaining two needs are compared to avoid redundancy.

4.4.1: The Attachment to Driving

Recall that Ryan and Deci (2000) found that the more intrinsically motivated an individual is by (or enjoys) a task, the more attached and loyal they will be to continuing that behaviour. Since this research is interested in reducing car-dependency, it is useful to understand the strength of car-dependency within the sample.

In this sample, three participants claimed to plainly dislike driving, three once liked driving, one occasionally liked driving, and three overall enjoyed driving. Of the participants, 30% were intrinsically motivated to drive, while 60% did not inherently enjoy driving. The most common reason for disliking driving was the stress it induced (see Section 4.4.3), which, in turn, supported a neutral to positive attitude when participants were asked whether they liked commuting by Gautrain. Participants particularly enjoyed the more peaceful travelling environment of the train.

Among the minority of participants who liked driving, the reasons for this are explored below. Terms from Self-Determination Theory, introduced in Section 2.4.4, are used to describe the source of their motivation.

- Social Distinction: As mentioned in Section 2.3.4, participants liked driving for its association with positive attention, which benefits their esteem needs. This is introjected motivation, as defined by SDT, revolving around the approval of others. The standard of approval motivating behaviour is set by others, making this a form of extrinsic motivation.
- Achievement: Some participants liked driving because mastering the skill made them proud of themselves, contributing to competence (further expounded in Section 4.4.3). This is also introjected motivation, as it centres around one's ego, but the standard of approval is self-defined. If the individual fails to meet the set standard, their reason for motivation disappears, making the motivation external.
- Independence: One participant liked the fact that a car gave them the freedom to move on their own terms, contributing to the need for autonomy. The participant highlighted independence from a stance of personal preference, making the motivation identified, according to SDT.
- The Destination: This participant liked driving when heading to a place or in company they enjoyed. However, their response said more about the participant's attitude towards their destination and community than about driving itself. The response alluded to social needs over transport needs and suggested an indifference to the mode of transport. It challenged the idea of transportation being a means to an end, rather than the goal itself.

Overall, most participants found driving to be stressful, and of those who liked it, they enjoyed it more for what could be achieved through driving than for the act itself. This is encouraging for the promotion of public transport (PT), as it suggests that attachment to driving is weak among choice commuters. Participants indicated that they first consider what is practical when deciding whether to drive or take the Gautrain, with the notion of 'liking' a certain transport mode being of little relevance compared to practicality.

Finally, the scenario in which participants overall dislike driving, but the majority still use it, as indicated in Table 4, suggests that participants in this research may be captive drivers. This notion is further explored in Section 4.3.1.

4.4.2: Autonomy

Autonomy is about having choices and the freedom to act on them without external influences. Ryan and Deci (2000) found that most human behaviour is influenced by external factors, suggesting that true autonomy is rare. Thus, it should come as no surprise that this need, even when met, is often fulfilled through perception rather than reality.

As drivers, participants discussed the freedom to choose when to leave, which route to take, and the environment inside the vehicle. These factors all contributed positively to their sense of autonomy. However, the relationship was more complex, as acting on one's autonomy was contingent on practical conditions, such as feeling safe and capable of doing so. For example, while driving theoretically offers the freedom to choose one's route, participants noted that they were creatures of habit, often taking the familiar route regardless of other options. Even when forced to take an alternative route, factors such as inclement weather, safety concerns, or time constraints pushed drivers to accept the most practical option, which contradicted the initial notion of autonomy. Similarly, while a driver may have more control over their vehicle environment, the enjoyment of that freedom could be tainted by external stressors within the vehicle (see Section 4.3.3). Drivers have more overt autonomy over their transport mode, but participants described most drivers as monotonous and habitual, with little conscious decision-making, except for the occasional trip to a new destination.

On the Gautrain, passengers must conform to the transit authority's schedule, route, and environment. While the Gautrain reliably communicates and adheres to its schedule, it is still imposed on passengers. Another factor that compromised passengers' sense of autonomy was the comprehensive and inflexible rules enforced (see Figure 25). While participants generally agreed that these rules enhanced the quality of service provided by the Gautrain Management Agency (GMA), some rules—such as the prohibition of any food or beverages (including water)—were specifically cited as annoying or overly restrictive. However, others referred to the cleanliness ensured by the rules or noted that the travel time on the Gautrain was too short to be bothered by them.

4.4.3: Competence and Effort

Competence refers to one's ability to effectively interact with the environment and achieve expected outcomes (Ryan & Deci, 2000), while effort refers to the resources exerted to attain a particular outcome (Onderwater & Kishoon, 2017). In the context of this research, both concepts relate to a commuter's ability to utilise a transport mode to reach their destination. Competence and effort were understood and experienced in close proximity by participants, particularly in relation to stress. The researcher has therefore chosen to discuss them together for a cohesive understanding.

Additionally, it is important to recall the distinction between the internal and external vehicle environments, as introduced in Section 4.3.3. As drivers, participants have more control over their internal vehicle environment, which benefits their need for comfort and autonomy. However, this control was challenged once external vehicle factors were taken into consideration, often making driving a stressful experience. Also recall that, for the Gautrain, the need for safety in the internal vehicle environment (namely social safety) has been established as comparable to that of the private car (Section 4.2.1). The subsequent text explains how the Gautrain better meets competency needs than the private car, albeit with some nuances and limitations to these findings.

Regarding the external environment, neither drivers nor Gautrain passengers have much control over it, but only Gautrain passengers have the assurance that they can disregard external stressors. This freedom from the responsibility and liability of vehicle navigation allows Gautrain passengers to engage in activities like napping, reading, or emailing without worry. The primary challenge to competency and effort for Gautrain passengers lies in navigating the stations, which is relatively easy due to various support features (Section 4.3.2). Some participants needed help when first using the

service, but rarely thereafter. Online resources regarding routes, schedules, and fares were easily accessible and intuitive, supplemented by reliable staff assistance. The researcher also suggests that the Gautrain's small scale (Figure 3) benefits perceived competence, as the station layouts are straightforward with minimal transfers. However, the GRRIN expansion plan (Figure 4) may challenge the intuitiveness of the Gautrain network if services to assist passenger competency do not grow in tandem with the system's scale.

In contrast, drivers must constantly remain alert to potential external threats, such as other drivers, inclement weather, and road conditions, all of which are beyond their control. In addition, baseline vehicle manoeuvring skills are also necessary. Responsibilities are higher for drivers, and consequently, the perceived need for competency is likewise high. However, despite participants generally feeling more competent as Gautrain passengers than as drivers, it is important to consider the role of challenge. Participant B, for example, noted that despite the extra effort, obtaining a driver's licence felt like an accomplishment, which the research inferred positively correlates with competency needs. The higher learning curve associated with driving created stress for some individuals, but overcoming this challenge sometimes resulted in a sense of achievement. This boost in self-esteem due to accomplishment was relevant to driving but absent from the Gautrain experience. This dichotomy introduces complexity: too much challenge can stress an individual and threaten their sense of competence, but a healthy amount of challenge could enhance the quality of competency.

4.5: Transport Needs of Choice and Captive Riders

Recall that Section 2.4.5 introduces the study by Onderwater & Kishoon (2017), which suggests that three transport needs—time, cost, and effort—impact transport behaviour. This section compares how participants understood and experienced time and cost for both modes of transport. Recall that effort has already been discussed in Section 4.4.3.

4.5.1: Time

Onderwater and Kishoon's study (2017) suggests that time is the most crucial factor in transport decision-making. The research did not find significant support for or against either transport mode in terms of real time, but the Gautrain was more favourable with regard to perceived time.

Real time refers to measurable intervals of time, while perceived time refers to the subjective experience of how time passes. Although the Gautrain portion of a participant's commute was short, the overall commute by public transport (PT) was significantly impacted by the timeliness of connecting services. These services—whether a connecting PT service, a private car, or a non-motorised mode—can vary in their punctuality. For example, one participant mentioned that for their last mile, the bus only arrives at 30-minute intervals, and their stop was the last one. Sometimes, the bus would leave just as the Gautrain pulled in, leading to long wait times. The unsynchronised timetables and intermediate stops contributed to the fact that it overall took the same 1.5 hours for this participant to commute by PT as it did by car. Another participant walked for their last mile, which freed them from the variable of traffic; therefore, their overall commute was shorter by Gautrain than by private car. Overall, the time saved by Gautrain compared to private transport was inconsistent.

However, the perceived time savings were generally in favour of the Gautrain, as the activities participants could engage in during the commute were of higher quality than the experience of driving. Recall that Section 4.4.3 discusses driving as a more stressful experience than taking the Gautrain, as it requires heightened alertness to both the internal and external vehicle environment. In contrast, as passengers on the Gautrain, participants were able to engage in more peaceful or productive activities. Participant C, for example, said that the Gautrain allowed her to 'buy time' by completing

employment-related tasks during her commute, whereas time spent in traffic was often perceived as wasted.

Finally, for some participants, the Gautrain allowed more control over arrival time, while the private car allowed more control over departure time. Participant D, for example, could estimate their arrival time at their workplace via the Gautrain with a smaller margin of error than by private car. The latter was unpredictable due to the variable of traffic, which could make their drive to work take anywhere from 30 minutes to two hours. However, because the Gautrain was less impacted by traffic and reliably punctual, this participant could better predict when they would arrive at work, making planning for the rest of their day easier. In contrast, drivers, despite being more affected by traffic, had more autonomy and choice over their departure time as they did not have to comply with the Gautrain's schedule.

In summary, the researcher did not find that the Gautrain consistently saved real commuting time, especially when considering the first and last mile legs. However, perceived time was in favour of the Gautrain, as time passed in a higher quality manner.

4.5.2: Cost

While public transport (PT) is generally more economical than driving, the Gautrain deviates from this trend. When asked, 90% of participants stated they do not save money by taking the Gautrain compared to driving, and some even claimed to spend more. For Participant E, the Gautrain's cost even discouraged them from using the service as often as they would have liked. Despite commuting between the same origin and destination each day, Participant E only used the Gautrain on Fridays. He dislikes driving because it leaves him fatigued, preferring the Gautrain where he can rest. However, from Monday to Thursday, he opts for his car because petrol is more budget friendly.

In the cost analysis below (Table 6), the researcher quantitatively compares the distance (in kilometres) an individual can travel on one monetary unit (South African Rand) by each transport mode (hereafter referred to as the Rand Efficiency). Off-peak costs for June 2023, as reported by the Gautrain Management Agency (GMA, 2023), informed Column B. The Rand efficiency for the car (Column F) was based on two constants. The cost of fuel (Constant H) was estimated to be 22.92 Rand per litre, as informed by the South African Automobile Association (AASA, 2023). Fuel efficiency was estimated at 16.70 km per litre (or approximately 6 litres per 100 km) for a generally fuel-efficient car, based on a cross-reference of three sources (IEA, 2021; Business Tech, 2022; Morley, 2022). The cheaper modal option is highlighted in green.

Table 6: Rand Efficiency from Park Station to Various Other Gautrain Stations by Gautrain and by Car

From Gautrain Park Station To:	Distance (kilometers)	Cost by Gautrain (ZAR)	Cost by Car (ZAR)	Difference (ZAR)	Rand Efficiency of Gautrain (ZAR/km)	Rand Efficiency of Car (ZAR/km)
	A	B	C = F*A	D = B-C	E = B/A	F = H/G
Rosebank Station	6.7	27.00	9.20	17.80	4.03	1.37
Sandton Station	12	30.00	16.47	13.53	2.50	
Marlboro Station	19.5	36.00	26.76	9.24	1.85	
Midrand Station	34.7	45.00	47.62	-2.62	1.30	
Centurion Station	55.4	66.00	76.03	-10.03	1.19	
Pretoria Station	67.7	74.00	92.92	-18.92	1.09	
Hatfield Station	74.4	80.00	102.11	-22.11	1.08	

Constants	
G: Average Fuel Efficiency (km/L)	16.70
H: Average Petrol Cost (ZAR/L)	22.92

Data supported by Gautrain Management Agency (2023), AASA (2023), IEA (2021), Business Tech (2022) & Morley (2022).

Overall, the analysis demonstrates that trips are cheaper by Gautrain when the distance is greater. Despite this trend, it is important to note that both modes have associated costs. Taking the Gautrain, for example, can include parking fees as well as transfers to other modes. The greatest cost difference in favour of the Gautrain occurs between Hatfield and Park Station, at just over 20 ZAR. However, if driving to the Gautrain station, that difference would only cover parking fees and would not account for the fuel potentially used to get to the station.

Additionally, Participant B noted that public transport charges are per person. Therefore, when travelling in groups or with family, passengers can leverage economies of scale in a way that is not possible with the Gautrain. A similar rationale makes e-hailing services more appealing than public transport. Overall, even when the Gautrain is cheaper, the margin is small and unlikely to be attractive to group or family commuters.

Cars also incur supplementary expenses such as maintenance, insurance, and a high upfront cost for the vehicle itself. However, participants often did not remember these costs on their own, as they did for the Gautrain. The researcher hypothesises that the associated costs of driving, even if significant, are infrequent or automatic (e.g., through debit orders), leading to a passive perception of them. In contrast, individuals physically engage in payment processing each time they use Gautrain parking, pass card machines, or board feeder buses. This active participation may heighten their awareness of the costs associated with using the Gautrain.

Two participants noted that commuting to O.R. Tambo Airport was especially expensive by Gautrain. Using the previously established methods and constants, Table 7 demonstrates the Rand Efficiency from each of the eight Gautrain stations to the airport by car and by Gautrain. For consistency, distances were updated to compare direct car routes to the airport, as this would better reflect realistic driving behaviour.

Table 7: Rand Efficiency from O.R. Tambo Airport to Various Gautrain Stations by Gautrain and by Car

From O.R Tambo Airport To:	Distance (kilometers)	Cost by Gautrain (ZAR)	Cost by Car (ZAR)	Difference (ZAR)	Rand Efficiency of Gautrain (ZAR/km)	Rand Efficiency of Car (ZAR/km)
	A	B	C = F*A	D = B-C	E = B/A	F = G/H
Park Station	22.5	217.00	30.88	186.12	9.64	1.37
Rosebank Station	24.4	217.00	33.49	183.51	8.89	
Sandton Station	28.7	206.00	39.39	166.61	7.18	
Marlboro Station	21.8	206.00	29.92	176.08	9.45	
Midrand Station	24.0	217.00	32.94	184.06	9.04	
Centurion Station	47.6	234.00	65.33	168.67	4.92	
Pretoria Station	48.1	234.00	66.02	167.98	4.86	
Hatfield Station	52.0	234.00	71.37	162.63	4.50	

Constants	
G: Average Fuel Efficiency (km/L)	16.70
H: Average Petrol Cost (ZAR/L)	22.92

Strictly in terms of Rand Efficiency, it is consistently more expensive to take the Gautrain than to drive to O.R. Tambo Airport. The difference is significant, exceeding 100 ZAR regardless of the origin station, and excludes the first-mile variable cost between a passenger's home and their nearest Gautrain station. However, those who opt for the Gautrain justify the cost by citing the freedom from the mental strain of traffic and the financial burden of airport parking.

Recall also that Onderwater & Kishoon (2017) highlight the limited flexibility of recovering from a missed flight, noting that doing so can incur significant costs and disrupt subsequent plans. Thus, the unforgiving nature of flight schedules makes punctuality critical for airport commutes. While traffic is notoriously unpredictable, the Gautrain prides itself on punctuality (Section 4.3.1). Therefore, despite the large cost gap between driving to O.R. Tambo and taking the Gautrain, the latter carries fewer associated risks.

Arguing for the objective financial competitiveness of the Gautrain compared to the private car was inconclusive and is likely to vary from person to person. One participant noted that the cost of the Gautrain was more predictable than driving. The cost of petrol fluctuated significantly in 2023 as an aftereffect of geopolitical tensions between Russia and Ukraine, but Gautrain passengers did not feel this as acutely as drivers. Overall, cost does not favour the Gautrain, and arguing for its competitiveness in this regard will remain a challenge.

4.6: Notable Criticisms of the Gautrain and Potential Solutions

Informed by the previously discussed findings, and with the goal of encouraging commuters to shift away from private car use, the following are some possible suggestions for making the Gautrain a more attractive option. These suggestions are based on the transportation needs discussed earlier and aim to address both the strengths and weaknesses of the system. The transport needs that participants found to be poorly met by the Gautrain are evaluated for potential improvements, while the areas in which the Gautrain excels are discussed in terms of how they could be further accentuated.

4.6.1: Addressing Weaknesses

Notable criticisms of the Gautrain centred around the transport needs of cost, reliability, and autonomy.

Regarding costs, while neither mode was objectively cheaper, the Gautrain offered advantages in terms of cost reliability and transparency. Driving involves additional expenses such as insurance, maintenance, and fuel, which can fluctuate from month to month, making financial planning less predictable. In contrast, the Gautrain provides consistent and transparent pricing, facilitating easier budgeting and reducing mental strain. Defending the financial advantages of the Gautrain over driving should focus on its transparency and predictability.

In terms of reliability, driving currently holds an advantage due to the Gautrain's limited reach. Expansion projects, such as GRRIN, may enhance accessibility in the future, but the effectiveness of these efforts remains uncertain. Urban planners should prioritise corridor accessibility by public over private modes, both financially and legally, to encourage more sustainable transport.

While driving better supports autonomy needs, this perception can be deceptive or stress-inducing. Section 4.4.2 explores how, even with the freedom of autonomy, decision-making while driving is more influenced by practicality, habit, or convenience than by genuine preference. Additionally, the added responsibility that comes with autonomy can become burdensome, leading to stressful driving conditions. Advocacy for autonomy on the Gautrain should emphasise the freedom to use one's time for rest, work, or other activities, rather than the stress of navigating traffic.

4.6.2: Emphasizing Strengths

This section explores ways to accentuate and maintain the transport needs that the Gautrain excels in. Research found the Gautrain to outshine driving in meeting competency and time-related needs. The Gautrain offers a less stressful commuting experience, and in bustling urban areas, public transport could be marketed as a peaceful buffer between one's professional and personal life.

The Gautrain supports competency by ensuring both social and environmental safety, while relieving passengers from the heightened alertness required when driving. Reliable schedules ease passenger planning, as timetables are accurate, whereas the variable nature of traffic makes arrival times by car less predictable, especially during rush hour. Driving also demands more mental attention, particularly in stressful conditions, which can diminish the perceived quality of time spent.

Of the transport needs explored, competency was found to be most interconnected with others (see Section 5.1). Therefore, enhancing and maintaining competency can be strategically important for improving a range of other transport needs. While competency on the Gautrain is adequately addressed, it could be further enhanced by linking it with esteem needs through accomplishment. Although this was experienced by only a minority, some participants noted that overcoming the challenge of driving made them feel their competency needs were better met. Introducing a healthy challenge through gamification—similar to Japan's Eki stamps (Figure 26)—could engage especially younger or family passengers. Limited-edition stamps for holidays or events could encourage ridership at certain times, while design competitions involving local artists would allow for community contribution.

Gamification could dignify public transport by adding a fun, low-stress, and artistic element to the experience. However, such challenges must be optional to avoid introducing stress or risk into the commuting experience. If passengers feel that the primary task of navigating the system is too challenging, they are unlikely to be interested in a "side quest." Therefore, functional competency should be established and ensured first. This is where most participants came to dislike driving: when challenges became unavoidable, caused stress, and compromised their sense of competency.



Figure 26: An Example of a Self-service Eki Stamp Station in Japan (Kulture Kween, 2020)

Considering the GRRIN extension (Section 1.2), a gamified scavenger hunt could also encourage passengers to explore new stations. However, this expansion highlights the intricate relationship between different transportation needs, where addressing one need may benefit or come at the expense of another. While the GRRIN extension could improve accessibility, it could also challenge competency and safety needs. Currently, the smaller scale of the Gautrain network facilitates easy navigation, benefiting competency. However, new lines could introduce more transfers and increase the potential for passengers to get lost.

Regarding safety, expanding the network would serve a broader demographic, but already busy stations could become overcrowded, making it more difficult to ensure social safety. While these outcomes remain speculative, it is crucial to avoid unintentionally compromising one need when addressing another.

Therefore, with the planned changes, it is essential to consider how to maintain the existing strengths of the Gautrain, particularly those aspects in which the service currently excels. To address competency, customer services such as staff presence, signage, and intuitive maps should expand in line with the network's growth. Additionally, potential overcrowding issues should prompt consideration for maintaining safety. Strategies like designating certain train cars for women and/or families, as seen in countries like Mexico, Egypt, and Japan, could be considered. Such measures could be implemented formally or informally, with timing adjustments based on factors like rush hours, evening hours, or round-the-clock service.

While the development of rail infrastructure is beneficial for reducing car dependency and addressing ecological concerns, it should be approached cautiously to avoid neglecting the broader network of human transport needs. Failing to do so could have negative impacts on passenger attitudes, loyalty, and ridership.

4.6.3: Chapter Summary

This chapter compares private car usage with the Gautrain, examining how passengers with access to both modes experience various transportation needs. While some original needs were found to be irrelevant to commuting, the researcher identified key patterns in the needs that persisted. The comparative study revealed both similarities and differences in commuting experiences. For instance, safety concerns for drivers are more influenced by the physical environment, whereas Gautrain passengers' safety concerns are more related to the social environment.

In contrast, competency emerged as the most interconnected transportation need for both modes. Overall, competency was better met as a Gautrain passenger, as it induced less stress compared to the responsibilities of driving.

The chapter concludes with global examples of how other public transport systems address human transport needs and evaluates the potential impact of the GRRIN expansion on commuter needs. While each transport need was discussed separately, their interconnectedness will be further explored in Chapter 5.

Chapter 5: Conclusion

This final chapter outlines the relational dynamics between transport needs, summarizing key comparisons of how these needs are experienced on the Gautrain versus private car usage. It also includes a reflective overview of the research process, reiterating the original purpose and objectives of the study.

5.1: Summary on the Interconnection of Transport Needs

Regardless of the transport mode, participants consistently viewed their needs as interconnected rather than isolated. While similarities emerged within each mode's network of needs, notable differences also arose.

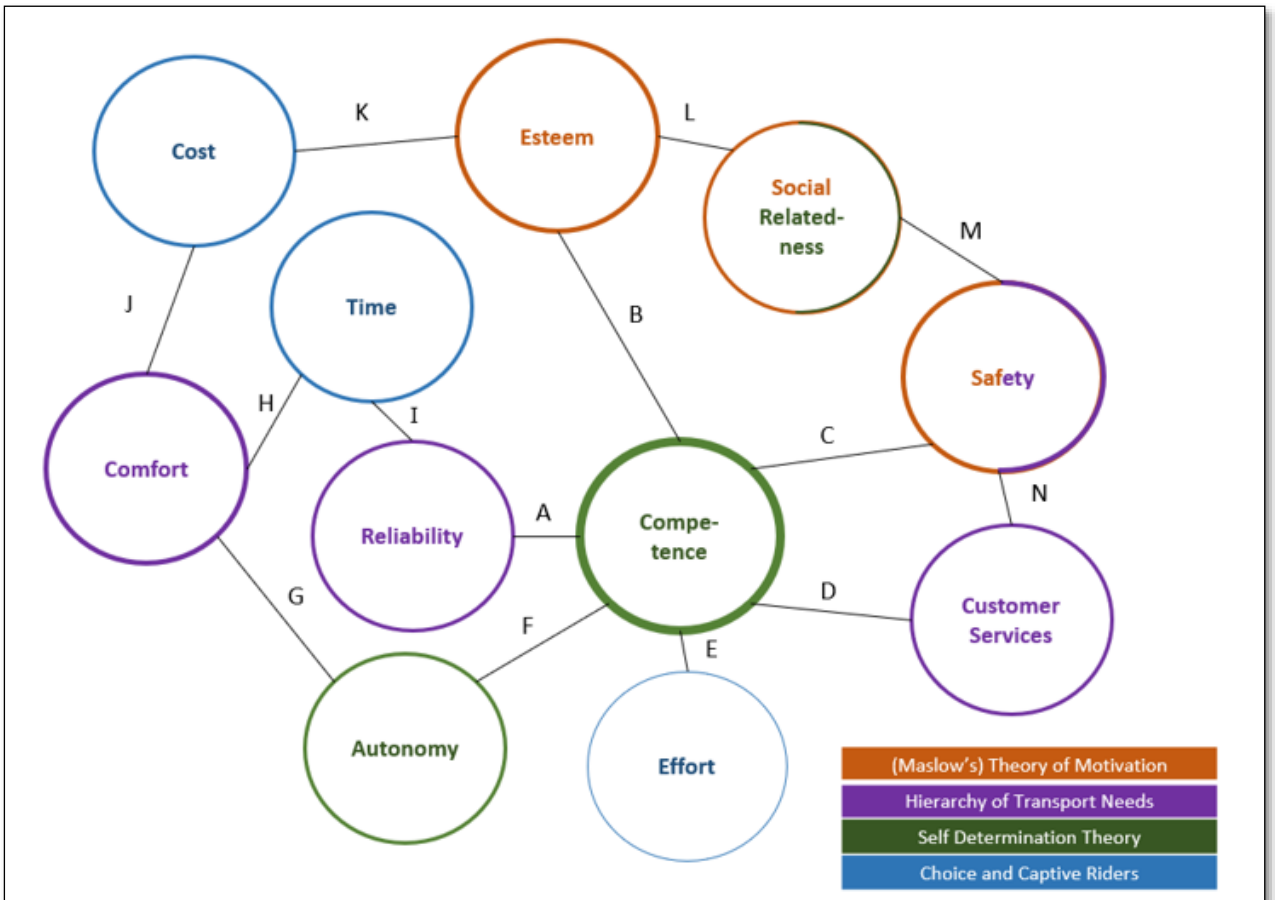
For instance, safety concerns were relevant for both modes, but the sources of these threats differed. Gautrain passengers cited concerns related to other people, while drivers faced safety threats from the physical environment. This distinction made social needs—particularly trust in strangers—more pertinent for Gautrain passengers than for drivers. While the Gautrain has effectively addressed safety within its facilities, its proximity to public spaces with potential crime creates a sense of insecurity through association. Efforts by municipalities to improve public space safety would benefit all public services, including transportation.

Competency emerged as the most interconnected need across both modes, with its absence leading to stress. The Gautrain met competency needs more effectively than private cars, owing to lower mental demands and the availability of customer service support. Stress levels also influenced the perceived passage of time, with participants reporting that time spent on the Gautrain felt more peaceful than time spent driving. This had a direct impact on comfort, where private cars offered material comfort through customization, while Gautrain passengers experienced comfort by being in a more relaxed mental state. Participants consistently felt competent navigating the Gautrain, but competency while driving varied. Future improvements in Gautrain management and operations should prioritize reducing stressors and safeguarding competency needs, as these are currently its greatest strength.

However, the Gautrain fell short in addressing autonomy, reliability, and cost needs compared to private cars. The ability to choose one's schedule when driving enhanced autonomy, though it sometimes induced stress when driving conditions or responsibilities were unfavorable. Reliability issues with the Gautrain mainly stemmed from its limited accessibility. While neither mode was inherently cheaper, the discrete nature of driving-associated costs made the overall price of driving less immediately impactful.

Figures 26 and 27 illustrate how transport needs interact with one another in the context of the Gautrain and private cars, respectively. Each figure uses the width of the circular border around each transport need to indicate the level of interaction with other needs. Descriptive captions following each figure further discuss the relational dynamics between these interdependent transport needs,

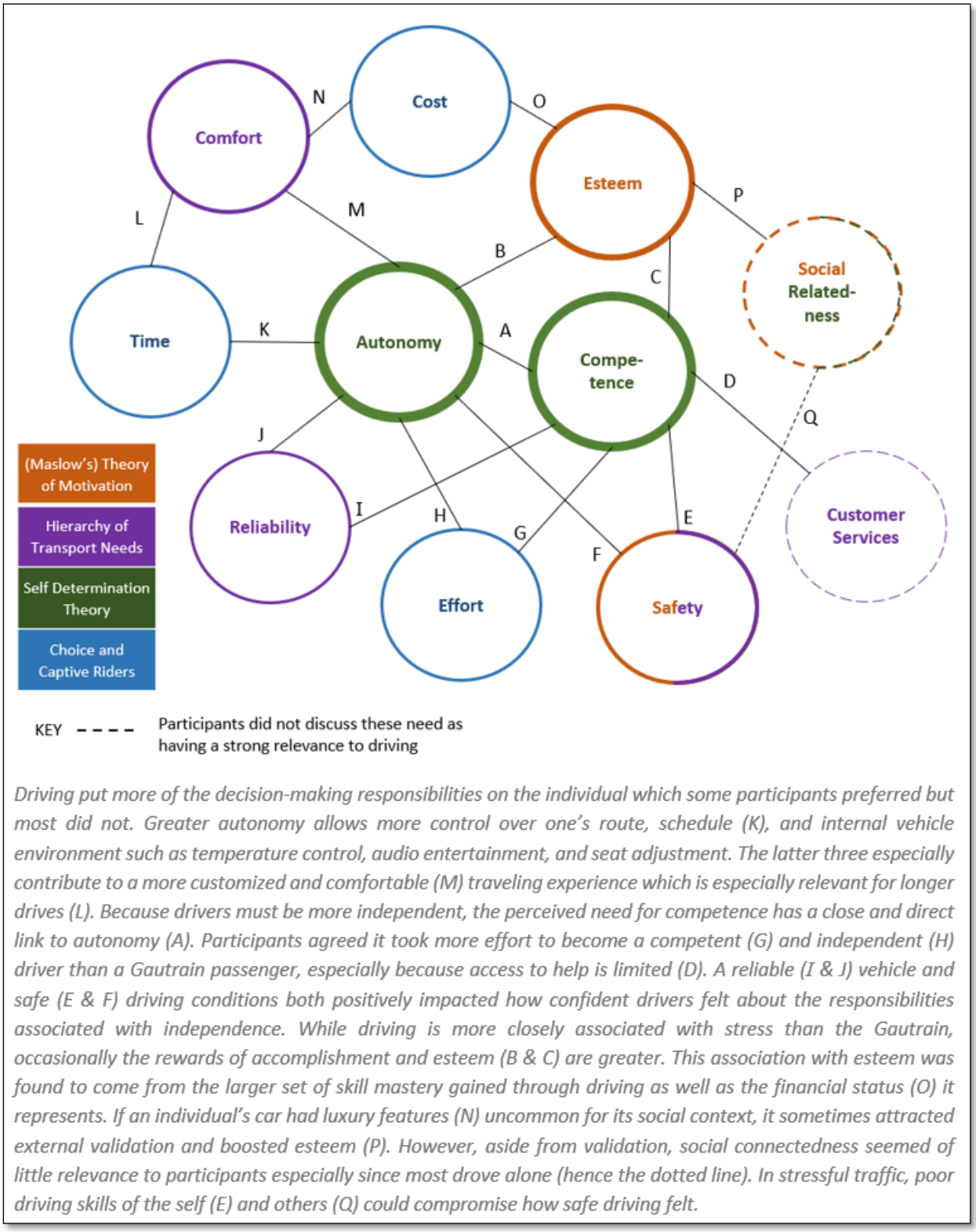
labelled with letters.



On the Gautrain, the less effort (E) passengers feel they must put into effectively navigating PT, the more competent they feel, which contributes positively to their sense of esteem (B) and autonomy (F). The Gautrain has sufficiently ensured safety within their facilities, notably through their onsite guards (N), which reduces the mental stress of being on high alert in public. A significant number of safety fears originate from trust in the people around (M). Thus, reducing the mental stress of safety leaves logistical competency (C) the main responsibility of the passenger, which passengers did not find difficult given the ample customer services (D) available. When the Gautrain is reliable (A) -- operating where expected and when expected (9) – passengers felt more confident to plan on using the system, and this confidence contributes positively to competency too.

The autonomy to customize one's travel conditions can lead to more comfortable trips (F). In PT these choices include to stand or sit, what music to listen to, and a broader range of relaxing or productive activities such as sleeping, reading, or working. The cost of the Gautrain is higher than others, which allows for more comfortable features and design (J) like air conditioning, cushioned seats, and carpeted floors. Irrespective of these, the average Gautrain trip is short, thus even if uncomfortable, it is within a tolerable time span (H). The higher expenses associate the Gautrain with a more luxurious experience than other PT services, contributing to a more esteemed (K) brand identity. The practical features already discussed in addition to these hedonistic ones make the Gautrain's reputation one of dignity. The dignity is carried on by its passengers who even if they do not primarily drive as their peers do, are seen as socially acceptable (L).

Figure 2 7: Relation Dynamics Between Transport Needs for Gautrain Passengers (Laurie, 2024)



Driving put more of the decision-making responsibilities on the individual which some participants preferred but most did not. Greater autonomy allows more control over one's route, schedule (K), and internal vehicle environment such as temperature control, audio entertainment, and seat adjustment. The latter three especially contribute to a more customized and comfortable (M) traveling experience which is especially relevant for longer drives (L). Because drivers must be more independent, the perceived need for competence has a close and direct link to autonomy (A). Participants agreed it took more effort to become a competent (G) and independent (H) driver than a Gautrain passenger, especially because access to help is limited (D). A reliable (I & J) vehicle and safe (E & F) driving conditions both positively impacted how confident drivers felt about the responsibilities associated with independence. While driving is more closely associated with stress than the Gautrain, occasionally the rewards of accomplishment and esteem (B & C) are greater. This association with esteem was found to come from the larger set of skill mastery gained through driving as well as the financial status (O) it represents. If an individual's car had luxury features (N) uncommon for its social context, it sometimes attracted external validation and boosted esteem (P). However, aside from validation, social connectedness seemed of little relevance to participants especially since most drove alone (hence the dotted line). In stressful traffic, poor driving skills of the self (E) and others (Q) could compromise how safe driving felt.

Figure 28: Relational Dynamics Between Transport Need for Drivers (Laurie, 2024)

In Section 4.6, the research explored solutions such as assigning specific cars to families for safety and using gamification to enhance competency as ways to support areas where the Gautrain currently excels. It also considered reframing growth areas for the Gautrain. However, it is essential to acknowledge the interconnectedness of transport needs and the potential ripple effects that any solution may have on the overall system. This networked nature presents opportunities to address multiple needs with a single strategy but also complicates efforts to address individual needs in isolation.

In addition to the GRRIN expansion discussed earlier, consider a scenario with potentially mixed impacts on transport needs. As noted in the Literature Review, most governments subsidize public transport (PT), leading to financial losses. The Gautrain, too, struggles with affordability, which makes it financially inaccessible to many South Africans. Keegan (2019) points to the Hong Kong exception, where the Metro Rail Transit (MTR) system profits from a Rail Plus Property financing model. The MTR owns public property, often above its stations, which it leases for retail and residential purposes. The revenue from these leases creates a net profit, helping the MTR improve its services while maintaining affordability.

The atmosphere around MTR stations is typically mixed-use, with shops, restaurants, and residential areas coexisting alongside public transport. If the Gautrain adopted a similar strategy, it could address several transport needs—such as cost, social interaction, and safety—by diversifying its income streams to subsidize transport costs, creating social spaces, and leveraging residents and shop owners for passive security. However, this model could challenge the need for competency. Currently, the Gautrain network and stations are relatively simple to navigate, partly because of the small scale and focus on transport. Introducing mixed-use developments could make stations more complex, potentially increasing stress for passengers who are primarily focused on commuting. Some passengers might find services unrelated to transport—such as retail or residential spaces—distracting from their main goal of travel.

This scenario illustrates how a single strategy can both help and hinder different transport needs. The complexity of this issue extends beyond transport itself, emphasizing the need for collaboration between various stakeholders. For instance, the overall commuting experience often depends on the smooth integration of multiple public transport services. For passengers to have a positive experience, public transport entities must collaborate effectively. On a city-wide scale, enhancing social and employment structures, typically provided by public services, could help reduce crime rates and alleviate socio-economic pressures. This, in turn, would indirectly benefit public transport by improving safety.

On an international level, the goal of sustainable development involves balancing social, economic, and environmental pillars (Section 2.3 and 2.3.3). Achieving sustainability often means “balancing trade-offs between equally desirable goals” (Purvis *et al.*, 2019:5). While the researcher does not wish to overburden readers with overly complex trade-offs, it is clear that achieving sustainable transportation and urban systems requires a collaborative approach. Individual entities must act in consideration of one another, rather than in isolation, to build a more integrated and sustainable future.

5.1: Reflection of Research and Closing Note

The researcher’s initial aim was to explore how city planners can enhance public transport (PT) to prioritize human transport needs over private cars. Notably, the middle class, with its higher accessibility to and reliance on private transportation, contributes significantly to environmental threats, as cars produce higher CO_2 emissions per capita than other modes of commuting (Ritchie & Roser, 2023). Achieving this aim required an in-depth understanding of the advantages and disadvantages of both public and private transport. To gather this insight, participants who use both modes were identified and qualitatively interviewed to explore how they experienced their transport

needs on each mode. Esser & Vliegenthart's (2017) guidelines were used to structure a mature, qualitative case-comparative study.

The first research sub-question involved explicitly listing transport needs, which was partially addressed in the Literature Review through Table 2. This table outlined fifteen original transport needs, along with the studies supporting them. However, at this stage, the research had not yet determined how, or whether, these needs influenced the mode of transport used by participants in this study. During the fieldwork phase, the researcher examined this question and presented the findings in Chapter Four. It became apparent that some of the original fifteen needs were either irrelevant to commuting or were too similar to others. As a result, the researcher decided to revise Table 2, producing Table 8, which consolidates or eliminates these exceptions. This updated table presents the ten transportation needs identified throughout the research.

Table 8: Human Needs Found to Have Notable Applicability to Transportation (Modified from Table 2)

(Type of) Transport Need	Theory/Study
Safety / Safety	Maslow, 1943; Allen, Muñoz & Ortúzar, 2019
Social / Relatedness	Maslow, 1943; Ryan & Deci, 2000
Esteem	Maslow, 1943
Reliability	Allen, Muñoz & Ortúzar, 2019
Customer Services	Allen, Muñoz & Ortúzar, 2019
Comfort	Allen, Muñoz & Ortúzar, 2019
Autonomy	Ryan & Deci, 2000
Competence / Effort	Ryan & Deci, 2000; Onderwater & Kishoon, 2017
Time	Onderwater & Kishoon, 2017
Cost	Onderwater & Kishoon, 2017

Where Table 2 listed transport needs with potential applicability to commuter transit, Table 8 filters those needs, confirming which were relevant to the participants in this study. Notably, Maslow's psychological and self-actualization needs were found to have limited relevance to commuter transport. Additionally, needs related to safety, social connection/relatedness, and competence/effort were often experienced synonymously by participants. Of these, competency emerged as the most relevant and interconnected need across both modes of transport evaluated.

The second part of the original research aim focused on identifying ways the Gautrain could better support commuters' transportation needs. This was achieved by exploring how the Gautrain Management Agency (GMA) could enhance, maintain, and promote the transport needs the system currently excels in. Specifically, the research recommended emphasizing the Gautrain's ability to offer a more relaxing commute compared to the mental stress commonly experienced by drivers. Additionally, strategies such as designating rail cars for families and implementing gamification were considered potential ways for the Gautrain to sustain its strengths in competency and safety, even amidst planned changes like the GRRIN expansion.

Major criticisms of the Gautrain revolved around issues of unreliability and high costs. Regarding cost, neither the Gautrain nor private cars were objectively cheaper, but participants noted that the costs of driving were often less apparent, as they included long-term expenses like insurance and maintenance, which are not immediately felt. To advocate for the Gautrain's cost-effectiveness, the research suggests focusing on its financial predictability and pricing transparency. On the issue of reliability, participants highlighted the limited number of accessible Gautrain stops, suggesting a need for further station expansions to increase accessibility. The research suggests that initiatives like the GRRIN expansion may help address these reliability concerns. However, it also emphasizes that any

solution must consider the interconnectedness of transport needs, with feasibility studies accounting for the ripple effects that changes may have on other needs.

Encouragingly, most choice commuters expressed a dislike for driving once the novelty wore off but continued to drive out of necessity. Future studies could explore the impact of advocating for public transport (PT) specifically to older commuters who have outgrown the novelty of driving, or how transportation needs evolve at different life stages. Overall, it is promising to note that the middle-class attachment to driving is not particularly strong. The idea of "liking" a particular commuting mode was found to be weak, which aligns with findings from the literature review. Onderwater and Kishoon (2017) suggest that transportation is generally viewed as a means to an end, while Ryan & Deci (2000) found that most behaviors are driven by external regulations or rewards. Therefore, reducing car dependency may be more about redirecting drivers than forcing them to abandon their vehicles. This can be achieved effectively when public transport, such as the Gautrain, is competitively viable compared to private cars, especially since it is already seen as socially desirable. When there is no strong preference for one mode over the other, efforts should focus on promoting options that align with urban sustainability goals.

The Gautrain, in comparison to private cars, offers a more environmentally conscious and socially inclusive alternative. For this reason, this research advocates for the Gautrain as a sustainable mode of transportation over private car use.

Reducing car dependency was identified as a key ecological challenge in South Africa, where the country's growing middle class, along with its attraction of migrants from across the continent, presents both an opportunity and a risk. As South Africa rises as an economic powerhouse, increasing wealth may normalize environmentally harmful lifestyle choices, including car ownership. This research thus takes a preventative stance, addressing the potential ecological threat posed by rising car use and advocating for systems that reduce these impacts. The aim is to ensure that, even as more South Africans attain car ownership, public transport remains competitive enough to be the preferred choice. In doing so, the overall carbon footprint of the country can be reduced.

Since public transport is inherently designed for people, this research adopts a human-centric approach. All transport modes should be designed with a baseline consideration for human needs—not as afterthoughts or luxury features available only to certain groups. By normalizing high levels of passenger care through human-centric design, public transport can become more attractive, encourage higher ridership, and contribute meaningfully to the larger goal of creating sustainable and energy-efficient cities.

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Appendix

Appendix A: Interview Guide

A. Do you enjoy driving? Why or why not?

B. When deciding which mode of transport you'll use, what variables do you consider? (Time, cost, other people, convenience, distance etc.)
   a. Which of those are most and least important and why?

C. In the different sections of your Gautrain commute (fist mile, waiting at station, in train, last mile, transferring, etc.), is there a particular part you enjoy?
   a. Is there a portion you wish you could change and why (in terms of safety, connectedness, cleanliness, etc)?
   b. What about the environment of that portion of your commute makes that trip portion (un)enjoyable?
   c. How does driving in a car compare with regards to this?

D. In your ideal world, would your transportation routine look different than it does currently? If so, how? (a) what specifically would you change and not change? (c) If not yourself, who or what dictates your transportation mode? (d) are there any trips that you wish you could take by Gautrain or car but can't?

E. Are there any parts of using the Gautrain or driving that feel confusing or intimidating? (a) do you feel like you could comfortably teach other people how to navigate the Gautrain or drive? (b) Do you know how to and feel comfortable with asking for help if unplanned circumstances arise in your commute? (c) Is there anything about each transportation mode that feels stressful? What about peaceful (d) What are the responsibilities associated with taking the Gautrain and car ownership? (e) Do those responsibilities feel manageable, why/why not? (f) do you enjoy or feel proud of those responsibilities? (g) (d) Do you have a story about a time you felt competent or incompetent in driving or using the Gautrain?

F. When you travel by car or Gautrain, do you travel by yourself or with others? Do you have a preference (a) if others, who? (b) who do you consider part of your social community (b) How do you travel to those people? (c) do you ever feel lonely in either form of commute? (d) do you ever feel a lack of privacy? (e) Is there a mode of transport that is more common among your social circles? (f) have you ever felt ostracized or had to defend your commuting choice?

Appendix B: Participant Demographic Questionnaire

Name:
Age:
Gender:
Ethnicity:
Highest level of qualification/education:
I am living with : extended or immediate family, a partner, housemates, independently Other: _____
I have _____ (number) of dependents
I consider my household: working class, middle class, upper class, other
Occupation (mark all that apply): Unemployed Self Employed Employed - Full Time / Part Time Student – Full Time / Part Time Other _____

Each participant completed the above demographic sheet. The researcher did not want to limit the participants in the kind of responses and therefore allowed as many free responses as possible. However, for reasons of clarification, some questions followed a multiple-choice format. In those cases, the researcher ensured to also include an "other" option to allow free response.

Appendix C: Participant Information Sheet and Consent From

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Participant Information Sheet

Dear Sir/ Madam

My name is Lindsay Laurie. I am a post-graduate student in Urban Studies focusing on Sustainable and Energy Efficient Cities at the University of the Witwatersrand, Johannesburg. My supervisor is Professor Muhammed Suleman. I am conducting a research study about sustainable transport choices.

The study title is *Intrinsic and Extrinsic Factors That Shape Sustainable Transport Choices in the Middle Class, a Case of the Gautrain*

I am inviting you to take part in a semiformal interview about your transportation habits, needs, and preferences. If you decide to take part, your participation in this research study will last between 1-1.5 hours. The interview can take place at a public location of your choice or online within the dates of September 18th and October 31st, 2023 (with some flexibility).

With your permission, I would like to audio record the interview. This data will be stored in a password protected device. Only the researcher will have access to the data. During the research activity, I will ask for some personal information about you including your demographics and well as your transportation choice making, needs, and experiences. The interview will remain closed. When I share the results of the research study in my report, I will not include your name or anything else that could identify you. With your permission, other researchers may use the data collected from this research study, but your name and any personal information will not be used or passed on.

The risks for this research study are no more than what happens in everyday life. You do not have to take part in this study. If you decide to take part, it should on a volunteer basis. Taking part in the research study will not cost you anything nor will you be paid for being in this research study. You can stop being in the study at any time. You do not have to answer any questions you do not want to. You will not get any direct benefits if you choose to join the research study or lose any services, benefits, or rights you would normally have if you decided not to join.

This research study will be written up as a research report. The report will be available on the university's library website. Upon completion, if you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11.717.1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,
Lindsay Laurie

Researcher:
Lindsay Laurie, 2734443@students.wits.ac.za

Supervisor:
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Participant Consent Form

Factors Motivating Sustainable Transport Behaviour - a Case of Gautrain Passengers

I, ……., agree to participate in this research project.

I agree to the following:

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that direct quotations from my interview may be use by the researcher in their research report	YES	NO
I understand that my participation will remain anonymous. My name or other identifying data will not be used by the researcher in their research report	YES	NO
I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

…… (signature)
…… (name of participant)
…… (date)

…… (signature)
Lindsay Laurie (name of researcher)
…… (date)

Appendix D: Questions for the GMA

1. **Safety & Security**

Context: In my process of interviewing public transit passengers, I have found people consider safety to be important in their transport decision making. The Gautrain is known for being exceptionally safe compared to other forms of public transit. Some people have noted that Gautrain guards/staff "actually" do their job, suggesting that security in other entities may only offer the perception of safety.

Question: What systems (formal or informal) have been implemented to create safe environments? How are staff trained or held accountable to protect passengers to such a degree that its noticeably different? What suggestions would you give other public transit entities if they are faced with issues of safety?

2. **Data on Private Car Passengers**

Context: from an environmental standpoint, those who typically commute by car would make good impact if they were to switch to mass transit. Given there are parking lots, the Gautrain serves a population who also drive. Additionally, the parking lots are card accessed, and presumably, there would be information about car passengers.

Questions: Which of the Gautrain stations has the most and least (numbers or as a percentage) passengers who arrive/leave the station by car? Is it proportionate to the general number of passengers who use that station? If not, are there any reasons for it?

3. **Gautrain's Environmental Impact**

Context: To be more environmentally competitive than a car, public transit must meet a critical passenger mass to justify the large energy inputs. Ridership on the Gautrain has been struggling to return to pre-pandemic levels, especially with the popularity of remote work. Additionally, while the Gautrain is electric, the electricity itself is generated by fossil fuels. (Please correct me if I am wrong in any of these assumptions)

Questions: From per passenger impact level, is the Gautrain a more environmentally conscious option than the private car? I struggled to find any studies on this, but if there are internal justifications to consider, I would appreciate it. If the ridership levels do not currently justify the energy requirements, how much would ridership levels need to increase to do so? If not the trains themselves, could any of the supporting infrastructure (stations, buses, etc.) be powered by renewable energy? To what extent have green solutions been explored and what are notable progress/challenges in that regard?

4. **Cost**

Context: One common issue that repels potential passengers away from the Gautrain is the cost of the service. Some interviewed passengers would like to use the service more often but do not because driving ends up being a more financially sound option. Outside of participant interviews, there is scepticism considering the large percentage of public funding that goes to the GMA, and why its services can't be more financially accessible to the public.

Question: What is the largest expense of the GMA's budget? Are there loans still being paid off? Does the GMA pay rental fees? What about the Gautrain’s operations makes it significantly more expensive than other forms of public transit?

Appendix E - Ethics Clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | SCHOOL OF ARCHITECTURE PLANNING

19 September 2023

Dear Lindsay Laurie (2734443)

This letter confirms that your clearance/waiver application has been approved. Your protocol/clearance number is: SOAP077/07/2023

Yours sincerely

lerato nkosi

Lerato Nkosi

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