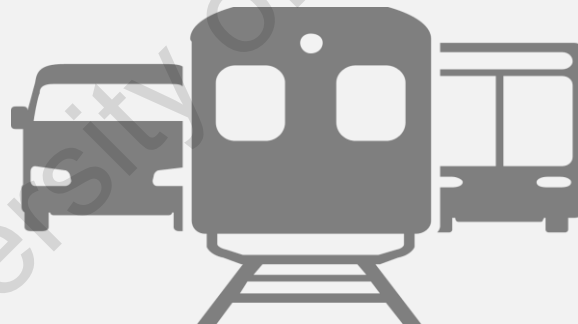




UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Public Transport Modes: Measuring user quality perceptions and preferences in Cape Town

Thesis Presented to the Faculty of Engineering & the Built Environment
at the university of Cape Town in partial fulfilment of the requirements
for the Degree of Master of Science (MSc) in Civil Engineering
(Eng.)—120 Credits



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Declaration

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Signed in Cape Town on this _____ day of ____February__ 2023

By: Sandisile Paul Walaza

(Signature)

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February 2023

Abstract

Public transport has become increasingly important in developing nations, playing a pivotal role as the primary mode of transportation for economic, social, and cultural endeavours for numerous individuals. While there has been extensive research on the technical aspects of public transport, the customer's perspective has received limited attention. Passenger's perception of the individual characteristics of the service plays a crucial role in evaluating service quality. Therefore, it is important to identify the factors that significantly influence the overall assessment of the service and those that have minimal impact. Understanding the order and magnitude of the importance of these external factors is of great importance to service providers when wanting to improve user experiences, for planning purposes, for marketing purposes as well as for fare setting. Considering this, the primary focus of this research is to provide empirical evidence on the existence of a hierarchy in transportation needs. Such evidence is provided in this research by investigating the existence of a user quality pyramid on public transport modes as claimed in literature. We do this for the City of Cape Town using the Best-Worst Scaling (BWS) method, which measures consumer priorities in a manner that is robust and transparent, by compelling respondents to make trade-offs among items. BWS is a survey technique of measuring individuals' priorities as it identifies the extremes in a given list as best as well as worst items and is used in other disciplines where prioritisation of items is required to guide decisions. In this study, 282 public transport users rank the best and the worst quality attributes in a given set of 14 quality attributes. The research findings indicate that travel time followed by affordability are the most important quality attributes in regional public transport modes. Equally, in- vehicle security followed by service transfers are the least important public transport quality attributes. We use this to construct and comment on the user quality pyramid.

Index Terms

Best-worst scaling, Public Transport, user quality perceptions and preferences, quality attributes

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Terms and Concepts

Term	Explanation
Best-worst scaling (BWS)	is a survey method for assessing individuals' priorities
MBT	Minibus taxi
Minibus taxi	Is an unscheduled public transport service operated on a specific route or routes, or where applicable, within a particular area, by means of minibus
GABS	Golden Arrow Bus Services
Perception	the way in which something is regarded, understood, or interpreted
Preferences	something that is liked or wanted more than another thing
SERVQUAL	Is a multi-dimensional research instrument designed to capture consumer expectations and perceptions of a service along five dimensions that are believed to represent service quality.
IPA	Importance-Performance Analysis

1. Introduction

This chapter provides context for the study and introduces the reader to the research problem and objectives. The study then states the research question and purpose. The section concludes by identifying the target audience and outlining the structure of the thesis.

1.1 Background

Public transport has become increasingly important in developing nations, playing a pivotal role as the primary mode of transportation for economic, social, and cultural endeavours for numerous individuals. While there has been extensive research on the technical aspects of public transport, the customer's perspective has received limited attention (Mouwen, 2015). To address this gap, Eboli and Mazzulla (2011) initiated the measurement of both the technical quality of public transport and the perception of its users. It is worth noting that individuals who are unfamiliar with public transportation may have biased perceptions, thus regular users are better positioned to evaluate its services. Quality characteristics in public transport encompass aspects such as accessibility, security, convenience, direct service, comfort, ticket price, travel time, and other factors catering to diverse consumer needs.

Prior to 1998, Olivková (2015) states that there were no established methods for measuring customer satisfaction in transportation, and little attention was paid to the status or nature of public transport and its customers. Most studies on public transport had predominantly focused on Parasuraman's five service dimensions for assessing service quality (Hussein & Hapsari, 2015). However, the SERVQUAL instrument, which measures service quality, has faced criticism, as most researchers do not support the five-factor structure proposed by Parasuraman et al. (1985). In response, Franceschini & Mastrogiacomo (2018) identified five service dimensions for assessing service quality: tangibles (physical facilities, equipment, personnel, and communication materials), reliability (ability to perform the promised service dependably and accurately), responsiveness (willingness to help and provide prompt service), assurance (knowledge, courtesy, trust, and confidence conveyed by employees), and empathy (provision of caring, individualized attention to customers). Additionally, some researchers have suggested other factors influencing service quality in public transportation. For instance, Govender (2015) proposed using the RECSA model to measure service quality in the mini-bus taxi service in South Africa.

Various scholars and researchers have examined customer perceptions of service quality and established positive relationships between these perceptions, satisfaction, and brand image (Barber et al., 2011; Marinkovic et al., 2014; Truong et al., 2017). Perception, according to Barber et al. (2011), refers to users' assessments of a service based on their experiences and comparisons to their prior expectations. Individuals actively select, organize, and interpret information to construct a meaningful image of the world through their perception.

According to Moslem & Çelikbilek (2020), the choice of transportation mode can be influenced by various factors such as economic, sociological, and geographical considerations. Numerous studies have been conducted to explore these influences and understand the factors that impact public transportation ridership (Moslem & Çelikbilek, 2020). These studies have examined different parameters within various categories to determine the most significant factors affecting ridership.

Two key factors have emerged as influential in public transport usage. The first factor is the user perspective, which investigates how socio-demographics, accessibility measures, the built environment, and infrastructure impact the utilization of transport modes (Moslem & Çelikbilek, 2020). The second factor is the transport system perspective, which focuses on system-level attributes that influence transport usage.

In recent years, there has been a growing emphasis on passengers' perceptions of public transport (Moslem & Çelikbilek, 2020). The quality of public transportation, as perceived by passengers, is now recognized as an essential component of quality indicators. Gathering passenger feedback is vital in identifying issues and developing effective plans to enhance the quality of public transport services.

For public transport operating companies, the quality of service is determined by how customers perceive it. This perception of quality is influenced by various factors related to the service itself, including reliability, frequency, punctuality, as well as aspects associated with terminals and vehicles, such as cleanliness, safety, and comfort (Moslem & Çelikbilek, 2020).

The measurement of public transportation service quality often relies on the widely used SERVQUAL method. This method employs a scale to assess various indicators of service quality. However, one limitation of this scale is that it does not allow for discrimination between items, making it impractical to rank them. Despite this limitation, evaluating the quality of public transportation service provides valuable feedback to both commuter

operators for improving service levels and to the government for enhancing service quality.

According to Pavlína (2015), the passenger's perception of the individual characteristics of the service plays a crucial role in evaluating service quality. Therefore, it is important to identify the factors that significantly influence the overall assessment of the service and those that have minimal impact. In this study, we present an alternative approach to assess public transport quality preferences and perceptions using the best-worst scaling method.

1.2 Research Problem

Van Hagen (2003) developed a theoretical framework based on user needs, which indicates that public transport users consider safety and reliability to be of great importance. This framework, however, was developed for train users at the station considering the Dutch realities and may not always apply to the South African context. The framework does not also take into account the social and economic circumstances in South Africa, which may lead to different quality preferences and perceptions among users compared to those in more developed countries. Furthermore, the model neglected to include ticket price in the list of service quality attributes, despite the fact that it is a crucial factor in determining transport quality in South Africa.

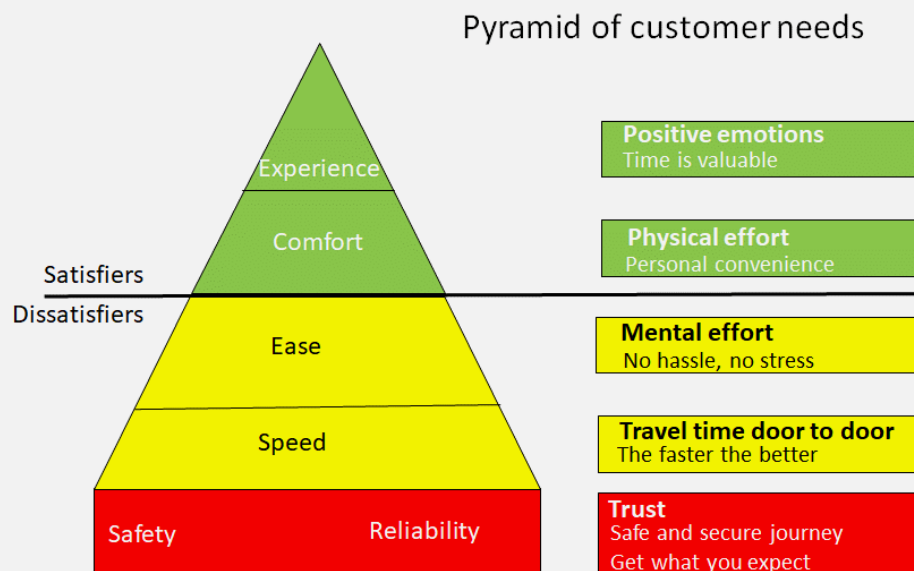


Figure 1: Pyramid of Customer Needs (Van Hagen 2003)

According to de Oña et al. (2013), it is a common approach to employ customer satisfaction surveys as a means of assessing users' perceptions of service quality. The

collected data from these surveys is then utilized to gain insights into the quality of service and monitor its progress over time. To uncover the existence and structure of a customer needs hierarchy in the public transport sector, this study adopts the Best Worst Scaling (BWS) method to collect and analyse empirical evidence. The main objective is to examine how users perceive and prioritize the quality of various modes of public transportation in Cape Town. The research identifies and prioritizes attributes related to public transport service quality, including affordability, comfort, speed, accessibility, reliability, safety, security, and more. These attributes are ranked based on their level of importance.

In spite of the efforts made by public transport service providers to deliver satisfactory services, there can be a discrepancy between their understanding of "quality service" and the perceptions of users (Sinha et al., 2019). As a result, resources may be directed towards areas that do not effectively enhance service quality from the viewpoint of users (dell'Olio, Ibeas, & Cecin, 2010). Consequently, it is becoming increasingly crucial to analyse and comprehend users' perspectives, as well as identify the factors that influence their decisions to utilize public transportation. From a passenger's standpoint, service quality refers to the overall assessed or perceived performance of the transportation system, as defined by TRB (2003).

1.3 Organization of the Dissertation

This dissertation consists of six chapters. As a part of chapter one, also known as the **(Introduction)**, the author presents an introduction to the thesis topic, offering background information on public transport in developing and developed countries. In the following sections, the focus of the research is discussed and justified, followed by a description of the overall research aim and individual research objectives.

In the second chapter of this document **(Literature Review)**, we review the literature surrounding public transport modes and user perceptions and preferences regarding quality and accessibility of the service. The purpose of this chapter is to discuss the modes of public transport and to justify the need for empirical data regarding the quality of public transport.

The third section of this report **(Research Design and Methodology)**, discusses in detail the research strategy and data collection techniques used to achieve the project's objectives. The site details, sample size, and framework for data analysis are also specified along with the project details. Moreover, the chapter discusses some of the

potential problems associated with collecting empirical data and conducting a research-based project. This falls under the ethical issues section of the document.

The results of the study of selected public transport interchanges in Cape Town are presented in Chapter four (**Results**). The results are based on interviews conducted with public transport users, during which they were asked to rank the most important and least concerning public transport quality attributes. To explain the results, the chapter also analyses the data and presents it logically

In this chapter, chapter five (**Discussion of Findings**), we discuss the results presented in the previous chapter. Literature is synthesized with research findings here.

This document concludes with the sixth chapter (**Conclusions and Recommendations**) which is the last chapter of the document. The research project's overall aim and specific objectives are reviewed. Research conclusions are derived and linked to the research objectives, and recommendations are made based on these conclusions. There is a clear definition of how this research contributes to the body of knowledge.

The study concludes with references and appendices. The reference section of this document contains an alphabetical listing of sources referred to in this study. The author-date method, also known as the Harvard system of referencing is used. The appendices contain pertinent and additional information that can be referred to for further details or clarity.

1.4 Aim and objectives of the study

The aim of this study is to provide robust evidence on the existence of hierarchy of transport needs by exploring the perceptions and preferences of public transportation users in Cape Town regarding three different modes of transportation: minibus taxis, buses (including Golden Arrow bus services and My Citi), and trains. Our approach involves scientifically establishing the existence of a transportation needs hierarchy, akin to the hierarchical model of needs proposed by prominent humanistic psychologists such as Maslow (1943a, 1943b) and Alderfer (1974), as well as Van Hagen in 2003, specifically for public transport users. Once we have established beyond doubt that a hierarchy of transportation needs exists, we will use it as a framework to model user quality

perceptions and preferences for all modes of transportation in Cape Town. This study has several related objectives; all geared towards improving public transport modes.

Objectives:

1. Conduct a literature review on public transport modes, customer satisfaction, user quality perceptions, and preferences.
2. Investigate whether a user quality pyramid exists across public transport modes in Cape Town, Bellville, Khayelitsha, and Mitchells Plain, and determine which quality attributes are most important to public transport mode users.
3. Examine the use of the BWS method to measure user quality preferences and perceptions of public transport modes in Cape Town.

1.5 Research Question

After providing a description of the research problem, aims, and objectives, this study seeks to address the question of whether there is a hierarchy of user preferences for different public transport modes in Cape Town. The examination will encompass various public transportation options, as well as diverse social demographics and residential areas.

1.6 Significance

The purpose of this research is to examine customer preferences and perceptions of quality in order to gain insights into areas that require improvement. This study aims to contribute to the existing body of literature on public transport, user quality perceptions, and user preferences. Empirical data and the Best Worst Scaling methodology will be used to investigate the potential existence of a quality pyramid as perceived by users. Based on the findings of this study, further research will be conducted to delve deeper into the subject.

1.7 Limitations

The study faces a notable limitation as it only includes a small number of participants between the ages of 55 and 64 in the survey. Consequently, a comprehensive understanding of the perceptions of this specific age group is not possible. Another constraint of this research is its primary focus on transportation in inner-city areas, neglecting rural areas. The study investigates the perceptions and preferences of Cape Town's public transportation users towards three modes of transportation: minibus taxis,

buses (including Golden Arrow bus services and My Citi), and trains. Furthermore, it is important to acknowledge that the accuracy and validity of the results heavily rely on how the users provide their responses.

1.8 Methodology

To enhance our understanding of how participants perceive and prefer public transportation, we employed the Best-Worst Scaling technique. This method involves ranking preferences among different alternatives. We organized a comprehensive set of statements related to public transportation into groups of five, both in a general sense and specifically for different modes of transportation.

Participants were presented with a list of quality attributes and asked to indicate the attribute they considered most important and an attribute they consider to be least important. This allowed us to establish rankings and gain insights into the level of importance attributed to each attribute.

Trained surveyors conducted the survey during morning and afternoon peak periods from February 15th to 18th, 2021, at various public transport facilities. The data collected was then analysed and interpreted. Software tools like Microsoft Excel 2016 were utilized to model the responses and determine the attributes that were deemed most important and less important in public transportation.

Overall, the Best-Worst Scaling method proved to be a valuable tool for uncovering participants' biases and perceptions regarding public transportation. Through our analysis, we gained a deeper understanding of the factors that influence individuals' decisions to use public transportation.

2. Literature Review

The next section of the document provides a literature review, which presents an overview of published research and theories related to public transportation issues. Within this chapter, we will explore the efforts made by professionals and researchers around the world to tackle problems associated with transportation and customer service.

2.1 Hierarchy of human needs and transport customer needs

Extensive research has been conducted on human psychology and the recognition of Abraham Maslow's theory of human needs (Allena, Muñoz, & Ortúzar, 2019). However, there is a lack of substantial information regarding the presence of the customer needs pyramid within Cape Town's public transport modes.

A study conducted by the Florida Department of Transport evaluated the level of service in a balanced manner across different modes of transportation (Winters et al., 2001). The study emphasized the significance of identifying shared factors among modes and users to assess the level of service consistently and enable trade-offs between modes. It also suggested incorporating user perceptions to address a variety of needs represented by different level of service measures and the evolving demands of transportation users. Consequently, the study acknowledged the existence of a hierarchy of needs among transportation system users that applies to all modes. A subsequent review of relevant literature further highlighted the importance of these psychological factors in influencing mode choice decisions (Winters, Cleland, Mierzejewski, & Tucker, 2001).

In a study conducted by Perone et al. in 2005, the researchers aimed to examine the hierarchy of needs in terms of service levels. The main objective of this research was to offer empirical evidence regarding the hierarchy of transportation needs. Based on their

findings, survey participants' responses provided support for the existence of a hierarchical structure of needs.

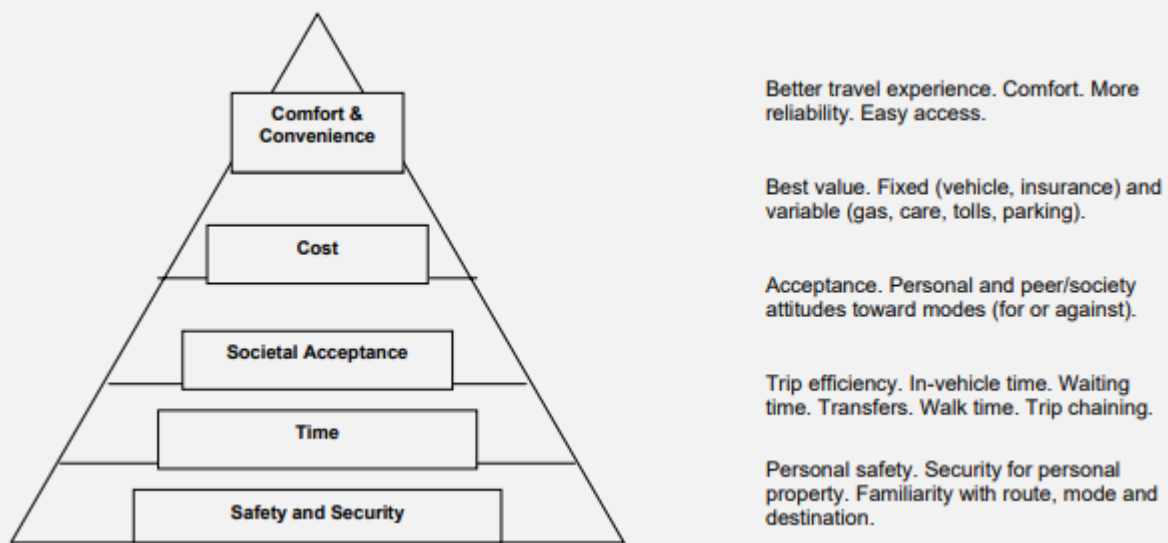


Figure 2 : Transport hierarchy of needs based on Maslow (Winters et al., 2001)

According to figure 2 above, the hierarchy levels are similar to Maslow's hierarchy of needs. Safety and security is at the lowest level of the pyramid.

In 2003, van Hagen developed similar modal analysing waiting conditions for commuters at train stations. According to their model, safety and reliability have the same importance score, and the shape of the model at the bottom is rectangular. However, it is proposed that this hierarchy be modified again to reflect Alderfer's Existence, Relatedness, and Growth (ERG) theory of Needs. Observing that Maslow's hierarchy of needs was difficult to apply to the real world, Alderfer modified it to improve its utility in 1973. As a result of his research, he developed a different theory and perspective known as Existence, Relatedness, and Growth Theory (Alderfer & Schneider, 1973). The following section describes Alderfer's ERG theory and how it has been operationalized in an organizational context.

2.1.1 Alderfer's Existence, Relatedness and Growth Theory

On the basis of empirical research findings, Alderfer proposed the ERG theory to explain the relationship between the satisfaction of needs and human desires (Yang, Hwang, & Chen, 2011). In Alderfer's view, the categories of existence, relatedness, and growth are more appropriate for describing human behaviour than Maslow's hierarchy. The ERG theory holds that addressing only one need at a time will not result in a change in

behaviour. Maslow's hierarchy asserts that humans will prioritize physiological needs over safety needs; however, Alderfer's research contradicts this assumption. An example would be that a person in the event of a thunderstorm would not choose water over shelter. Additionally, Alderfer reduced the number of hierarchy levels from five to three, simplifying any comparison between hierarchy levels (see Figure 3).



Figure 3 : The ERG theory versus Maslow's Hierarchy (Bharti, ND)

The above figure illustrates that Alderfer has created a general category of needs in contrast to Maslow's hierarchy. According to him, either belongingness or self-esteem needs can take precedence at various points in time. The thesis of Alderfer was that humans will only satisfy higher-level needs once relatedness needs have been met. As a result of Alderfer's theory, a broader range of observed behaviours can be accommodated.

1) Existence needs

Existence needs are the most concrete and accessible to verify, and they include various forms of safety, physiological and material needs (Bharti, n.d.). Existence is used by

Alderfer to describe the general human concern with primary material requirements for existence. It covers Maslow's physiological and safety needs. According to Alderfer's theory of existence, the basic necessities of life are oxygen, food, water, a constant body temperature, sleep, protection from the elements, and a secure living space. Food, clothing, and other resources necessary for survival are considered material needs. Alderfer's theory has a greater degree of flexibility since it can be used to explain situations in which a person will seek shelter from a tornado before seeking a drink of water. Following the satisfaction of the existence needs, the theory states that humans are able to move on to the next level of the hierarchy, the relatedness needs.

2) Relatedness needs

Relatedness needs are less concrete than existence needs, which depend on a relationship between two or more people (Bharti, n.d.). According to Alderfer's theory, relatedness is the desire to maintain interpersonal relationships. According to Maslow, this term refers to the need for belongingness and esteem. Security, love, and a sense of acceptance are some of the characteristics that define a sense of belonging. A sense of security refers to the mutual trust of humanity, whereas a sense of belonging refers to the prevention of suffering, isolation, and loneliness. In Alderfer's hierarchy, Alderfer argues that there are four main goals that must be accomplished in order to achieve self-respect, achieve success, receive positive recognition, and maintain a good reputation. Having such needs gives people value to their existence (Yang, Hwang, & Chen, 2011)

3) Growth needs

Growth needs are minor and concrete in that they are determined by the uniqueness of each individual (Bharti, n.d.). The term "growth" refers to the desire to improve oneself, as defined by Alderfer. The highest level of need includes both self-esteem and self-actualization. This level includes the pursuit of truth, knowledge, peace, wisdom, and justice as well as the desire to realize one's full potential. In many ways, it is similar to Maslow's hierarchy of needs. The only difference is that Alderfer's hierarchy is less specific and more flexible. It has been noted by Alderfer (Perone et al., 2005) that ERG has proved to be a valuable theory in the context of applied research. It would be much easier to conduct empirical research using Alderfer's ERG theory. Additionally, as discussed above,

it is simpler to test for the existence of three more general hierarchy levels than five more specific hierarchy levels (Perone et al., 2005).

2.1.2 Three levels of transportation attributes

As previously mentioned, Alderfer's (1972) ERG theory consists of three levels. The first level, known as Existence, encompasses the initial two stages of Maslow's Hierarchy of Needs, namely physiological needs and safety and security needs (Winters et al., 2001; Perone et al., 2005). Various types of public transport systems incorporate these attributes. In the realm of public transportation, service quality attributes have been identified and categorized as follows:

- a) Existence level of transportation needs;** In order for the user to be satisfied, these attributes must meet a minimum level of compliance. They include waiting time, comfort, accessibility, frequency, reliability, speed, safety and security or concern about victimization during travel, ease of way finding/navigation in the system (Li, 2003; Perone et al., 2005).
- b) Relatedness;** These attributes cover both relationships and self-esteem in Maslow's hierarchy such as consistency, reciprocity, social proof, authority, liking, and belongingness when using a certain transportation mode (Perone et al., 2005).
- c) Growth;** the term Growth describes the desire to become a better person, and is used to refer to the desire to improve oneself (Perone et al., 2005). The term growth encompassed self actualization and is the highest level need, according to Alderfer. These attributes refer to accessory aspects of the mode. Among them would be the desire to reach one's full potential and the pursuit of things such as truth, knowledge, peace, wisdom, and justice. In addition, the desire to realize one's highest potential. In public transport, this category includes ease of use, vehicle comfort, availability of seats, vehicle cleanliness, information, air conditioning, connectivity to the Wi-Fi, driver's behaviour, noise, convenience, aesthetic amenities, cost, convenience, etc.

2.2 Customer perception and Quality of Service

Over the last twenty years, there has been a concerted effort to assess the quality of transport services and determine the preferences of users (TRB, 2004). The public transportation user is considered a customer who expects a satisfactory level of service, and their evaluation is based on a comparison between the actual service delivery and their own expectations (Imam, 2014). It is crucial to differentiate between service quality and satisfaction, as quality assessments can be made without directly experiencing the service, whereas satisfaction judgments require first-hand experience (Imam, 2014). Apart from the service attributes, satisfaction can also be influenced by the user's individual needs, preferences, past experiences, and existing knowledge.

Transit Capacity and Quality of Service Manual (TCRP 165) defines service quality in public transportation as reflecting passengers' perception of transit performance. Taylor and Brogan (1978) assert that the measurement of service quality should be based on system attributes that are perceived as significant by the general public. TCRP presents an exhaustive list of 48 public transport quality attributes. These include service availability factors such as days and hours of operation, access and egress times, comfort and convenience of passengers, information availability, staff behaviour, and safety hazards (Sinha, Swamy, & Modi, 2020).

Public transport users choose their mode of transport by assigning each quality feature a specific weight (Watson, 1974). Quality of service comprises attributes related to price, information, driver behaviour, waiting conditions, accessibility, and vehicle conditions (Tyrinopoulos & Antoniou, 2008). The quality of service in public transport modes is reflected through passengers' perception of performance (Tyrinopoulos & Antoniou, 2008).

According to Grujičić et al. (2014), passengers in a unique manner will choose their mode of transport whose combination of speed, costs, and comfort weighted the best in the importance scale compared to other modes of transport. Olsen (2007) states that public transport users' satisfaction depends on the perception of the service quality. From this, one can conclude that quality of service is the perceived performance and customer satisfaction is the expected performance (Radam, Kartadipura, & Yuliana, 2014).

According to Eboli and Mazzulla (2011), as cited in Arora and Jothi (2016), evaluating the quality of a service involves considering the customer's perception and expectations. The

customer's perception of factors impacting quality is vital when assessing service quality from their perspective. However, relying solely on perceptions is insufficient. The crucial task is to identify the factors that hold the greatest influence on the overall assessment of the service and distinguish them from those with lesser impact (Juan, Oña, Eboli, & Mazulla, 2013).

2.2.1 Service Gap Deployment: a framework to link quality gaps to service activities

Service can be defined as a sequence of interactions between the customer and the service provider, aimed at resolving the customer's needs (Franceschini & Mastrogiacomo, 2018). These interactions encompass a set of activities that are delivered to the customer. To prioritize service quality activities and address features that fail to meet customer expectations, a service gap deployment (SGD) framework can be employed. **Figure 4** illustrates this framework (Franceschini & Mastrogiacomo, 2018).

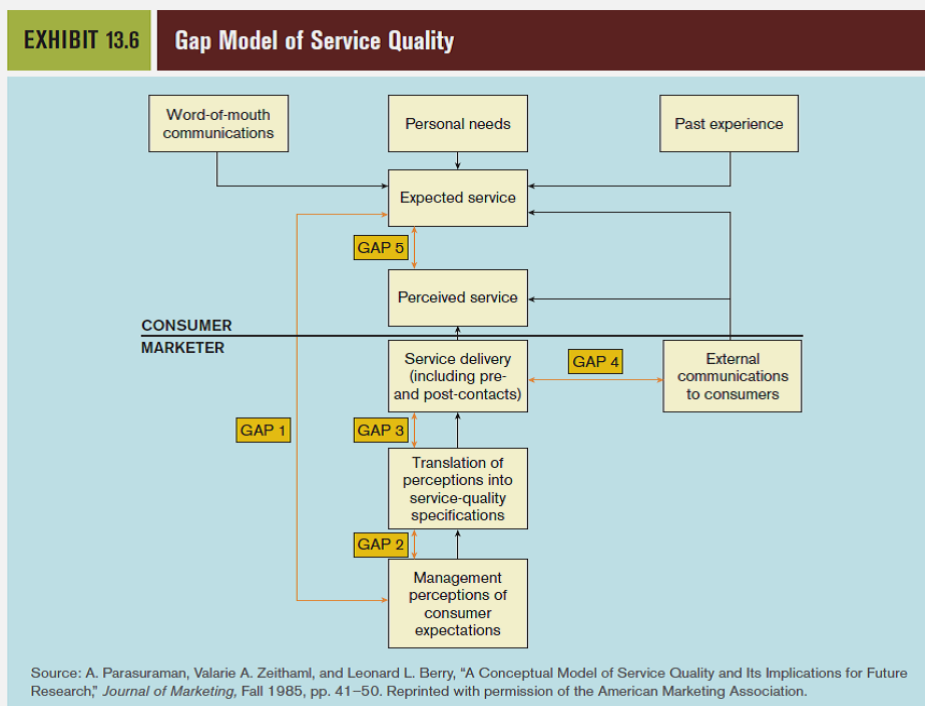


Figure 4 Service Gap Deployment: A Framework to link quality gaps to Service activities (Parasuraman et al., 1985)

Parasuraman, Zeithaml, and Berry developed this model in 1985 and showed gaps between customer perception and expectation. The framework theorizes the existence of five different gaps that must be adhered to meet customer expectations. In this model, service activities are related to gaps between customer expectations and perceptions

identified that may need improvement to satisfy customer needs (Franceschini & Mastrogiacomo, 2018).

Franceschini & Mastrogiacomo (2018) identified five service dimensions for assessing the quality of service:

- 1) **tangibles:** the appearance of physical facilities, equipment, personnel, and communication materials
- 2) **reliability:** the ability to perform the promised service dependably and accurately
- 3) **responsiveness:** the willingness to help customers and to provide prompt service
- 4) **assurance:** the knowledge and courtesy of employees and their ability to convey trust and confidence
- 5) **empathy:** the provision of caring, individualized attention to customers.

They further defined a SERVQUAL tool for operationalizing service quality measurements, specifically for the quality dimensions above. The main idea is that service quality is related to gaps in customer expectations and perceptions of the service under study. SERVQUAL is a multi-item questionnaire designed to examine service components and critical characteristics. There are two components to it, the first focuses on assessing the five aspects of service from the consumer's perspective, and the second has to do with client expectations. The evaluator is asked to rate 22 essential service features on a 7-level ordinal scale.

Radam et al. (2014) studied intercity public transport perception of service quality. Parasuraman et al. (1988) SERVQUAL scale identified five-quality determinants: reliability, assurance, tangibles, empathy, and responsiveness. Their study also used the Importance – Performance analysis tool to determine service quality improvement.

The SERVQUAL instrument, utilized for assessing service quality, has faced criticism in its application. Many researchers do not endorse the five-factor structure proposed by Parasuraman et al. (1988) for the SERVQUAL method. Subsequently, Cronin and Taylor (1992) developed a different performance-based measure called SERVPERF. The SERVPERF scale is the unweighted perceptions component of SERVQUAL, consisting of 22 perception items that discount any consideration of expectations. In their empirical work in four industries, they found that the unweighted SERVPERF measure performs better than

any other measure of service quality and that it can provide a more accurate service quality score than SERVQUAL.

They argue that current performance best reflects a customer's perception of service quality and that expectations are not part of this concept. Parsuraman et al. (1988) noted that even if it may be necessary to reword or modify some items, the SERVQUAL scale applies to many business services. However, Parasuraman et al. (1991) cautioned that the addition and deletion of items and dimensions might result in losing the scale's integrity. Considering this, in this study, the best-worst scaling approach has been selected as the most suitable method for measuring user perceptions of service quality.

2.2.2 Importance-Performance Analysis

Martilla and James developed an Importance-Performance Analysis framework in 1977 for analysing service quality perceptions. The method has been applied to several sectors, including the evaluation of public transport service quality (Sinha et al. 2019). In this framework, customer satisfaction is determined by two aspects - importance and perceived performance of an attribute associated with the service. Using a Likert scale, customers are asked to rate each service attribute based on how important and how well it performs. All sampled customers' responses are compiled and the mean importance and performance ratings are calculated and plotted as per the figure below.

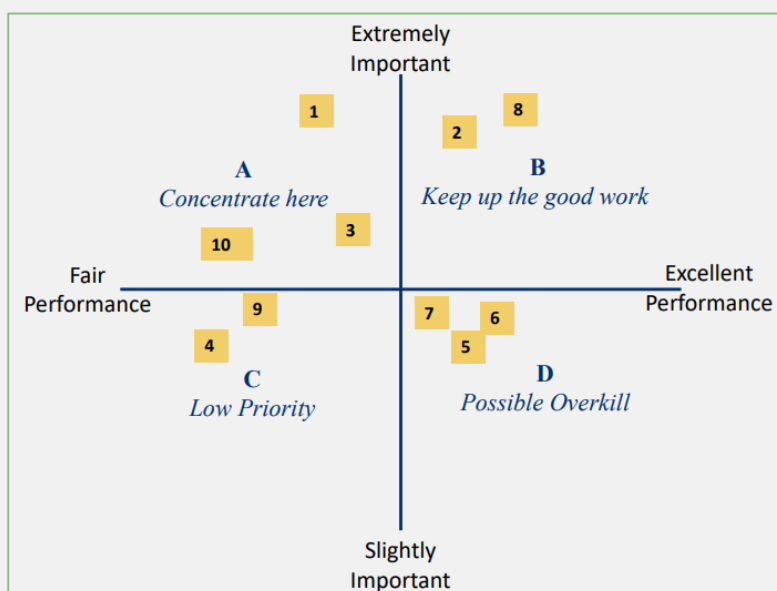


Figure 5: Importance Performance Grid (Martilla & James 1977)

Using this quadrant chart, we can quantify the importance of each attribute from a customer's perspective as well as view the average customer rating for each characteristic. As a result of this simple technique, attributes that need to be improved are prioritized, and strategies are developed in accordance with this technique (Slack, 1994). However, the IPA matrix is merely a method for visualizing the information, and it remains unclear how the precise ranking of the importance of improving attributes can be determined (Abalo et al., 2007).

Public transport managers use IPA due to its simplicity in evaluating transport systems, including airlines (Oña & Oña, 2014). This is a basic model, in which different weights are assigned to each quality attribute, and which enables prioritizing improvements. However, one of its disadvantages is that it provides a visualizing method without accurate ranking of priority; it does not account for heterogeneity; if importance is stated by passengers, most attributes are grouped together at the top of the grid.

Behrens et al., (2018) evaluated the performance satisfaction of a minibus taxi feeder service in Mitchells Plain using a quadrant analysis. In this study, they explored the degree of satisfaction among passengers that use unscheduled feeder services and identified attributes that need to be improved in the future. The results are depicted in Figure 6.

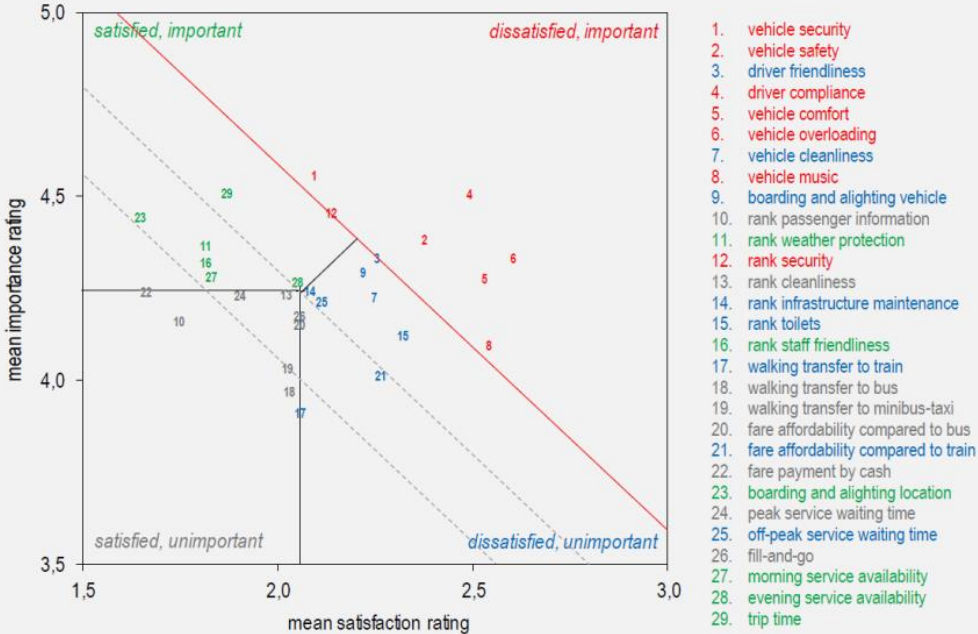


Figure 6: Service attribute satisfaction and importance (Behrens et al., 2018)

According to their analysis, transferring passengers place the greatest importance on driver compliance, vehicle overloading, vehicle comfort, vehicle safety, and driver customer service. In addition, the study suggests that among transferring passengers, proximity and flexibility of service routes; trip time; rank weather protection; morning service availability; and rank staff friendliness are the most important and satisfactory service attributes.

2.3 Public Transport Modes

Public transport is essential for social inclusion, for providing access to opportunities, and for reaching activities and services such as work, education, health, shopping, and social-recreational activities (Currie et al. 2007; Lucas 2005; Lucas 2010).

Public transport provides access to economic opportunities, reduce the cost of doing business, provide environmental sustainability in supporting other broader strategies, provides access to social opportunities and achieves shared growth and integrated development (Roux, 2013). Public transport does not only provide public transport services, it also brings up legislation, policy determination, the regulation as well as control, and provision of infrastructure (Roux, 2013). To explore passengers' preferences and perceptions, the study employed the following working definitions:

- **Regional Public Transport System:** This refers to the collective passenger transportation services operating within regional cities and urban centres. Such services are primarily designed to transport riders from lower density areas and suburbs to the central areas of larger cities (Hasson et al., 2019).
- **Local Public Transport System:** This pertains to the transportation services that facilitate passenger travel within an urban area. In other words, the focus is on transportation within urban areas, rather than specific urban centres or densities. Consequently, travel between different parts of an urban area is considered local rather than regional (Hasson et al., 2019).

Transport modes are a crucial element of transportation systems as they facilitate the movement of people and goods. With the growing demand for transportation, the importance of public transport becomes even more evident. Public transport plays a vital role in alleviating traffic congestion, which is primarily caused by private modes of transportation. It enables the efficient transportation of large numbers of people while utilizing fewer scarce resources such as land, fuel, and environmental costs. One of the key advantages of public transport is that it reduces the dependency on and desire for private vehicle ownership. In Cape Town, three main modes of public transport are prominent such as commuter bus services, minibus taxis and commuter trains.

2.3.1 Commuter Bus Services

In general, buses offer regular, scheduled services along predetermined routes with fixed stops and fares. The Western Cape province of South Africa is served by the largest private bus company, Golden Arrow Bus Services (Pty) Ltd. (GABS). GABS operates under a contract with the Western Cape Department of Transport, providing subsidized and scheduled transportation services to commuters within the Cape Town Metropolitan Municipality.

In 2007, the City of Cape Town introduced a new bus service known as Bus Rapid Transit (BRT) in response to various factors, including its role as a host city for the FIFA World Cup, where efficient transportation was of utmost importance (Ugo, 2014). The City of Cape Town was driven by the vision of transforming public transport, leading to the development of a customer-oriented system that integrates stations, vehicles, planning, and intelligent transport systems into a unified and distinctive identity (Wright & Fjellstrom, 2003).

BRT, exemplified by the My Citi system in Cape Town, typically involves dedicated bus lanes, either at-grade or grade-separated, with features including swift boarding and alighting, efficient fare collection, clean bus technologies, mode integration, comfortable stations, and a stylish marketing identity. Compared to rail systems, BRT offers greater flexibility for future expansion and modifications to adapt to demographic changes and new planning decisions (Wright & Fjellstrom, 2003). It also allows for the introduction of signal prioritization. BRT systems consist of stops located along streets with limited infrastructure, stations at locations with higher passenger volumes and more extensive infrastructure, and terminals that serve as end stations with provisions for vehicle turning and standing. Depots serve as facilities for vehicle storage and maintenance (Institute of Transportation Engineers, 2009).

2.3.2 Mini Bus Taxis

Minibus taxis play a significant role in the public transportation system of the Western Cape, with over 10,000 vehicles offering unscheduled services within the province (Western Cape Provincial Government, 2011). These services are provided by private operators who obtain licenses from the Operating Licensing Board to run passenger services. These licenses specify the designated ranks and roads where the services should be operated (Western Cape Provincial Government, 2011).

The nature of minibus taxi services varies across municipalities due to differences in population densities, economic activities, and geographical locations (Western Cape Provincial Government, 2011). In densely populated areas, the minibus taxi services are primarily focused on transporting passengers to work or school, with additional emphasis on meeting other travel needs such as shopping and access to healthcare during off-peak periods. In such areas, the taxis often provide a door-to-door service for passengers (Western Cape Provincial Government, 2011).

Conversely, in low-density areas, non-motorized transport (NMT) is commonly used, and when minibus taxis are utilized, they tend to offer a door-to-door service due to the lower demand (Western Cape Provincial Government, 2011). In regions with high population densities and a strong demand for minibus taxi transport, taxi operators typically wait until their vehicles are fully occupied before departing from the rank. As a result, waiting times for a full vehicle can be extended.

On the other hand, in rural areas, taxi operators are usually unable to wait for the vehicle to fill up due to low demand. Consequently, the utilization rates are low, and end-user costs are high, making public transport unaffordable for the majority of people. (Western Cape Provincial Government, 2011).

According to Kokernot (1984), minibus taxis fulfil three key roles. Firstly, they serve as a means to facilitate the movement of people, offering increased accessibility and meeting individual travel needs. They provide a relatively affordable, flexible, and convenient service, particularly benefiting economically disadvantaged communities. Secondly, minibus taxis serve a dual purpose by offering social benefits such as door-to-door service and catering to the needs of small groups and individuals (Kokernot, 1984). This mode of transport also provides a sense of security compared to other public transportation options and can accommodate fluctuations in demand (Kokernot, 1984). Lastly, minibus taxis play a significant economic role by serving as a source of employment and generating income.

The lack of documented routes in the minibuses necessitates that commuters rely on informal knowledge passed through word of mouth to navigate the network. As minibuses lack formal stops and route signage, commuters are required to utilize a complex and location-specific system of hand signals to hail a taxi (Neumann, Röder, & Joubert, 2015). These hand signals communicate to the approaching taxi the desired

destination of the commuter. If the commuter's destination aligns with the driver's intended route and capacity allows, the driver will stop to allow the commuter to board.

The minibus plays a crucial role in the integrated public transport system by serving as both a trunk and feeder service within the network (South African Cities Network, 2015). The City of Cape Town acknowledges the ongoing presence of minibus taxis and proposes a hybrid public transport system as part of its public transport reform strategy (CITP, 2013). This hybrid system combines minibus taxis with scheduled bus services. Jennings & Behrens (2017) contend that public transport reform strategies that acknowledge the continued existence of paratransit services, such as minibus taxis, are more likely to create effective transport systems compared to those that disregard their ongoing presence.

Minibus taxi operations typically follow specific routes that have developed based on demand and location of ranks. These trips involve regular line hauls with limited stops along the way, but passengers have the flexibility to board and alight the taxi during the journey (Kokernot, 1984). According to Ryneveld (2018), the model and size of minibus taxis allow them to operate efficiently and cost-effectively as a demand-responsive service. Unlike legal services such as trains or buses, minibus taxis, which are smaller petrol and diesel-driven buses, can provide this demand-responsive service, giving them an advantage. The frequency of minibus taxi services varies throughout the day, with operations occurring during both peak and off-peak hours. The morning peak period typically begins at 06:00 and ends at 08:30, while the evening peak period starts at 16:00 and lasts for approximately two hours until 18:00. Additionally, the regularity of daily and weekly service also varies.

2.3.3 Commuter Rail

Commuter rail serves as a mode of transportation for passengers within urban areas and between urban areas and suburbs. Typically, it is a heavier system compared to light rail and operates on established railroad tracks (Wright & Fjellstrom, 2003). Commuter rail systems share the tracks with regional and national passenger and freight trains. These rail systems are usually owned by the state, either at the local or national level, due to the significant initial investment and ongoing maintenance costs involved. Unlike bus and minibus taxi routes, rail routes are fixed and cannot easily adapt to changing demand since they follow the predetermined structural layout of the rail line. Modifying or

expanding a rail system is generally more intricate and expensive (Wright & Fjellstrom, 2003).

In the context of Cape Town, the primary rail lines that serve the Cape Metropolitan Transport Area converge at the Salt River Junction, providing an opportunity for commuters to transfer between trains without the need to travel to the central railway station in Town (Kokernot, 1984). Three main radial rail lines extend outward: the Mitchells Plain Line, the Strand Line, and the Stellenbosch Line. The Strand and Stellenbosch Lines merge at Bellville Junction. Along these rail lines, there are stations that also function as interchanges, where bus terminals, parking facilities, and taxi ranks are located (Kokernot, 1984). Additionally, there is a planned Atlantis rail line that is currently in the development phase and not yet operational. This line will serve as the sixth link of the radial lines (Kokernot, 1984).

2.4 The impact of COVID-19 in community mobility

On March 11, 2020, the global outbreak of COVID-19 led to the World Health Organization declaring it a pandemic. This unprecedented crisis has had a significant impact on public transportation ridership and service provision worldwide (Gkiotsalitis & Cats, 2021). As countries strive to return to normalcy, new requirements for public transport planning have emerged in response to the pandemic. These measures have resulted in a substantial reduction in service capacity compared to the pre-COVID-19 period. Various sectors, including schools, shops, workplaces, and public transportation, have been subject to social distancing measures due to the increasing number of cases. Gkiotsalitis & Cats (2021) have highlighted that the operations of public transport services have been greatly affected by the sharp decline in travel demand levels, alongside the implementation of regulations that impact service capacity.

As indicated by Wen, Sheng, & Sharp (2021), the implementation of lockdown measures resulted in a significant reduction in mobility, ranging from 69% to 89% compared to baseline levels. During this period, businesses, except for essential services, were closed, and a considerable number of individuals adopted work-from-home arrangements. By analysing geolocation data from Google, Figure 7 demonstrates the percentage change in mobility related to retail and recreation, workplaces, and public transportation interchanges. The different alert levels implemented had a profound impact on people's mobility patterns and the functioning of businesses.

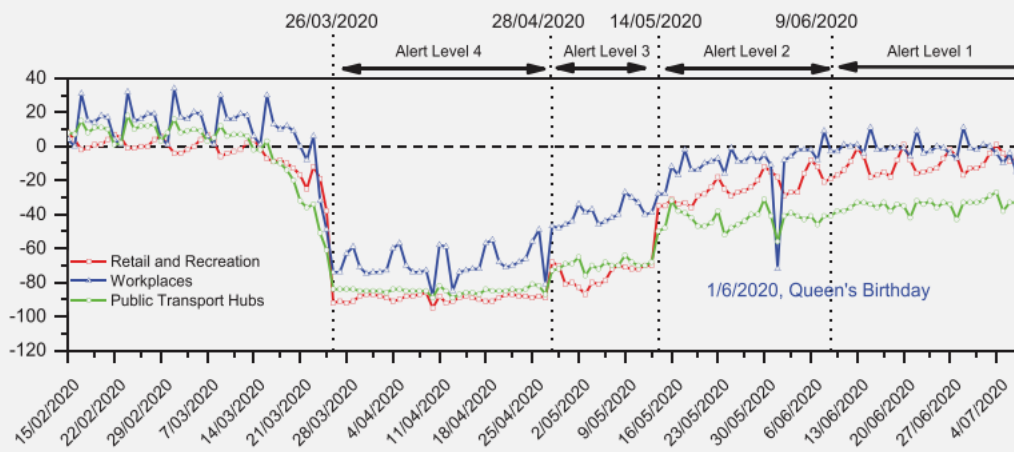


Figure 7: Percentage change in mobility (Wen, Sheng, & Sharp, 2021)

The blue line in the graph represents a significant decrease in mobility for workplaces. During Alert Level 3, although businesses were allowed to operate with strict restrictions, people were encouraged to work from home whenever possible. As a result, mobility to workplaces increased but remained 40% lower than the baseline. With the relaxation of rules, travel to workplaces increased, and there was only a 2% reduction in travel due to Work From Home (WFH).

Similarly, the red line illustrates the impact on locations such as restaurants, cafes, shopping centres, theme parks, museums, libraries, and cinemas. During Alert Level 4, there was an 89% decline in travel to these places. This decline decreased to 75% during Alert Level 3, 25% during Alert Level 2, and 10% during Alert Level 1. This reduction in mobility can be attributed to people's concerns about the risk of infection and their avoidance of non-essential activities such as dining out or participating in public gatherings. Additionally, the closure of businesses unable to cope with the financial challenges of the pandemic may have contributed to the slower return to pre-COVID levels.

The green line in the graph represents mobility trends at public transportation interchanges, including train stations and bus stops. These locations experienced changes in mobility patterns corresponding to the different alert levels imposed during the pandemic.

2.5 Public transport quality of service attributes

Various service quality attributes have been developed and utilized worldwide in different contexts. However, there is a lack of focus on establishing a systematic approach for identifying the most suitable performance measures specifically for public transport users. The Transit Cooperative Research Program (2003) highlights that many performance measures used in transportation, particularly those collected for national public transport databases, primarily reflect the operational aspects of managing a transit agency. These measures are commonly employed by transportation engineers and planners for designing and planning roadways. The Highway Capacity Manual also acknowledges these measures, which primarily reflect the experiences of vehicles using the road rather than the experiences of passengers using public transport vehicles. The Transportation Research Board (2003) emphasizes that traditional measures of service efficiency and cost-effectiveness do not always align with customer and community concerns. They argue for the development of a process that encompasses customer-oriented and community-related issues to establish a performance measurement program. Consequently, this study aims to uncover respondents' perceptions and preferences regarding public transport modes based on various quality attributes.

2.5.1 Accessibility and Easy to use

Accessibility is commonly assessed by considering journey time, cost, or a combination of both, often referred to as generalized cost. When evaluating accessibility to a shopping mall or centre, one can measure the time required to reach the destination or the associated transportation expenses. Ha, Ibrahim, Lo, and Mah (2019) argue that accessibility is a crucial factor influencing people's willingness to use public transport and revisit specific destinations. A key determinant of accessibility is the distance and time required to access public transportation from one's residence. The amount of time spent walking to the bus stop significantly affects the level of accessibility to public transport (Eboli & Mazzulla, n.d.). Apart from the transportation network's structure, accessibility is also influenced by land use patterns, available transportation modes, and the characteristics of the surrounding area (Meyer, 2016). It defines the extent to which the transportation system is acceptable and contributes to the value of associated activities such as businesses, employment opportunities, recreation, and overall quality of life. To be deemed accessible, transport services and infrastructure must be easily accessible.

Ha, Ibrahim, Lo, and Mah (2019) acknowledge that access plays a significant role in determining train usage rates. From an academic perspective, access to public transportation is considered a vital measure of customer satisfaction when evaluating public transport systems (Eboli and Mazzulla, 2011; Aydin, Celik, & Gumus, 2015). Several studies have provided empirical evidence demonstrating the positive relationship between accessibility, satisfaction, and loyalty in the context of public transport (Ha, Ibrahim, Lo, & Mah, 2019).

2.5.2 Station proximity and service availability

By proximity, it is meant that public transport stations are easily accessible. Besides proximity to shopping centres and town centres, proximity to public transportation systems can also influence transport decisions (Whittle et al., 2019). The most ideal location for a public facility is along an arterial or freeway intersection since downtown locations are undesirable due to excessive traffic congestion and parking costs (Litman, 2011).

Using public transportation is dependent on the availability of a service, according to the Institute of Transportation Engineers (2009). It measures how easy it is for passengers to use public transport for various trips. As passenger mode choice is determined by service availability, public transport can only be used if a service is available (Meyer, 2016). Availability is determined by how close a public transport stop or station is to the user's origin and destination. Commuters' willingness to use a public transport service is affected by the distance from the service, as well as the mode of access, type of service, and surrounding conditions (Institute of Transportation Engineers, 2009; Meyer, 2016). In situations whereby access and egress of a trip is considered to be unsafe or inconvenient, potential users may avoid using that particular service, so it is crucial to consider the "first or last mile" portion of a trip for safety and effectiveness, as this can play a critical role in attracting and retaining transit riders. Availability attributes includes readiness of public transport (bus, train or minibus taxi) route, number of bus stops, location of the bus stops and distance between bus stops (Eboli & Mazzulla, N.D.). Walking distance and time to access public transport from home is a key indicator of availability. The time spent walking in order to reach the bus stop, defines the level of accessibility to public transport & Mazzulla, N.D.).

2.5.3 Comfort and Convenience

Factors such as crowding, cleanliness, ventilation, and vehicle condition are commonly used to represent on-board comfort in public transport (Hansson et al., 2019). The quality of on-board facilities significantly influences passengers' perception of service quality. According to the Institute of Transportation Engineers (2009) and Meyer (2017), comfort in a transportation system is primarily influenced by factors such as seat availability or crowding level, temperature, cleanliness, and vehicle movement characteristics. Consideration should also be given to aspects such as vehicle design, riding comfort, and overall image, as they contribute to passengers' comfort and attraction. Additionally, comfort and convenience are influenced by factors such as ease of boarding and alighting, the ability to transfer between lines, information systems, and the handling of luggage (Hansson et al., 2019).

When evaluating public transportation, users often compare the comfort and convenience of different modes. This includes assessing the walking distance to public transport facilities. Convenience encompasses the proximity of stations and the ease of reaching them from point A to point B. Other important factors to consider include reliability of the service, waiting time for the mode of transport, security concerns, trip comfort, cost, number of transfers required, and overall travel time.

The level of comfort in public transport is generally measured against globally accepted standards (Ha et al., 2019). Passenger comfort can be evaluated based on the usability of facilities, comfort for riders, and the surrounding environment. Previous studies have shown a strong correlation between passenger comfort, perceived satisfaction, and loyalty (Ha et al., 2019). Furthermore, crowding within the vehicle is a significant factor affecting the overall comfort and safety of public transport passengers. Negir, Erkan, and Taskin (2015) argue that passengers assess their comfort during the journey based on factors such as interior hygiene, noise levels, vibrations, as well as temperature and humidity within the public transportation mode.

2.5.4 Affordability /Fares/Ticket Price

Ticket pricing refers to the structure and cost of various ticket types and passes available for public transportation (Tyrinopoulos & Antoniou, 2008). Cost is also discussed as a policy attribute in other literature (Hansson et al., 2019). The affordability of public transportation is determined by assessing the price in relation to the financial resources of potential

users. According to Piek (2017), affordability plays a crucial role in determining who can access specific transport services. Gao, Yu, and Liang (2016) found that fare value significantly influences public transportation usage, and dissatisfaction with fare value can lead to a decline in ridership. Key features related to pricing may include the cost of a single ride, transfer fees, discounts for seniors and children, monthly discounts, as well as parking fees at park-n-ride facilities or other designated parking areas (Aydin, Celik, & Gumus, 2015).

According to a study by Eboli & Mazzulla (2011), the cost of a product is a crucial factor that not only includes the price but also takes into account the psychological factors that influence consumers' purchasing decisions. Aydin et al. (2015), who found that cost plays a significant role in predicting passenger satisfaction and behaviour, support this viewpoint. The cost of public transportation, often referred to as user cost or fare, is the actual expense incurred by passengers during their trips, distinguishing it from other modes of transportation (Meyer, 2016). It directly impacts passenger satisfaction with the transportation system and influences their decision to utilize it. Empirical evidence supports this claim, as Aydin et al. (2015) discovered that passenger satisfaction and behaviour are indeed influenced by the cost factor. Ultimately, the cost of public transportation affects citizens' accessibility and can have implications for urban development.

2.5.5 Direct Service

When planning a transportation network, it is important to consider the movement patterns of various modes of transport, including pedestrians (CSIR, 2005). Public transportation systems that offer direct service aim to transport passengers along a main route from point A to point B. This approach requires buses and minibuses to cater to passengers' needs and provide an appealing and convenient alternative to driving. Therefore, it is crucial to design routes that allow these vehicles to travel directly through neighbourhood centres, ensuring that passengers can board and alight as close as possible to their desired starting and ending points. Passengers generally prefer avoiding transfers and favour being picked up and dropped off as close as feasible to their origin and destination points, as research by the CITP (2022) indicates. Considering these factors when designing a transport network ensures enhanced convenience and satisfaction for public transport users.

2.5.6 Public Transport Information

Passenger information at stations pertains to the departure details of trains or public transport services. The evaluation of this information by passengers is based on two key criteria: announcements and bulletin boards (Nathanail, 2008). In order to plan and undertake journeys using public transportation, whether under normal or abnormal conditions, it is crucial to have access to relevant information about the modes of transport (Hansson et al., 2019). The availability of comprehensive public transportation information significantly influences the utilization and overall quality of the public transportation system (Eboli & Mazzulla, N.D.). Public transport users highly value being informed about various aspects such as how to utilize the system, how to access it, where to disembark in their area, if any transfers are required, and the departure and arrival times of the services (Eboli & Mazzulla, N.D.). As highlighted by the Transportation Research Board (2003), commuters are less likely to utilize public transportation if they are not adequately provided with this essential information.

According to Palmer et al. (2011), there are several crucial pieces of information that should be easily accessible both before and during travel. These include fare information, route maps, timetables, and arrival times. The availability of such information from various sources like mobile phones, the Internet, and telephone inquiry systems can greatly facilitate users in navigating their journeys, especially when multiple transfers are involved. It has been observed that passengers are less likely to search for information if it is difficult to find (Palmer et al., 2011). Therefore, it is important to ensure that passengers can quickly obtain the information they need while on their journey. In this regard, effective branding can play a significant role in guiding passengers to the relevant sources of information and helping them continue their journey smoothly.

Providing passengers with information throughout their journey is crucial in ensuring a smooth and efficient public transportation experience (Eboli & Mazzulla, N.D.). Pre-trip information plays a vital role in helping commuters plan their routes and connections. This includes details such as fares, departure times, nearest bus stops, trip duration, and routes that reach the desired destination and transfer points. However, it is equally important to have access to information while on-board or within the public transportation system. This type of information helps passengers identify the correct bus to board at the starting point, locate transfer points and bus stops for transfers and disembarking. It can also include instructions on how to transfer to another route at transfer points, information on

cost, time constraints, and restrictions, the location of the final destination in relation to the bus stop, and return trip information at the destination (Eboli & Mazzulla, N.D.). By providing comprehensive information at each stage of the journey, passengers can make informed decisions and navigate the public transportation system more effectively. Passengers' perceptions of operational services are strongly influenced by the effectiveness of public transportation information systems (Bachok, et al., 2011). The availability of various types of information plays a crucial role in assisting users in making informed decisions throughout their journey. This information can be obtained from pre-trip sources, as well as at stops and terminals. On-board information systems and updates about the progress of the trip or any upcoming transfers also contribute to the passengers' overall experience. According to Bachok et al. (2011), providing a comprehensive pre-trip information package enables potential travellers to understand the available choices for their specific journey, thereby empowering them to make better decisions. Furthermore, access to information facilitates the smooth execution and completion of the entire journey.

2.5.7 Reliability

According to Hansson et al. (2019), the likelihood of choosing public transport decreases when there is a higher chance of service delays. Reliability in public transportation refers to the ability of vehicles to arrive and depart according to the scheduled timetable (Van Lierop, Badami, & El-Geneidy, 2018). Extensive research has been conducted on the importance of reliability as a key feature of public transport (Eboli & Mazzulla, N.D.; Ha, Ibrahim, Lo, & Mah, 2019). Loyola, Shiffan, Aviram, & Monterde-i-Bort (2019) note that reliability has been studied for the past three decades. Ha, Ibrahim, Lo, & Mah (2019) define reliability as consistent punctuality and adherence to schedules. A public transportation system that follows the schedule or maintains regular intervals and predictable travel times is considered reliable (Turnquist & Blume, 1980 cited in Eboli & Mazzulla, N.D.). According to other scholars, reliability is often associated with schedule adherence, and if there is a lack of control over vehicle arrival, the service is perceived as unreliable (Eboli & Mazzulla, N.D.). This unreliability results in additional travel and waiting time for passengers, potentially leading to customer loss for service providers who do not address the issue. To enhance customer satisfaction and loyalty, services must be reliable, as it significantly influences customers' intention to use them. Loyola et al. (2019)

agree with this notion, emphasizing that reliability is an important factor when individuals make decisions about their mode of transportation. Consumers consider a public transportation service reliable when it meets their expectations regarding arrival times (Loyola et al., 2019)

2.5.8 Vehicle Cleanliness

As stated by Pavlina (2015), a clean vehicle refers to one that has a well-maintained exterior and a clean interior. The cleanliness of a vehicle can be assessed from various aspects, including the condition of seats, handles, windows, doors, and floors (Tyrinopoulos & Antoniou, 2008).

To evaluate the cleanliness of a vehicle, it is important to consider both its interior and exterior condition, including the cleanliness of seats, windows, and the absence of graffiti. The TCRP Synthesis 12 (Transportation Research Board, 1995b) provides specific recommendations for cleaning activities that transit agencies can undertake. These include tasks such as exterior cleaning, interior cleaning, detailed cleaning, as well as graffiti removal and prevention measures.

2.5.9 Safety

According to Nathanail (2007), safety during a trip is defined as the number of passenger fatalities for which the operator is responsible. Safety encompasses both protection from accidents and a sense of personal security against crime (Hansson, Pettersson, Svensson, & Wretstrand, 2019). It is important to distinguish between safety, which refers to the likelihood of being involved in an accident, and security, which pertains to the likelihood of becoming a victim of crime while using public transport (Transportation Research Board, 2003; Roux, 2013).

Safety considerations encompass objective factors related to the consequences of accidents, such as incidents involving vehicles or individuals, such as slips or trips when boarding or alighting from a vehicle, or at intersections and pedestrian areas (Beecroft & Pangbourne, 2015). Aydin, Celik, and Gumus (2015) emphasize that the safety of the system comprises two aspects: safety at subway stations and safety inside the public transportation system. The feeling of safety is associated with protection and a sense of refuge against traffic incidents and attacks while waiting at railway stations or using

public transportation. In simple terms, safety measures the likelihood of passengers being involved in an accident (Joewone & Kubota, 2006).

2.5.10 Security

Security focuses on objective issues surrounding crime and antisocial behaviour. According to Beecroft & Pangbourne (2015), negative experiences and perceptions of public transport can influence travel behaviour. When public transport travel behaviour is impacted, this will affect the modal split, knock-on congestion, and pollution from the dominance of private vehicles. Beecroft & Pangbourne (2015) believe that technological innovations are crucial to supporting excellent personal safety when taking public transportation. The support involves facilitating individual travel options, providing safe and reliable operation of transportation systems, and providing personal support via cell phones. For example, transportation technologies with general applications may include personal security features or support trust in some way, such as travel planning services, that address security issues specifically. For technological solutions to be sustainable and gain public acceptance, they must consider users' needs and perceptions.

According to Beecroft and Pangbourne, 2015, personal safety in public transportation systems must be a mix of security, safety, and confidence. "Confidence" refers to not feeling uncomfortable, such as a smooth ride and no fear of getting lost, of getting into an accident, or of being threatened. Figure 8 illustrates the concept of personal security in relation to travel. There are three distinct aspects to this, and how they overlap and interact.

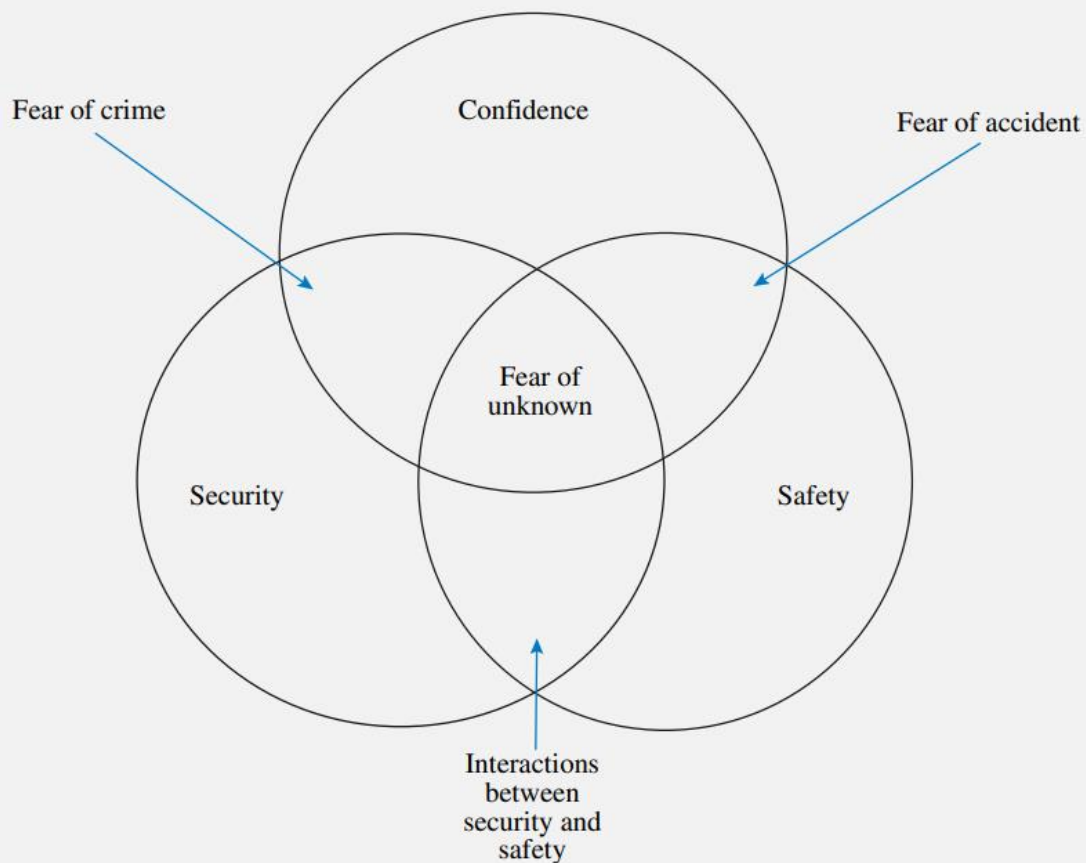


Figure 8: A conceptual framework for personal security (Beecroft and Pangbourne, 2015)

Security and self-confidence are interconnected, as cognitive discomfort can arise from the presence of crime and antisocial behaviour in traffic and public environments, ultimately affecting an individual's confidence (Beecroft and Pangbourne, 2015). According to the authors, measuring confidence requires considering a combination of objective factors, such as knowledge and experience related to undertaking a physical activity journey, as well as subjective factors, such as an individual's capability and self-belief. These factors are intertwined, as compromised security and safety due to crime and antisocial behaviour can have consequences that harm health and safety, such as accidents resulting from vandalism.

2.5.11 Flexibility to travel

The term "flexible public transport" is used to describe services that incorporate elements of both fixed-route and demand-responsive models (Bakas, Drakoulis, Floudas, Lytrivis, & Amditis, 2016). Such a system, characterized by flexibility and responsiveness to user demands, has been identified as a promising solution in the literature. Well-designed public transportation services play a crucial role in ensuring sustainable and

environmentally friendly mobility for users (Bakas, Drakoulis, Floudas, Lytrivis, & Amditis, 2016). In areas with low demand and sparse population, more dynamic approaches are necessary, making flexible and reorganized public transportation services vital. Velaga, Nelson, Wright, and Farrington (2012) emphasize that a well-designed flexible transport system allows users to have greater control over their route, time, mode of transport, service provider, and payment system, ultimately offering a more user-centric, comfortable, and cost-effective transport experience. Various solutions, such as shared taxis, shuttles, dial-a-ride services, minibus taxis, lift shares, and carpooling, have been implemented to address accessibility gaps. In many areas, fixed-route public transport may not offer the desired level of flexibility due to financial and carbon efficiency constraints (Velaga et al., 2012).

2.5.12 Service Frequency

Service frequency refers to how often public transport lines operate within a transportation system. Implementing an effective public transport dispatching system is crucial for improving service quality and system efficiency (Gkiotsalitis & Cats, 2021). By reducing waiting times, service frequency plays a significant role. It is determined by the number of departures per time period and the duration between departures, also known as vehicle headways (Meyer, 2016). Balancing these factors is important as excessively short intervals can lead to wasted resources and capacity, while excessively long intervals may result in passengers waiting longer than acceptable. Thus, departure intervals should be set based on passenger demand, aiming to enhance both the quality of service and the economic benefits for the service provider (Luhuaa, Yin, & Xinkaic, 2011).

By reducing waiting times and minimizing car usage, increased service frequency brings notable benefits to public transport users (Nielsen, ND).

2.5.13 Travel Time

Travel time refers to the duration it takes to complete a trip, taking into account factors such as adherence to schedules, punctuality, and regularity (Hansson et al., 2019). It encompasses various elements in public transportation, as defined by the Transportation Research Board (2003), including running time (time spent in motion), delays caused by

traffic control devices and congestion, and dwell times at stops, which can contribute to significant delays in congested systems.

In the perception of passengers, a longer journey by public transport, compared to using a private vehicle, is often seen as less convenient (Transportation Research Board, 2003). People value their time during commute more than monetary costs, emphasizing the importance of travel time for public transport users (Perone et al., 2005). According to Li (2003), the perceived travel time on public transport tends to be the shortest. Transfer times, which involve waiting and transit vehicle travel times, fall between the wait times and the actual travel times.

Trip time encompasses the entire duration of a journey, including travel time from one's origin to a public transport stop, waiting time, time spent on board, and travel time from a public transport stop to one's destination. It also accounts for any additional time required for transferring between routes during the trip (Transportation Research Board, 2003). Wait time on transit is particularly significant in terms of personal safety, as individuals may feel more vulnerable to crime during this period (Perone et al., 2005).

2.5.14 Transfers

Service transfers refer to the instances when passengers need to change from one vehicle to another during a single trip. Transfers can occur internally within a metro system or externally between buses and metros, among other types (Wang et al., 2020). Internal transfers within metro lines are often considered as a single trip segment, where commuters only need to swipe their cards upon entering and exiting a metro station, without the need for additional swipes when transferring between lines.

The perception of transfers among public transport users can be influenced by various socio-demographic and trip-related factors. Studies have shown that age, gender, income, health status, familiarity with public transportation, and personal preferences play a role in how individuals perceive transfers (Iseki & Smart, 2012; Cascajo et al., 2019). Some factors may be influenced by an individual's beliefs and controllability, while others may be influenced by the frequency of public transport usage, trip purpose, modes of transportation, and specific circumstances such as carrying luggage or being pressed for time (Cascajo et al., 2019). These factors collectively impact the passenger's experience and attitudes towards transfers during their public transport journey.

The inclusion of transfers in public transportation trips adds complexity and can act as a barrier for commuters, affecting overall demand for the service (Transportation Research Board, 2003). Transfer time is determined by the duration of walking from the departure point to the boarding stop, as well as the time spent transferring between lines and waiting for the next connection (Olivková, 2016). The efficiency of transfers is influenced by factors such as punctuality, adherence to schedules, interruptions in transportation, and consistency.

Transfers refer to the number of times passengers need to change modes during a trip. Each transfer increases the total travel time and inconveniences passengers, although timed transfers can help minimize delays (Transportation Research Board, 2003). The need for transfers in completing a journey diminishes the quality of the trip. While efforts should be made to minimize this drawback across different transport modes through effective timing and coordination, complete elimination of transfers is not always feasible (Olivková, 2016).

On the other hand, transfers can also offer benefits to passengers, such as time savings, improved service frequency, or access to additional advantages through a new route. However, transfers also increase the risk of missed connections, resulting in longer travel times for passengers (Transportation Research Board, 2003).

3. Research Design and Methodology

In the subsequent chapter, the methodologies and datasets employed in this project are expounded upon to fulfil the intended research goals. The primary aim of the study is to examine the presence of the user quality pyramid by gathering and analysing empirical data on public transport modes in Cape Town. To accomplish this objective, the data collection approach, infrastructure prerequisites, equipment, and the analysis of the collected data are thoroughly outlined and discussed. The methodology encompasses a combination of qualitative and quantitative approaches.

3.1 Research Methodology

As indicated earlier in the document recent studies on public transport customers have used SERVQUAL method to measure satisfaction and dissatisfaction levels on public transport modes. IPA measurements and the SERVQUAL model are quite similar (Grujičić et al.,2013). This method does not discriminate against items and therefore no trade-offs. This section of the chapter presents and proposes a new method of soliciting user quality preferences and perceptions on public transport across modes. Figure is a process flow chart depicting the research methodology employed in the current study.

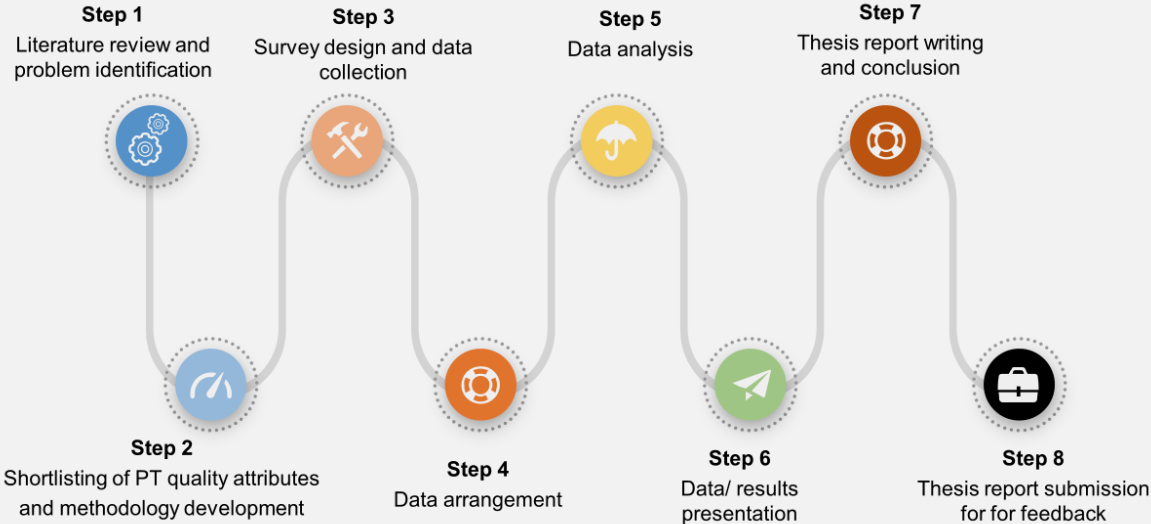


Figure 9: Research methodology

3.1.1 The Best Worst Scaling (BWS) Approach

Best-worst scaling (BWS) has gained popularity as a method to assess human preferences across various disciplines. In the realm of marketing, practitioners utilize BWS, also known as maximum difference scaling (MaxDiff), to measure preferences (Finn and Louviere, 1992; Louviere et al., 2013). Over time, the MaxDiff method has evolved and taken on different variations in various studies, deviating from its classical approach. In light of this, the original authors of MaxDiff have proposed the use of BWS as a more encompassing term for these methods, as it is widely recognized across academic research fields (Louviere et al., 2013). While MaxDiff continues to be extensively employed in market research, the authors themselves have now suggested BWS as a viable alternative (Louviere et al., 2015). Following these recommendations, our study employs the term BWS to describe the methodological approach utilized.

Research conducted by Hensher (2014) has demonstrated that the best-worst scaling (BWS) method offers a more efficient and comprehensive approach to eliciting discrete choices compared to other methods. This allows us to identify the key factors that significantly influence individuals' perceptions of public transportation and narrow down those factors. BWS combines paired comparison with multiple choices, prompting participants to select both the most and least attractive options (Münnich, Karsai, & Nagy, 2022). It has gained popularity as a tool for studying and modelling choice among academics, business practitioners, and professionals from various fields (Louviere, Flynn, & Marley, 2015). By employing BWS, it is possible to circumvent common rating scale problems and provide a well-understood and easily applicable measurement for assessing subjective quantities. This method is employed to capture the best and worst cases from a set of alternatives, such as brands, products, or services (Münnich, Karsai, & Nagy, 2022). By varying the choices presented to respondents and repeating the questions at different points in the survey, we can discern their preferences.

In practical terms, there are three main types of BWS: the object case (case 1), the profile case (case 2), and the multi-profile case (case 3). Each case involves asking respondents to express their preferences by selecting the best and worst options from a list of alternatives, with varying complexities in the alternatives presented (Louviere, Flynn, & Marley, 2015).

Among the three cases, Case 1 is referred to as the object case and is considered the most straightforward. This particular method is widely adopted due to its simplicity, making it easily applicable in various research contexts (Teffo, Earl, & Zuidgeest, 2019). On the other hand, Case 3 involves bundling attributes into a product or service and evaluating it as a whole. This approach explicitly outlines the trade-offs that individuals must consider during the decision-making process and presents them in a relevant context. As a result, the outcomes derived from Case 3 are anticipated to be more reliable and realistic compared to traditional rating scales (Adamsen et al., 2013). In the subsequent sections, we will provide a brief discussion of these different cases.

1) Object case (Case 1)

Researchers who aim to investigate the values associated with a list of objects (Flynn & Marley, 2014) commonly employ the object case, also known as Case 1. Its primary purpose is to determine the relative importance of attributes within the given context (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016). In this case, respondents are presented with a set of objects and asked to select the best and worst options (Louviere, Lings, Islam, Gudergan, & Flynn, 2013). These objects can encompass brand names, public policy goals, or any set of objects that can be meaningfully compared. To obtain the best and worst data, the researcher compiles a choice set and presents it to the respondents. The choice sets function similarly to traditional discrete choice experiments (DCEs), and statistical designs are incorporated with certain assumptions to enable inferences about the value associated with the broader list of objects (Flynn & Marley, 2014). Initially, this case was introduced as an alternative to conventional measurement methods like ratings and Likert scales (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016).

2) Profile case (Case 2)

The profile case involves individuals evaluating multiple profiles of objects, which are defined by combinations of attributes in a designed framework (Louviere, Lings, Islam, Gudergan, & Flynn, 2013). In this case, respondents are presented with a single profile in each choice set, and their task is not to assess the value of the entire profile but to consider the attribute levels that describe it, then select the best and worst options (Flynn & Marley, 2014). The profiles are displayed one at a time, and respondents choose the most and least preferred attribute levels within each profile (Louviere, Lings, Islam, Gudergan, & Flynn, 2013). This case is commonly used in healthcare services. Unlike the object case (Case 1), where the attributes are shown separately, in the profile case, the

attributes appear consistently across different scenarios, but the levels of those attributes vary (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016). In this case, respondents explicitly evaluate attribute levels, which makes the choices more transparent and informative. Therefore, the profiles in this variant of BWS need to be properly combined with one or more additional profiles to yield meaningful insights (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016)

3) Multi-profile case (Case 3)

Case 3, also known as the multi-profile case, differs from both Case 1 and Case 2 in that respondents are repeatedly presented with choices between alternatives that include all the attributes, with varying levels, in a sequence of choice sets (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016). In this case, participants are required to select the best profile as well as the worst profile from a given choice set. The data obtained from worst choices are valuable in various marketing applications, as they aid in better parameter estimation and help identify attribute levels that are deemed unacceptable (Flynn & Marley, 2014). Case 3 involves individuals choosing the best and worst profiles from multiple choice sets within a designed framework (Louviere, Lings, Islam, Gudergan, & Flynn, 2013).

In all three cases, the participants are asked to select the best and worst alternatives from a set of attributes, rather than simply identifying the best alternative (Mühlbacher, Kaczynski, Zweifel, & Johnson, 2016).

The best-worst scaling (BWS) method requires participants to make choices between two extremes, the best and worst, based on their own judgment. Unlike rating scales, BWS creates distinct rankings among choices, eliminating the issue of varying degrees of emphasis. Additionally, BWS is easier for respondents to complete compared to choice experiments (Münnich et al., 2022).

In our study, the survey was designed to ensure that respondents could not select the same item as both the "most important" and the "least important." The choice sets were created using the balanced incomplete block design (BIBD), which ensures that each item appears in an equal number of combinations and occurs the same number of times, regardless of the presence of other items in the choice set (Münnich, Karsai, & Nagy, 2022).

3.1.2 The Strengths of Best Worst Scaling Method

The BWS method offers several advantages and is applicable to a wide range of problems and contexts (L. Peay, Hollin, & F.P. Bridges, 2014). By asking participants to choose between the extremes and determine the best and worst options, BWS creates differentiation in ratings, eliminating the issue of varying degrees of emphasis encountered in rating scales when making valuations (Münnich, Karsai, & Nagy, 2022). Furthermore, BWS is easier to complete and imposes less burden on respondents compared to choice experiments.

In their 2014 paper, Finn and Louviere argue that BWS is a superior alternative to rating scales for several reasons. Firstly, rating scales fail to elicit differentiation between items, making it challenging to establish their relative importance when multiple items are equally significant. Secondly, the interpretation of rating scale values is difficult. Finally, rating scales often exhibit issues related to reliability and validity.

Muhlbacher et al. (2016) further emphasize that BWS addresses the limitations commonly associated with evaluation and ranking scales by allowing respondents to select both the best and worst attributes, thereby generating additional information. This approach values items within a random utility framework (Flynn & Marley, 2014). By comparing the importance of two items through choice frequencies, the BWS method enables predictions regarding the likelihood of one item being chosen over another. Consequently, this approach achieves real-life significance by circumventing the problems typically associated with rating scales, such as determining how a rating of 6 out of 10 translates into real-life decision-making (Flynn & Marley, 2014).

3.2 The development of the research questionnaire

The utilization of the BWS method in transportation studies is relatively recent. Consequently, a new research questionnaire was developed to gather data and validate the existence of the transportation hierarchy of needs. This development process involved identifying both quantitative and qualitative attributes of public transport services from existing literature. Quantitative attributes include factors such as travel time and fare, while qualitative features encompass safety, cleanliness, and ease of transfers (Sinha et al., 2019).

Furthermore, a feature list was created based on Maslow's Hierarchy of Needs, adapted specifically for different modes of transportation. For instance, when defining each level of the hierarchy of transport needs according to Maslow's model, the first level would encompass survival and physical needs. For individuals commuting by public transport, concerns may arise regarding access to food and water during their journeys. The second level, focusing on safety and security, would pertain to the need for a sense of safety while traveling and in transit. The third level, social belonging, would relate to the presence or absence of peers during travel and public transportation. The fourth dimension, self-esteem, would encompass feelings of personal status, prestige, intelligence, and inner strength. In the context of public transportation, a young person who doesn't have a driver's license but possesses self-esteem, strength, intelligence, and independence, which may be more significant for them compared to an older individual who is unable to drive, could exemplify this. Finally, the highest level of Maslow's hierarchy, self-actualization, can be viewed positively and self-fulfilling when using public transport as a means to contribute to environmental preservation, reduce congestion, and fulfil a higher altruistic purpose.

However, Maslow's hierarchy of needs suggests that physiological needs take precedence over safety needs. However, research by Alderfer challenges this assumption. Therefore, this study aims to address this discrepancy by incorporating elements from Alderfer's studies (1972, 1985), which operationalized the ERG hierarchy and served as a model for the current research. By adapting Alderfer's methodology and conducting tests, it was discovered that his studies provided a more streamlined approach than Maslow's hierarchy while addressing its limitations (Perone et al., 2005). Based on Alderfer's research, it was concluded that the ERG theory should be applied, regardless of the specific methodology chosen, to examine the existence of a transportation needs hierarchy.

During the development of the questionnaire, attributes within the Existence, Relatedness, and Growth categories underwent a selection process to identify the most significant and relevant ones. One criterion for selecting the final list of attributes (top fourteen) was to ensure standardization across all public transport modes, enabling users to choose each attribute regardless of their mode of transportation. For example, driver behaviour may not be applicable to all three modes of transport. While it may be a concern for minibuses and buses, train users may not have direct interaction with drivers. Therefore, mode-specific attributes were eliminated from the list.

Another criterion was to ensure diversity among the attributes, covering various aspects of quality, including both physical features and perceived qualities. Attributes that were closely related or prone to confusion were excluded. For instance, if there were multiple attributes related to performance or aesthetics, such as travel time, travel speed, and punctuality, the list was streamlined to include the most applicable attribute for all modes. Punctuality, for example, was removed from the list as not all public transport modes adhere to strict schedules or timetables. The concept of "punctuality" would be difficult to define in the context of minibus taxis, making it unsuitable for inclusion in the final list.

The ultimate goal was to include attributes that could be selected with equal frequency by users from any area. Each attribute should have an equal chance of being chosen as the best or worst attribute. Punctuality, in this case, would not be a universal attribute for all three modes since some modes operate on schedules while others do not. The subsequent section will discuss how the pilot testing of the initial survey significantly influenced the final configuration of the questionnaire.

3.2.1 Pilot testing

Following the design of the survey and questionnaire, a pilot study was conducted to test the proposed method and procedures on a small scale. The researcher applied the same principles, techniques, and methods as in the main survey. The questionnaire was administered to 10 current public transport users to assess its usefulness and identify any issues that needed to be addressed before conducting the main survey. The results of the pilot study were thoroughly examined, seeking patterns or trends that could inform the final survey.

Based on the analysis of the pilot study results, the researcher identified several areas where the questionnaire could be improved. This included making certain questions more specific and adding additional response options. These enhancements were incorporated into the final questionnaire, which underwent testing on a larger sample size to ensure the revised questions effectively elicited the desired information. Moreover, the researcher conducted a follow-up study to evaluate the impact of the revised questionnaire on the quality of the collected data.

Overall, the pilot study played a crucial role in refining the survey methodology and ensuring the accuracy and reliability of the final results. It allowed for the identification

and rectification of any shortcomings or ambiguities in the questionnaire, leading to an improved research instrument for the main survey.

3.3 Data Collection

The aim of this study is to assess the quality preferences of public transport modes in Cape Town using empirical data. The study specifically targeted selected public transport interchanges or facilities during the morning and evening peak hours. These interchanges are characterized by extensive queues of passengers commuting to different destinations, primarily for work and school purposes. To gather the necessary data, a survey team consisting of three individuals was deployed at each transportation interchange. For a more comprehensive understanding of the process, please refer to Appendix E, which offers a detailed description.

3.3.1 Major Survey

The study sites in Cape Town CBD, Bellville CBD, Mitchells Plain, and Khayelitsha were chosen because of their size in terms of passenger volumes and their location along major trunk routes. The major survey was conducted over four days, from Monday to Thursday during the week of February 15th through 18th, 2021. The survey was conducted during the AM peak and PM peak periods each day, on working days and during school periods. We selected these times because peak commuters of various public transport modes are often found at these times and may demonstrate critical preferences and perceptions about the modes used. Interviews were conducted at various public transport sites or facilities in Cape Town. The data collection sites are depicted in Figure 10, and we selected the survey areas with the objective of collecting samples from diverse socioeconomic backgrounds and from geographically dispersed areas in the City of Cape Town Metropolitan Municipality.



Figure 10: Data collection sites

Users from each site were asked to rate public transport quality attributes by choosing the best and worst case from a list of statements that applied to public transportation in general or a specific mode in Cape Town. This method, called the best worst scaling method, was used to determine the role of each statement as a barrier against or in support of public transport. This approach allowed researchers to identify the most significant factors that influence an individual's perception of public transportation. The research questionnaire had two parts, with 20 questions in total. Part A had 5 profiling questions about demographic information and the public transport mode being used. Part B contained 14 public transport quality attributes questions; see Appendix D for details. Once participants completed Part A, they proceeded to the BWS task, where they were presented with a list of five items out of 14 attributes at a time and asked to discriminate the best and worst case. **Table 1** shows an example of what users were exposed to during the survey process. Respondents were also given the opportunity to provide additional comments regarding public transport mode quality attributes in case the researcher missed important questions or omitted anything.

Table 1: Example of case 1 BWS

Please rank what you consider as the most and least important attribute to you when choosing a public transport mode.		
Best/Important (valued)	Attribute	Worst/Not Important(Valued)
x	Affordability/ Ticket price	
	Station proximity	
	Service frequency	
	Travel time	x
	Cleanliness	

The research questionnaire was carefully crafted to primarily include closed-ended questions, with a few open-ended questions incorporated. Closed-ended questions prompt users to select an answer from a provided list of options, while open-ended questions allow respondents to freely provide their answers without any restrictions. The inclusion of open-ended questions aimed to capture any additional information that may have been missed and could be valuable for future studies or recommendations. The closed-ended questions facilitate easy quantification and analysis of the data (Mackey & Gass, 2016). Furthermore, open-ended questions provide respondents with the flexibility to answer in a manner they find suitable, with the response recorded as a summary note (Daniels & Minot, 2020). The questionnaire was designed to be easily readable and completed within a short period, typically less than 10 minutes, while users were waiting for their transportation mode to arrive or depart. The questionnaire was standardized across all three modes of transport, ensuring that users were exposed to the same attributes regardless of whether they used a bus, taxi, or train for their daily commuting. The survey targeted daily commuters who regularly utilized minibuses, buses, and trains.

3.3.2 Equipment

The data collection process involved the use of the following equipment and resources:

- 3 survey staff members
- 4 public transport interchanges/facilities
- 3 clipboards

-
- 6 pens
 - 6 cloth masks
 - 3 bottles of 500ml sanitizer (with 70% alcohol content)
 - 300 survey questionnaires specifically designed for this research
 - 3 safety vests for the surveying staff
 - A vehicle to transport the surveyors to and from the sites
 - 1 computer with 2 monitor screens and a laptop with 8GB RAM (lower RAM capacity was also acceptable due to availability) for data analysis
 - Internet connection for sourcing and communicating data, such as literature review

It is worth noting that data collection did not take place during adverse weather conditions, such as heavy rain or protest actions, as these could compromise the safety and security of the surveyors and the survey equipment. Additionally, the study required transport infrastructure, including major transport facilities and bus stops or drop-off zones, with at least one active mode of transportation such as buses, trains, and minibuses. The selected study sites needed to be safe and convenient to encourage participation.

3.4 Results analysis and presentation

Through the modelling task, we were able to identify the most important quality parameter and the least attractive aspect from the user's perspective when selecting a mode of public transportation. This modelling exercise resulted in a hierarchy of needs similar to Abraham Maslow's hierarchy of needs.

In the BWS approach, data analysis varies depending on the type of case being used, such as the profile case, object case, or multi-criteria case, as discussed by Adamsen et al. (2013). For case 1, which is the focus of this study, a straightforward calculation of the best minus worst attribute is typically applied, along with an investigation of the variance-covariance matrix to uncover consumer heterogeneity. This method has been utilized by Flynn (2010), Steven Goodman, Lockshin, and Cohen (2005), and Mueller and Rungie (2009).

On the other hand, case 3 data are analysed using multinomial logit (MNL) and a clustering method such as latent class analysis (LCA) to capture a more comprehensive preference structure. However, the MNL model has a limitation in that it does not account for consumer heterogeneity, as pointed out by Adamsen, Rundle-Thiele, and Whitty (2013).

Since case 1 analysis in the BWS approach does not reveal heterogeneity in the data, variance and standard deviation calculations can be applied to assess the consistency of choices across respondents. These calculations help determine if the data is homogeneous or not, and the standard deviations are computed based on the individual Best-Worst scores. Based on the Random Utility Theory (RUT), the arithmetic function of BWS is utilized for the analysis.

$$U_{ij} = V_{ij} + \epsilon_{ij}$$

In the BWS approach, the quality preference of an individual i in choice set j is denoted as U_{ij} . The explainable components included in the choice experiment are represented by V_{ij} . The random components, accounting for variability among individuals and random error within individuals, are represented by ϵ_{ij} , as described by Flynn et al. (2008).

The theoretical attribute value is captured in $V_{ij} = X_{ij} \beta + Z_i \gamma$, where X_{ij} is the vector of attributes of choice set j as perceived by individual i , and Z_i is the vector of individual characteristics of individual i . The coefficients of the vectors, β and γ , need to be estimated.

By including attributes with competing characteristics in choice questions, it is possible to elicit preferences without bias, as discussed by Tina Tin Wan (2013). Each best-worst pair selected by respondents represents the maximum difference between the two options on an underlying utility scale (Flynn et al., 2007). Through a series of choice questions, the difference in utility between every best-worst pair can be estimated. Individual choice models can be estimated, and discrete choice models can be combined into a typical choice model that represents the population, as outlined by Flynn et al. (2007).

3.5 Socio-economic and travel characteristics

Travelers exhibit unique travel needs and patterns influenced by factors like household composition, income level, profession, car availability, and lifestyle choices (Susilo & Cats, 2014), which affect their time and financial constraints.

Based on the Comprehensive Integrated Transport Plan (CITP, 2018), we identified the four busiest public transport interchanges and facilities in Cape Town. These locations were selected for their proximity to major routes and their role as economic hubs in the region, attracting a significant number of commuters traveling to and from Cape Town, Bellville, Khayelitsha, and Mitchells Plain during peak periods.

In this study, we examined various socioeconomic characteristics of public transport users, including age, gender, trip purpose, origin point, and preferred/recently used modes of public transportation. A survey was conducted among 300 individuals to gather their preferences and perceptions of public transport modes at the most popular and busiest transportation facilities in the study area. Out of the 300 individuals surveyed, 282 responded to the questionnaire, with an equitable distribution of 75 users per area, considering different modes of transport and social demographics. The sample size was determined using a comparative approach, considering similar studies that used sample sizes of 285 or fewer to assess public transport preferences and measure service quality (Teffo et al., 2019; Perone et al., 2005; Minser & Webb, 2010). Our findings reveal that 54% of the surveyed users travelled for work purposes, while 18% travelled for business or shopping reasons. Table 2 shows that a significant proportion of participants in the study fell within the age range of 25 to 34.

Table 2 : Aggregated public transport user profile (Field data, 2021)

Sample Characteristics for all regions		Golden Arrow bus	Minibus taxi	Train	My Citi	Total
Respondents		34%	49%	11%	6%	100%
Gender	Male	18%	22%	7%	3%	50%
	Female	16%	27%	4%	3%	50%
Age	18 - 24 year:	4%	7%	1%	0%	13%
	25 - 34 year:	12%	15%	6%	4%	37%
	35 - 44 year:	10%	17%	3%	0%	29%
	45 - 54 year:	8%	9%	1%	0%	18%
	55-64 year	0%	1%	0%	1%	2%
Trip Purpose	Work	20%	24%	7%	4%	55 %
	School	6%	4%	3%	2%	15%
	Leisure	2%	4%	0%	0%	6%
	Shopping business	4%	13%	1%	0%	18%
	Other	2%	4%	0%	0%	6%

Sample Characteristics for all regions	Golden Arrow bus	Minibus taxi	Train	My Citi	Total
Cape Town	6%	6%	6%	6%	25%
Suburban area	7%	12%	4%	0%	24%
Khayelitsha	10%	13%	0%	0%	24%
Mitchells Plain	11%	17%	0%	0%	28%

Table 3; Cape Town sample characteristics

Cape Town sample characteristics	Golden Arrow bus	Minibus taxi	Train	My Citi	Total
Respondents	18	17	18	17	70
Gender					
Male	13	10	12	8	43
Female	5	7	6	9	27
Age					
18 - 24 year:	3%	9%	3%	1%	16%
25 - 34 year:	9%	6%	11%	17%	43%
35 - 44 year:	10%	6%	7%	1%	24%
45 - 54 year:	4%	4%	4%	1%	14%
55-64 year	0%	0%	0%	3%	3%
Trip Purpose					
Work	29%	18%	31 %	22 %	64%
School	4	4	3	6	24%
Leisure	1	0	0	0	1%
Shopping business	0	4	1	1	9%
Other	0	1	0	0	1%

Table 4; Bellville sample characteristics

Bellville sample characteristics	Golden Arrow bus	Minibus taxi	Train	Total
Respondents	21	34	12	67
Gender				
Male	13	15	6	34
Female	8	19	6	43
Age				
18 - 24 years	4%	3%	3%	10%
25 - 34 years	10%	16%	10%	37%
35 - 44 years	10%	19%	4%	34%
45 - 54 years	6%	12%	0%	18%
55-64 years	0%	0%	0%	0%
Trip Purpose				
Work	15%	34%	9%	58%
School	9%	2%	8%	18%

Bellville sample characteristics	Golden Arrow bus	Minibus taxi	Train	Total
Leisure	2%	8%	0%	10%
Shopping business	6%	5%	2%	13%
Other	0	2	0	2

Table 4 displays the characteristics of the Bellville sample. We conducted interviews with 67 public transportation users during peak hours.

Table 5: Mitchells Plain sample characteristics

Mitchells Plain sample characteristics	Golden Arrow bus	Minibus taxi	Total
Respondents	30	48	78
Gender	Male	11	21
	Female	19	27
Age	18 - 24 years	4%	8%
	25 - 34 years	17%	14%
	35 - 44 years	5%	24%
	45 - 54 years	12%	13%
	55-64 years	1%	3%
Trip Purpose	Work	17%	26%
	School	5%	4%
	Leisure	4%	8%
	Shopping r business	5%	14%
	Other	8%	10%

The characteristics of the sample specific to Mitchells Plain are presented in Table 5. The table provides details on the number of interviews conducted, which amounted to 78 public transport users during peak hours. These findings offer valuable insights into the usage patterns and behaviours of Mitchells Plain residents in relation to public transportation during peak hours.

Table 6: Khayelitsha sample characteristics

Khayelitsha sample characteristics	Golden Arrow bus	Minibus taxi	Total
Respondents	28	38	67
Gender	Male	11	48%
	Female	19	52%
Age	18 - 24 years	6%	9%

	25 - 34 years	12%	25%	39%
	35 - 44 years	13%	16%	30%
	45 - 54 years	10%	6%	16%
	55-64 years	0%	0%	0%
Trip Purpose	Work	28%	25%	55%
	School	6%	3%	9%
	Shopping	6%	27%	33%
	business			
	Other	2%	2%	3%

Table 6 above provides a summarized sample size for Khayelitsha. This area is mainly composed of commuters who are workers. Based on this information, we can infer that the majority of people traveling to and from Khayelitsha are doing so for work-related purposes.

3.5.1 Data Processing

After the completion of data collection, the questionnaires were digitized by inputting the data into an Excel spreadsheet. Excel 2016 or an earlier version was utilized for data entry and analysis, as indicated in item number 5 of the activity schedule provided in Appendix E.

Once the data was entered into Excel, various statistical analysis tools were employed to examine and interpret the data. These analytical techniques enabled us to identify noteworthy trends and patterns within the dataset, providing valuable insights for our research. The utilization of Excel for data analysis proved to be a highly efficient approach, allowing us to gain insights that would have been challenging to derive using alternative methods.

3.5.2 Data Analysis

According to Adamsen, Rundle-Thiele, and Whitty (2013), the Best Worst Scaling (BWS) approach at the profile level yields outcomes similar to those obtained from more complex Multinomial Logit (MNL) analyses. In this case, the standard calculation method involves determining the Best minus Worst (B-W) scores for each profile. To calculate the average B-W score, the B-W score is multiplied by the number of respondents and the frequency of each profile in the choice set (r). These scores allow for the ranking of individual profiles. Positive B-W values indicate that the profile was chosen more

frequently as the best option, while negative values indicate a higher frequency of selection as the worst option (Adamsen, Rundle-Thiele, & Whitty, 2013).

$$\text{Average Best – Worst score} = \frac{(\text{Bestscore} - \text{Worstscore})}{\text{frequency of statement in all choice sets}}$$

In accordance with the provided equation, the comparative best-minus-worst (BW) score can be calculated by subtracting the number of times an attribute was chosen as worst from the number of times it was chosen as best, and then dividing it by the total number of times it was presented for selection (Peay, Hollin, & Bridges, 2014). This calculation helps determine the relative importance of attributes. The participants' judgments about the best and worst attributes in each presented profile serve as the dependent variable in this analysis.

Alternatively, ratio scores can be developed to compare the importance of profiles. This involves dividing the total Best scores by the total Worst scores and then taking the square root. The resulting number represents the likelihood of choosing an option compared to the most important item. To facilitate interpretation and comparison across profiles, the square root of the best-to-worst ratio (sqrt of B/W) for all profiles is scaled using a factor. The profile with the highest square root (B/W) is assigned an Index value of 100 for a smoother comparison (Peay, Hollin, & Bridges, 2014).

4. Survey findings

In this chapter, the survey findings regarding public transport quality preferences and perceptions in Cape Town are presented. The primary data collection method involved the use of a research questionnaire administered to public transport users. The study focused on commuters traveling between four different locations: Cape Town, Bellville, Khayelitsha, and Mitchells Plain. These commuters had transportation options such as commuter trains, commuter buses, and minibus taxis. The Best Worst Scaling (BWS) method was employed to collect data from all four areas, as detailed in the methodology section of this document.

The survey questionnaire followed a well-structured format, with the initial page providing an overview of the research project and its theme. For a complete copy of the questionnaire, please refer to Appendix C attached to this document.

4.1 Research findings and analysis

The research findings for the four surveyed areas in Cape Town reveal valuable insights into public transport quality preferences and perceptions. A uniform questionnaire was employed to ensure consistency across all four areas, allowing for meaningful comparisons and analysis. The following is a summary of the key findings:

1. **Cape Town:** The respondents in Cape Town expressed a strong preference for direct service and affordability, ranking them as the top quality attributes for public transportation.
2. **Bellville:** In Bellville, travel time and easy to use emerged as the most preferred user quality attributes of public transportation. The respondents appreciated the extensive travel options and transport network offered for their daily commuting needs.
3. **Khayelitsha:** The respondents in Khayelitsha displayed a strong preference for Affordability and Travel time as their most important quality attributes of public transportation. This preference was influenced by coverage of taxi routes in the area.
4. **Mitchells Plain:** In Mitchells Plain, travel time and direct service emerged as the preferred quality attributes for public transportation. The respondents appreciated the convenience and flexibility offered by taxis, particularly for shorter trips within the area.

Overall, the survey findings highlight the diverse preferences and perceptions of public transport users in Cape Town's different areas. While certain modes of transportation, such as commuter trains and buses, received positive feedback across the surveyed areas, the dominance of minibus taxis in some locations emphasizes the importance of catering to the specific needs and preferences of different communities. These findings can inform policymakers and transportation authorities in developing targeted strategies to enhance public transport services and meet the evolving demands of commuters in Cape Town.

4.1.1 Question 1A— Frequently or recently used public transport mode

Field data was collected and analysed to determine the most frequently and/or recently used mode of public transportation. A count of users per mode was conducted in each area, with a total sample size of 300. This yielded several users per mode per area.

The first question of the survey – Question 1A – was: Please indicate a Public Transport Mode you use frequently or have used recently.

Response;

Table 7 : Public transport model split

PT Mode	User per mode	% of total sample
Golden Arrow bus	97	34%
Mini Bus taxi	137	49%
My Citi	17	6%
Train	31	11%
Grand Total	282	100%

The table presented above provides an overview of the number of public transport users surveyed in this study, categorized by different modes of transportation. Based on the collected data, the following observations can be made:

1. **Minibus taxi:** Among the surveyed population, the most popular mode of public transportation was the minibus taxi, with a total of 137 users included in the study. This finding suggests a significant preference for this mode of transport among the surveyed individuals.

2. **Buses:** Following minibus taxis, buses were the second most utilized mode of public transportation in the survey. A total of 97 users were surveyed, indicating a considerable number of individuals relying on bus services for their daily commuting needs.
3. **Trains:** The data collected from the survey revealed that trains were the third most popular mode of public transport among the surveyed population. A total of 31 users reported using trains for their daily commutes, highlighting a smaller but still notable portion of respondents relying on train services.
4. **My Citi bus service:** The least popular mode of public transportation among the surveyed individuals was the My Citi bus service, with only 17 users reported. This finding suggests that the surveyed population had a relatively lower usage rate of the My Citi bus service compared to other modes of public transportation.

These findings provide valuable insights into the popularity and usage patterns of different modes of public transportation among the surveyed population.

Table 8; Mode, region and age of respondents

Mode and Area	18 – 24 years	25 - 34 years	35 - 44 years	45 – 54 years	55 – 64 years	Grand Total
Golden Arrow bus	4%	12%	10%	8%	0%	34%
Bellville	1%	2%	2%	1%	0%	7%
Cape Town	1%	2%	2%	1%	0%	6%
Khayelitsha	1%	3%	3%	2%	0%	10%
Mitchells Plain	1%	5%	1%	3%	0%	11%
Mini Bus taxi	7%	15%	17%	9%	1%	49%
Bellville	1%	4%	5%	3%	0%	12%
Cape Town	2%	1%	1%	1%	0%	6%
Khayelitsha	2%	6%	4%	1%	0%	13%
Mitchells Plain	2%	4%	7%	4%	1%	17%
My Citi	0%	4%	0%	0%	1%	6%
Cape Town	0%	4%	0%	0%	1%	6%

Train	1%	6%	3%	1%	0%	11%
Bellville	1%	2%	1%	0%	0%	4%
Cape Town	1%	3%	2%	1%	0%	6%
Khayelitsha	0%	0%	0%	0%	0%	0%
Grand Total	13%	37%	29%	18%	2%	100%

Based on the information presented in Table 7 and Table 8, it can be observed that a significant number of individuals are in the age group of 25-34 and prefer minibus taxis and buses as their primary mode of public transportation.

Conversely, My Citi buses and trains seem to be less favoured among the surveyed population. When we analyse the cumulative data from both tables, we find that approximately 49% of individuals rely on minibus taxis, while approximately 6% choose to use My Citi buses as their preferred mode of transport.

4.1.2 Question 2A— Users per Suburban Area

The second question of the survey – Question 2A – was: Please tell us, which suburban area is closest to you or are you from, mark with an X.

Response:

Table 9 Response rate per suburban area (Field data 2021)

Suburban area	Response rate
Bellville	89%
Cape Town	93%
Khayelitsha	89%
Mitchells Plain	104%
Average	94%

To ascertain the origins and destinations of people's travels, an analysis of the data was conducted based on specific areas, as indicated in Table 9. Once responses were obtained from all four areas, a response rate was computed to assess the number of completed questionnaires that could be used for analysing the results in each area.

4.1.3 Question 3A— Trip Purpose

Question three of the survey – Question 3A – reads: Please mark an X to indicate the purpose of your trip or travel.

Response;

Table 10: Trip purpose per region (Field data 2021)

Trip purpose	Cape Town	Bellville	Khayelitsha	Mitchells Plain	Average
Work	64%	58%	55%	42%	55%
School	24%	18%	9%	9%	15%
Leisure	1%	9%	0%	12%	5%
Shopping or business	9%	12%	33%	19%	18%
Other	1%	3%	3%	18%	6%
Work	64%	58%	55%	42%	55%
School	24%	18%	9%	9%	15%
Leisure	1%	9%	0%	12%	5%
Shopping or business	9%	12%	33%	19%	18%
Other	1%	3%	3%	18%	6%
Total users	100%	100%	100%	100%	100%

According to the data presented in Table 10, the analysis reveals that work trips account for 55% of the total, while shopping or business trips constitute 18%. School-related trips make up 15% of the total, with 6% being classified as other purposes and 5% for leisure activities. These findings shed light on the primary motivations behind people's choice of transportation modes. It is noteworthy that a significant portion of trips is for work, followed by shopping or business, and school. This information holds value for urban planners and transportation authorities seeking to enhance transportation infrastructure and services to cater to the needs of their communities.

4.1.4 Question 4A— Gender Split

Question four of the survey, specifically Question 4A, asked participants to indicate their gender.

Response;

Table 11: Gender split per region

Gender	Cape Town	Bellville	Khayelitsha	Mitchells Plain	Average
Male	61%	51%	48%	41%	50%
Female	39%	49%	52%	59%	50%
Total users	100%	100%	100%	100%	100%

Table 11 provides a comprehensive overview of the gender distribution within the sample for different areas, including Cape Town, Bellville, Khayelitsha, and Mitchells Plain. The table reveals the percentage of men and women in each area, with Cape Town having 61% men and 39% women, Bellville having 51% men and 49% women, Khayelitsha having 48% men and 52% women, and Mitchells Plain having 41% men and 59% women. When considering the entire pooled sample, an equal split is observed, with females comprising 50% and males comprising the remaining 50%.

4.1.5 Question 5A—Age Distribution

The fifth question of the survey – Question 5A – was: "Please indicate which range includes your age?"

Response;

Table 12; Age distribution by region (field data, 2021)

Age range	Cape Town	Bellville	Khayelitsha	Mitchells Plain	Average
18 - 24	16%	10%	15%	12%	13%
25 - 34	43%	37%	39%	31%	37%
35 - 44	24%	34%	30%	29%	29%
45 - 54	14%	18%	16%	24%	18%
55 - 64	3%	0%	0%	4%	2%
Total	100 %	100 %	100 %		100 %

Based on the information provided in Table 11, the majority of participants, comprising 37% of the total, belong to the age group of 25 to 34. In contrast, the smallest segment

of respondents, accounting for just 2% of the overall sample, falls within the age range of 55 to 64.

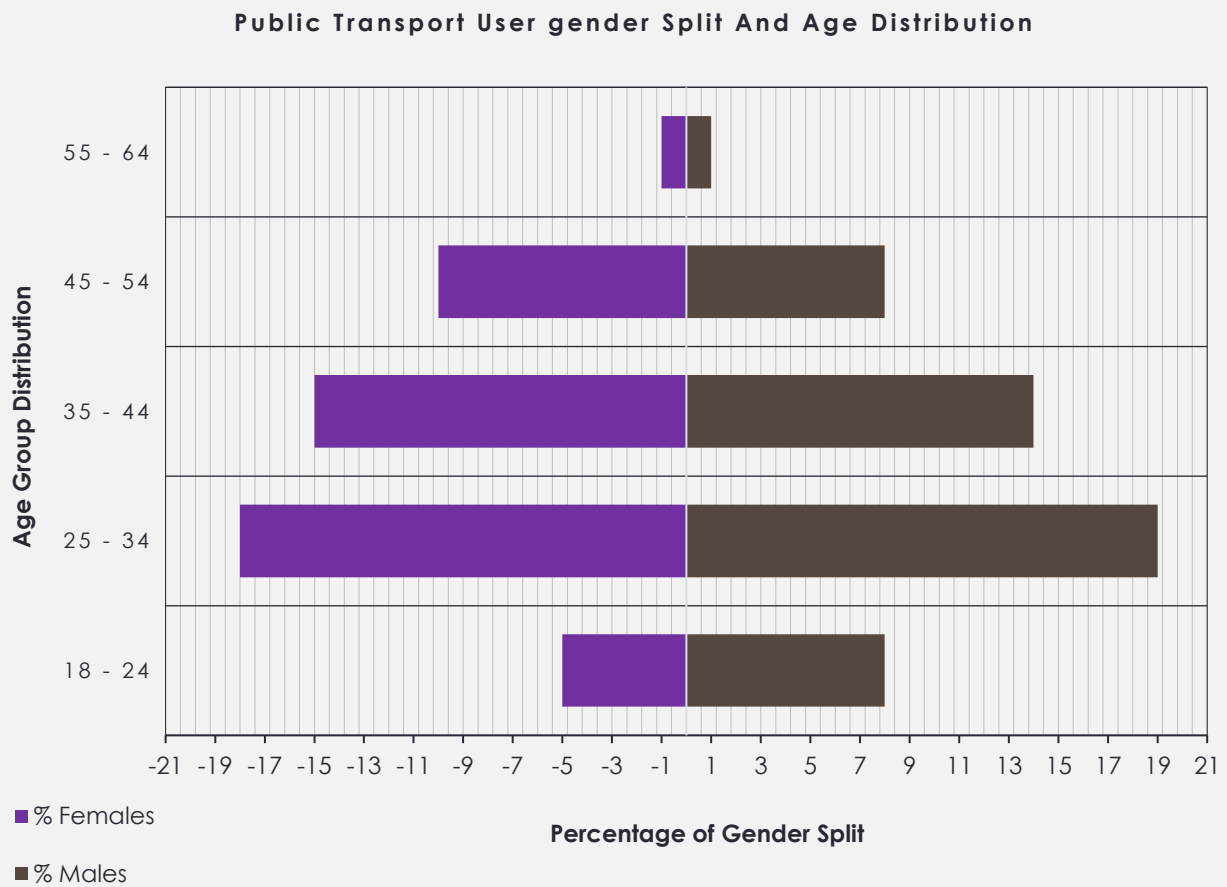


Figure 11: Aggregated gender split and age distribution of public transport users (Field data, 2021)

The visual representation in Figure 12 presents the distribution of gender and age across different modes of transportation and areas. The chart on the left depicts the proportion of female respondents, while the chart on the right represents the proportion of male respondents. The figure suggests that there is a similarity in responses between males and females. Furthermore, it indicates that individuals of similar age, regardless of gender, hold similar perceptions regarding the qualities of public transportation.

4.1.6 Question X— Ranking of Public Transport Quality Attributes and Best-Worst Scores

The main question of the survey was Question X: "In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public

transport mode." This question was asked 14 times, each time with a list of attributes grouped into five. Therefore, each user was shown 14 sets of attributes.

Response;

Table 13 : Public transport quality Attributes Best-Worst Scores (Field data 2021)

Attributes	Most Important	Least concerning/ Not important	Best-Worst Scores
Affordability/ Ticket price/ fare	713	205	101.6
Station proximity	241	187	10.8
Comfort	144	416	-54.4
Service frequency	60	213	-30.6
Direct service	523	154	73.8
Service Transfers	27	304	-55.4
Easy to Use	487	238	49.8
Information	149	450	-60.2
Vehicle cleanliness	121	295	-34.8
Flexibility to travel	190	148	8.4
Travel time	653	124	105.8
Security	63	505	-88.4
Safety	177	267	-18
Reliability	288	148	28

Table 13 presents a comprehensive compilation of both the best and worst scores, along with the identified key quality attributes based on their respective scores. This data plays a crucial role in comprehending and analysing the performance of these attributes, allowing for a better understanding of areas that require improvement. Furthermore, these scores serve as a valuable reference point for comparing similar attributes within the industry, offering a foundation for future research and analysis.

4.2 Aggregated ranking of attributes

The table below present the data with modes of transport perception of most important and least important quality attributes. There were more male respondents than female. This means the findings might have been different if there was an equal number of a respondent representing both genders. Below is Table 14, which lists PT quality attributes in an ascending order.

Table 14: PT quality attributes ranked in an ascending order (Field data 2021)

Attributes	Best-Worst Scores	Normalized Data	Ranking
Travel time	105.80	106.26	1
Affordability/ Ticket price/ fare	101.60	102.06	2
Direct service	73.80	74.26	3
Easy to Use	49.80	50.26	4
Reliability	28.00	28.46	5
Station proximity	10.80	11.26	6
Flexibility to travel	8.40	8.86	7
Safety	-18.00	-17.54	8
Service frequency	-30.60	-30.14	9
Vehicle cleanliness	-34.80	-34.34	10
Comfort	-54.40	-53.94	11
Service Transfers	-55.40	-54.94	12
Information	-60.20	-59.74	13
Security	-88.40	-87.94	14

Figure 12, below illustrates the quality preferences of users for public transportation in Cape Town. The figure reveals that half of the attributes were identified as the most important, while the remaining half were regarded as the least important. The attributes positioned on the far left, above the X-axis, are considered the most crucial quality features of public transportation in the region, whereas those situated on the far right and below the chart on the negative scale are deemed the least significant features.

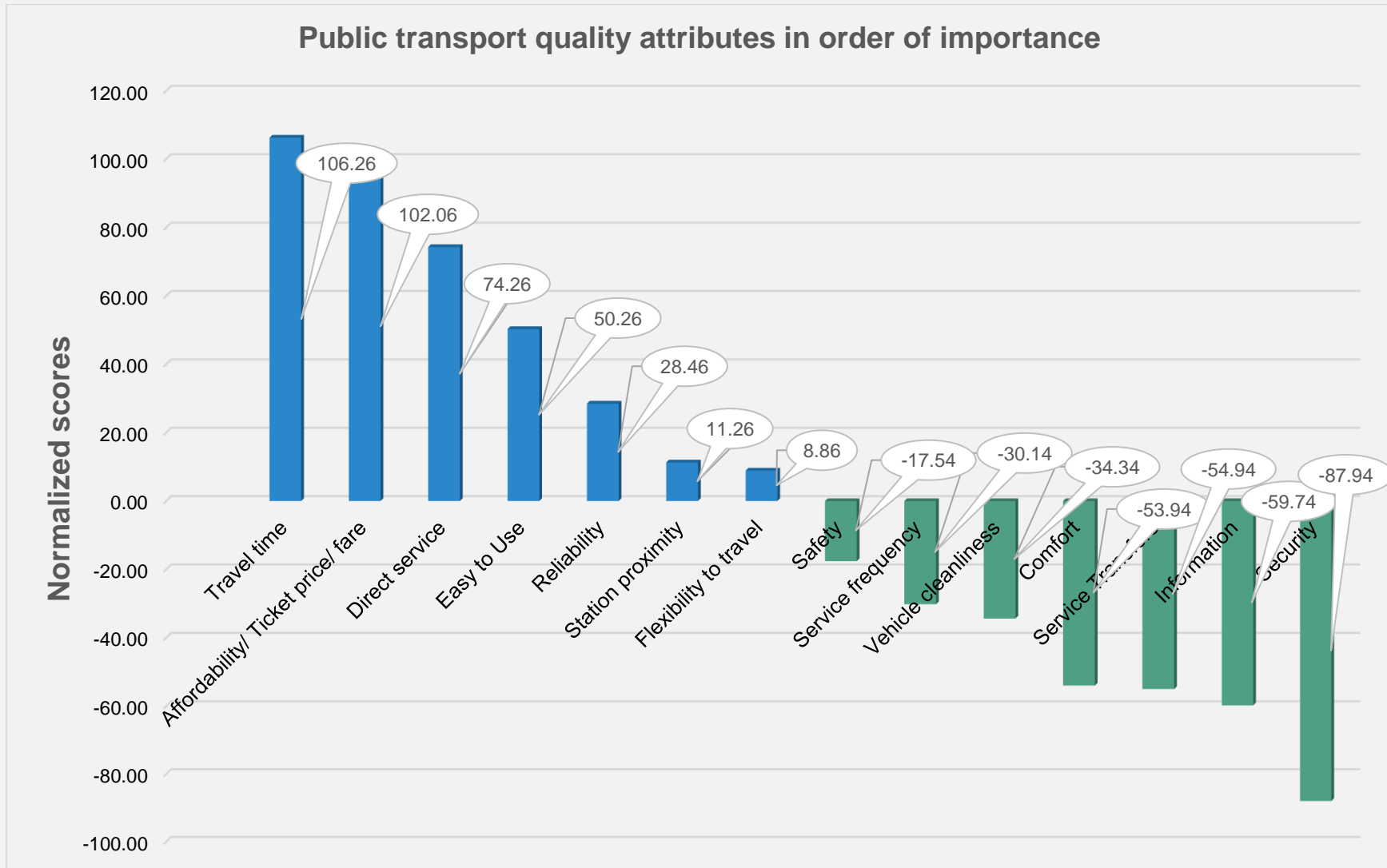


Figure 12 : B-W Scores of Public transport quality attributes in order of importance (Field data 2021)

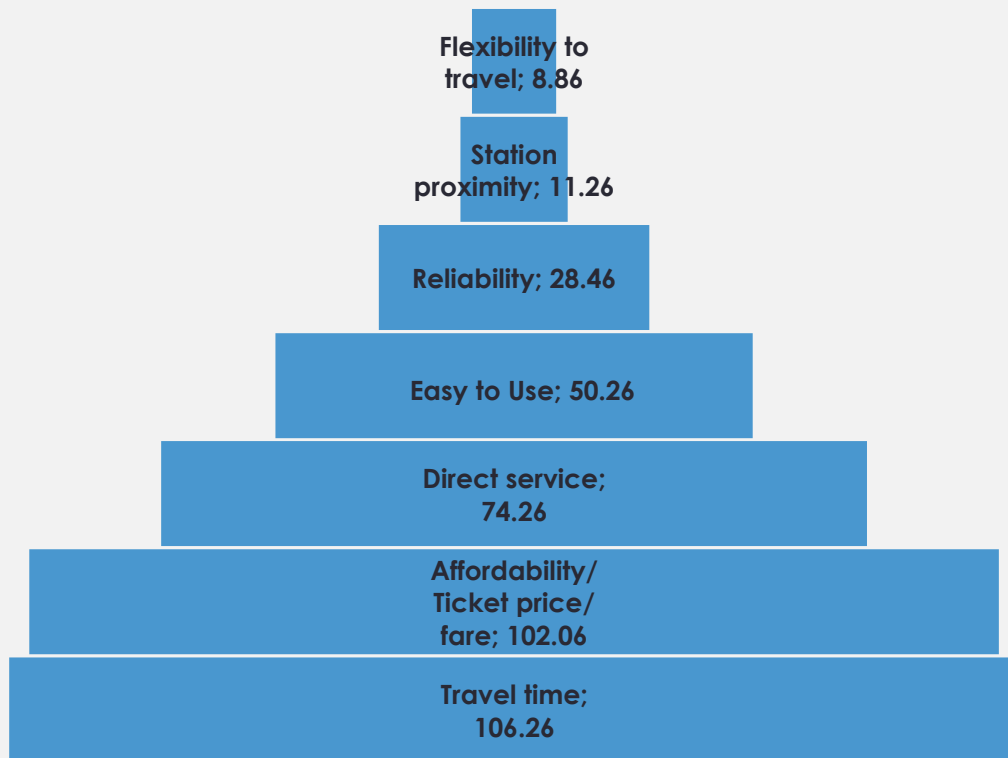


Figure 13: Most important public transport quality attributes (Field data 2021)

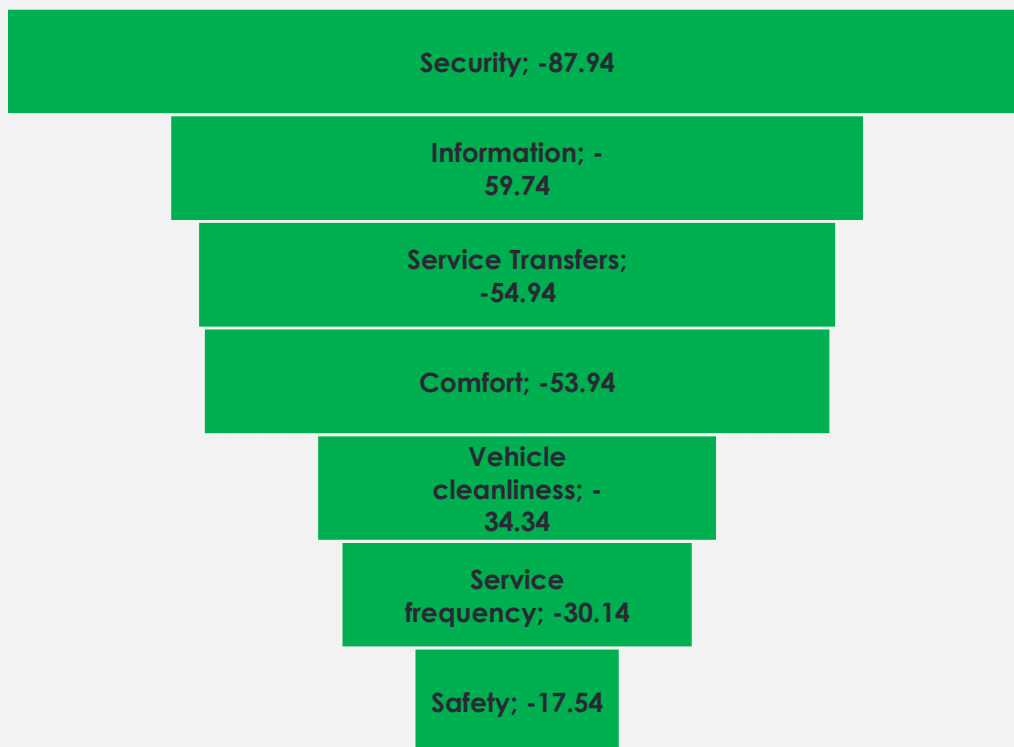


Figure 14 : Least important public transport quality attributes (Field data 2021)

4.3 Analysis of results per area

Table 15: Most Important and not important quality attribute frequencies per area (Field data 2021)

Attributes	Bellville		Cape Town		Khayelitsha		Mitchells Plain	
	Most Important	Least important	Most Important	Least important	Most Important	Least Important	Most Important	Least Important
Affordability/ Ticket price/ fare	187	67	171	78	186	60	164	102
Station proximity	27	58	38	55	72	73	49	55
Comfort	41	98	40	77	24	85	39	118
Service frequency	13	51	17	54	16	57	14	51
Direct service	133	51	160	38	127	25	162	40
Service Transfers	6	68	15	86	4	69	1	81
Easy to Use	161	30	100	78	128	62	123	68
Information	32	138	37	126	46	122	34	164
Vehicle cleanliness	18	107	74	43	28	89	15	121
Flexibility to travel	50	33	51	43	48	39	41	33
Travel time	165	29	136	54	133	29	228	8
Security	10	129	28	143	16	112	9	131
Safety	44	57	47	50	30	83	50	67
Reliability	45	43	75	52	86	33	82	52

Table 15 provides an overview of the frequency with which each quality attribute has been perceived as the most important or least important. It offers valuable insights into the relative importance assigned to these attributes by the respondents. To further delve into this analysis, the corresponding best-worst scores for each attribute are provided below, shedding light on the perceived importance of these attributes in relation to user preferences and perceptions.

Table 16 Best-Worst Scores per suburban area (Field data 2021)

	Bellville	Cape Town	Khayelitsha	Mitchells Plain
Attributes	B-W score	B-W score	B-W score	B-W score
Affordability/ Ticket price/ fare	24	18.6	25.2	12.4
Station proximity	-6.2	-3.4	-0.2	-1.2
Comfort	-11.4	-7.4	-12.2	-15.8
Service frequency	-7.6	-7.4	-8.2	-7.4
Direct service	16.4	24.4	20.4	24.4
Service Transfers	-12.4	-14.2	-13	-16
Easy to Use	26.2	4.4	13.2	11
Information	-21.2	-17.8	-15.2	-26
Vehicle cleanliness	-17.8	6.2	-12.2	-21.2
Flexibility to travel	3.4	1.6	1.8	1.6
Travel time	27.2	16.4	20.8	44

Security	-23.8	-23	-19.2	-24.4
Safety	-2.6	-0.6	-10.6	-3.4
Reliability	0.4	4.6	10.6	6

The preceding table displays the calculated best and worst scores derived from the collected data. This methodology was consistently applied to determine the Best-Worst (B-W) scores for each area, including Bellville, Khayelitsha, and Mitchells Plain. Subsequently, the scores were ranked accordingly to identify the relative importance of each attribute within these specific regions. A comprehensive summary of these findings can be found in Table 17 presented below.

Table 17: Ranking of attributes per area (all modes)

Attributes	Bellville	Cape Town	Khayelitsha	Mitchells Plain
Affordability/ Ticket price/ fare	3	2	1	3
Station proximity	8	9	7	7
Comfort	10	10	10	10
Service frequency	9	10	8	9
Direct service	4	1	3	2
Service Transfers	11	12	12	11
Easy to Use	2	6	4	4

Attributes	Bellville	Cape Town	Khayelitsha	Mitchells Plain
Information	12	13	13	14
Vehicle cleanliness	13	4	10	12
Flexibility to travel	5	7	6	6
Travel time	1	3	2	1
Security	14	14	14	13
Safety	7	8	9	8
Reliability	6	5	5	5

Table 18: Cape Town Best-Worse scores per mode

Cape Town all modes attribute ranking				
Attributes	GABS(Rank)	MBT(Rank)	My Citi(Rank)	Trains(Rank)
Affordability/ fare	2	2	2	2
Station proximity	5	10	11	4
Comfort	11	11	9	11
Service frequency	9	9	12	8
Direct service	3	1	3	1
Service Transfers	13	13	10	12
Easy to Use	3	8	1	5
Information	9	12	13	14
Vehicle cleanliness	7	2	4	6
Flexibility to travel	8	4	7	9
Travel time	1	5	8	3
Security	14	14	14	9
Safety	12	7	6	7
Reliability	6	5	5	13

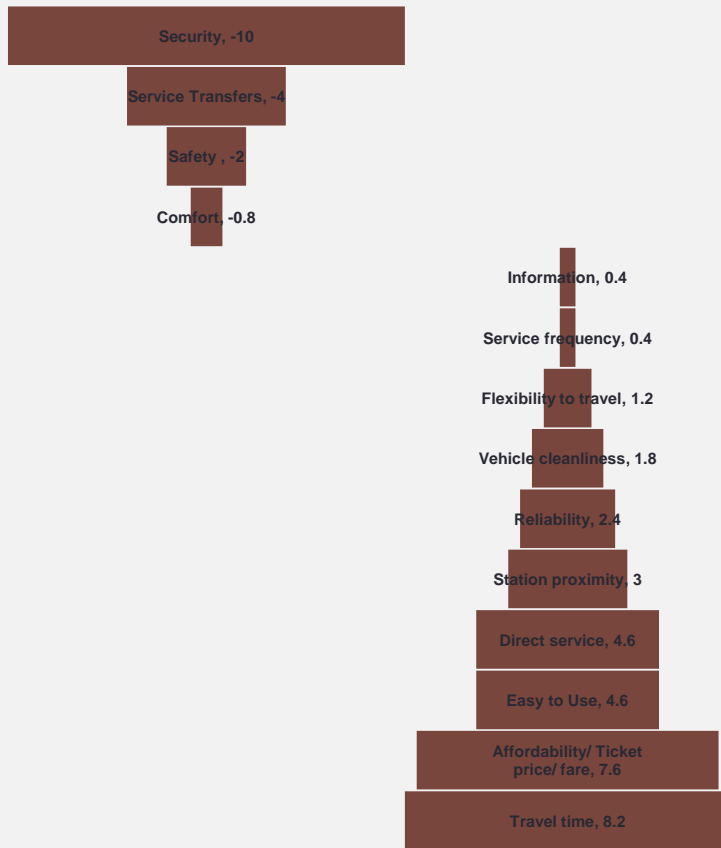


Figure 15: Cape Town, GABS user quality preference and perception

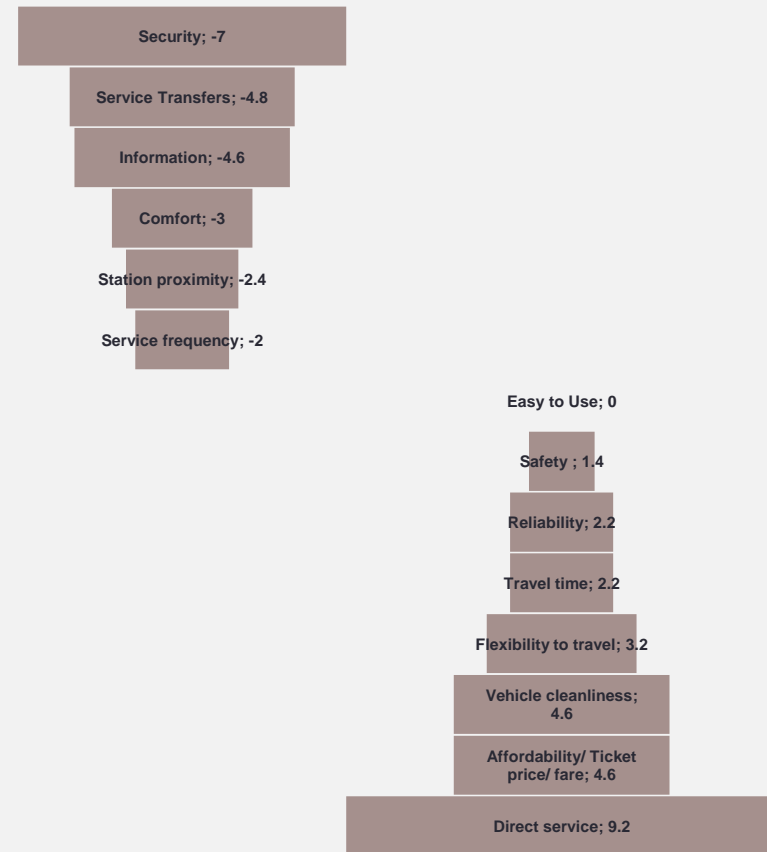


Figure 16: Cape Town, MBT user quality preference and perception

Figure 15 to Figure 18 provide visual representations of preferences and perceptions regarding the quality of public transportation across various modes. These figures offer valuable insights into how individuals perceive and prioritize different attributes of public transportation based on their personal preferences and experiences.

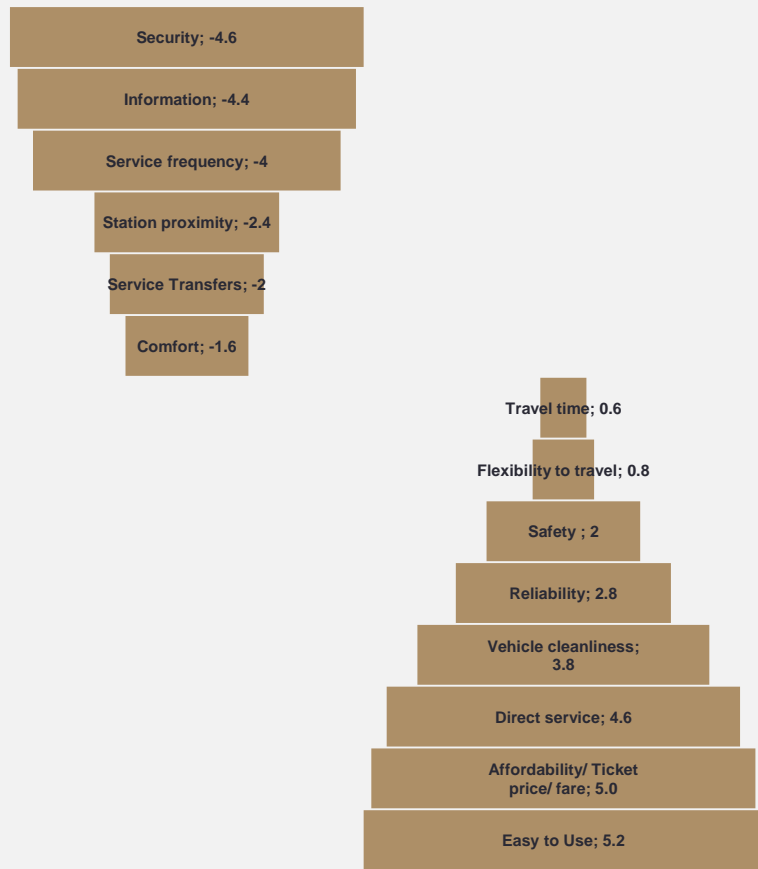


Figure 17: Cape Town, My Citi user quality preference and perception

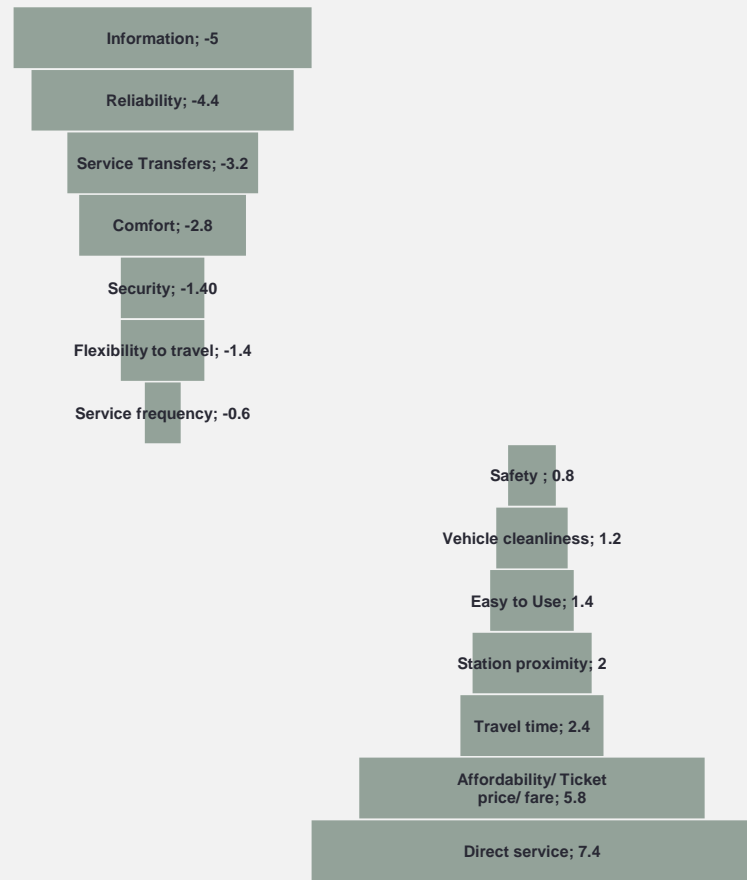


Figure 18; Cape Town, Train user quality preference and perception

4.4 Analysis of results per mode

To assess user preferences and perceptions of the public transport system holistically, we conducted a comprehensive analysis of best-worst scores for all modes in this study. This analysis enabled us to identify the quality attributes that were considered the best and the worst by users.

The table below presents the best-worst scores for each mode, which can be valuable in pinpointing areas for improvement to enhance user satisfaction and overall experience. Additionally, we incorporated visual illustrations in **Figure 17** to **Figure 20**, offering further insights into user preferences and perceptions of public transportation across different modes.

In **Table 20**, you will find the best-worst scores for each mode, displaying the best and worst scores attributed to each quality attribute. These scores were calculated by subtracting the number of times an attribute was chosen as the best from the worst, and then dividing it by the frequency of appearance in the choice set. Analysing this data allows us to identify the attributes that have the most significant impact on overall preferences and perceptions.

Table 19 ; Best-Worst Scores per mode (Field data 2021)

Attributes	Golden Arrow bus	Mini Bus taxi	My Citi	Train
Affordability/ Ticket price/ fare	17.2	46.6	3.2	14.2
Station proximity	9	-16.4	-0.8	-1
Comfort	-15.2	-24.6	-1.6	-5.4
Service frequency	-7.2	-15.8	-4	-2.8
Direct service	25.4	47.8	4.6	7.8
Service Transfers	-18.4	-29	-2	-5.4
Easy to Use	6	42	1.8	5

Attributes	Golden Arrow bus	Mini Bus taxi	My Citi	Train
Information	-12.2	-61	-1.8	-3
Vehicle cleanliness	-24	-17	3.6	-7.2
Flexibility to travel	1.2	1.6	-0.8	0
Travel time	42.4	57.4	1	5.2
Security	-30.8	-48	-4.6	-1.8
Safety	-8	-11.6	2	1
Reliability	10.8	14.4	3	-7.4

Table 20 : Aggregated attribute ranking per mode (all areas)

College	Golden Arrow	Mini Bus taxi	My Citi	Train
Affordability/ Ticket price/ fare	3	3	3	1
Station proximity	5	9	8	6
Comfort	11	11		
Service frequency	8	8	13	8
Direct service	2	2	1	2
Service Transfers	12	12	12	10
Easy to Use	6	4	6	4

College	Golden Arrow	Mini Bus taxi	My Citi	Train
Information	10	14	11	9
Vehicle cleanliness	13	10	2	12
Flexibility to travel	7	6	9	0
Travel time	1	1	7	3
Security	14	13	14	7
Safety	9	7	5	5
Reliability	4	5	4	13

Table 20. illustrates the comparative rankings of attributes for Golden Arrow bus services, Minibus taxi, My Citi, and train services. This table presents the order in which these modes of transportation are ranked in terms of their respective attributes.

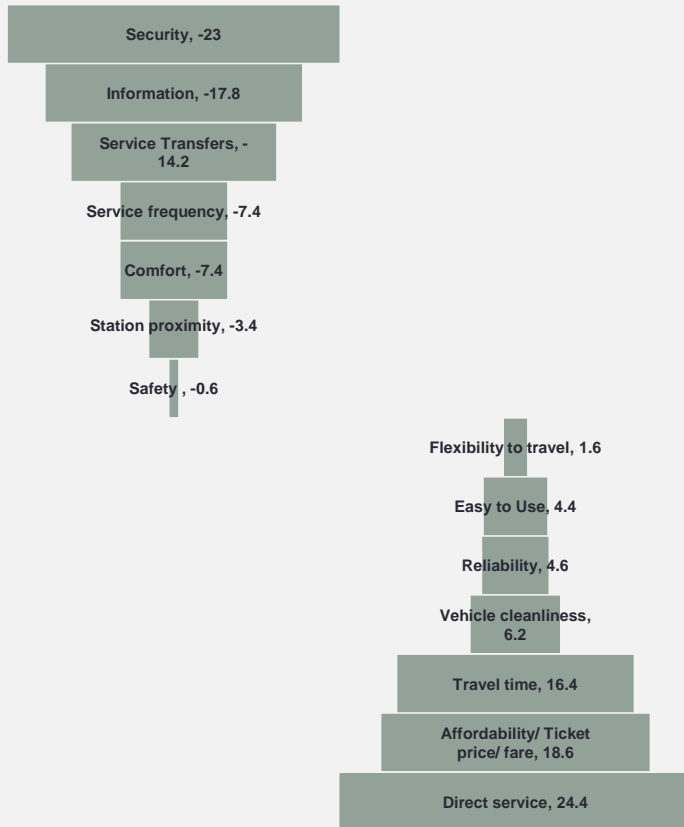


Figure 19: Cape Town (all modes) most important and least important quality attributes

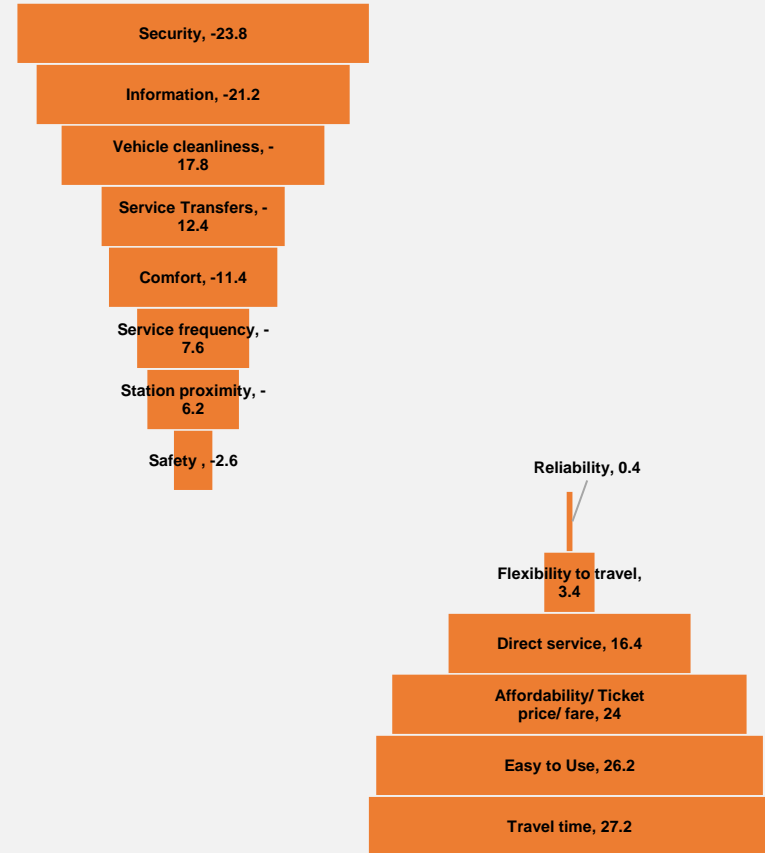


Figure 20: Bellville (all modes) most important and least important quality attributes

The data depicted in in **Figure 19** and **Figure 20** clearly demonstrate regional variations in quality preferences and perceptions. It is crucial to highlight that users in Bellville exhibit unique needs and preferences that distinguish them from users in Cape Town.

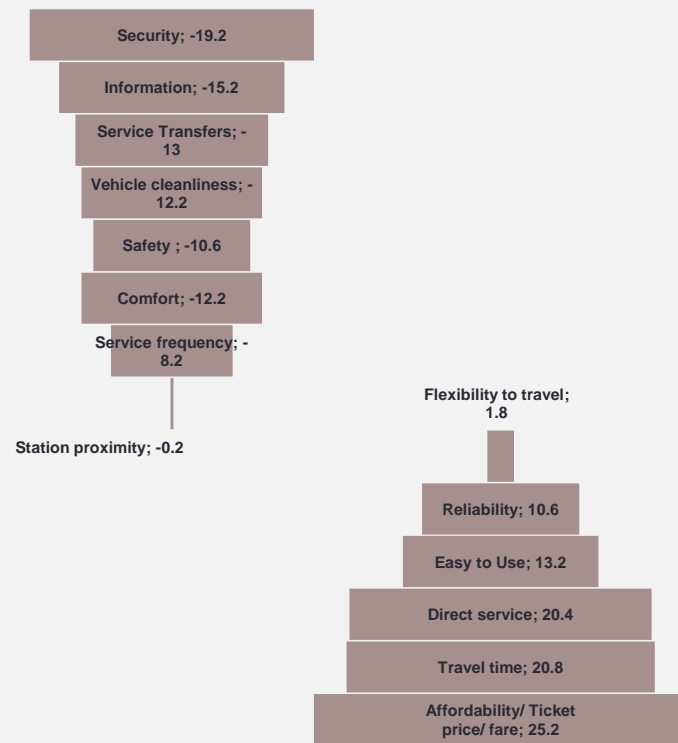


Figure 21: Khayelitsha (all modes) most important and least important quality attributes

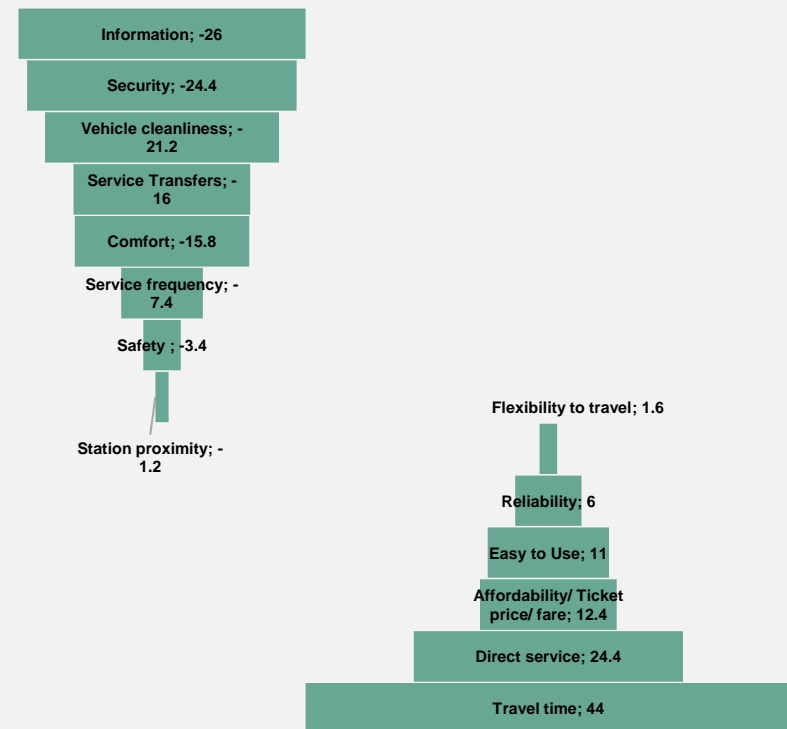


Figure 22: Mitchells Plain (all modes) most important and least important quality attributes

4.4.1 Mann Whitney U Test

The Mann-Whitney U test is a statistical test that is employed when comparing two randomly selected samples from different populations. Unlike the unpaired t-test, which assumes normal distribution of the data, the Mann-Whitney U test is a nonparametric test that does not make any assumptions about the underlying distribution of the data. Its purpose is to determine whether there is a significant difference between the two independent groups being compared (Shier, 2004).

In this study, the Mann-Whitney U test was utilized to examine whether there were significant differences between two distinct groups. It assessed whether the distribution of the dependent variable was the same across both groups and whether the samples represented the same population. To conduct the test, all the dependent values were ranked, with the lowest value receiving a rank of one. The sum of the ranks for each group was then used in the calculation of the test statistic.

Table 22 provides a concise summary of the results obtained from the Mann-Whitney U test, offering valuable information regarding the differences observed between the two independent groups and the significance of those differences.

Table 21: The Mann Whitney U Test for average scores

Most Important		Least concerning/ Not important	
Mean	274	Mean	261
Standard Error	60.61688373	Standard Error	32.26981
Median	183.5	Median	225.5
Mode	#N/A	Mode	148
Standard Deviation	226.8076108	Standard Deviation	120.7426
Sample Variance	51441.69231	Sample Variance	14578.77
Kurtosis	-0.479060297	Kurtosis	-0.23803
Skewness	0.927733007	Skewness	0.904185
Range	686	Range	381
Minimum	27	Minimum	124
Maximum	713	Maximum	505
Sum	3836	Sum	3654
Count	14	Count	14
Confidence Level (95.0%)	130.9548157	Confidence Level (95.0%)	69.71469

U	85	111
	85	
Mu	98	
Sigma	21.76388446	
P	0.27514693	

5. Discussion of Findings

The main objective of the study was to demonstrate the existence of a user quality pyramid on Cape Town's public transport modes. As opposed to traditional methods such as SERVQUAL, Structural Equation Modelling (SEM), Quadrant, or Importance-Performance Analysis, this study employs a different approach to quantify expectations and perceptions of a service, the Best worst scaling method. Respondents are required to select extremes from a given list of items in order to discriminate among them using the Best-Worst scaling method.

In order of importance, the following aggregated values were obtained: Travel time (normalized score = 1.66); Affordability/ Ticket price/ fare (normalized score = 1.59); Direct service (normalized score =1.15); Easy to Use (normalized score =0.76); Reliability (normalized score = 0.41); Station proximity (normalized score =0.13); Flexibility to travel (normalized score = 0.09). These findings confirm the existence of a pyramid of user quality according to the research objective section. Those attributes that were ranked as least important (worse) may indicate that they are not a course for concern compared to other attributes.

The results are fairly consistent per location, as shown in

Table 17. In Mitchells Plain and Bellville for example, affordability is number 3 as most important (valued)quality attribute, and travel time is even more important (best) and is ranked number 1 followed by ticket price. The results also reveal that , Bellville public transport system is easy to use, therefore easy to use is ranked number 2 as most important feature, meaning people value this feature about public transport in Bellville maybe given the various modes of transport and interchanges to use multi modes. In Cape Town Central Business District (CBD), vehicle cleanliness is a priority to public transport users and is ranked number 4 as the most important item as compared to other areas.

There are other inconsistencies in quality preference and perceptions, see Table 18 and Figure 18. For example, station proximity in the GABS and train is most important feature while in minibus taxis is chosen as least important feature. This may be due to the fact that mini bus taxis do not have stations except ranks, they load and offload passengers users almost anywhere. These inconsistencies may be because user preference is a dynamic phenomenon that can vary both spatially and temporally (Echaniz, et al, 2022).

It may differ between different cities or even between segments of a transportation line or between different areas of a metropolitan area. A person's preference can vary depending upon the time of day (peak or off-peak hours) or between various intervals of time.

According to these results, users of public transportation have multiple needs to consider when using a public transportation mode. The needs of different users can also take a different priority order under similar circumstances, depending on their circumstances. It is evident from the abnormalities observed in each area or region. However, these abnormalities are not severe, as they occur only every two or three points at worst. In other words, the feature moves by two points to three in a region.

The Mann-Whitney U test indicates that public transport mode users choose travel time and affordability as the most important quality attributes, so there is a quality pyramid in public transportation. The median score for the most important quality attributes was 184, while the median score for the least important quality attributes was 226.

5.1 Synthesis of research findings

5.1.1 Travel time

In this study, participants placed significant importance on travel time as the most crucial quality factor, especially during peak periods. This finding was consistent among individuals with typical working schedules, as well as business and academic travelers. Sinha et al. (2019) conducted a similar study and also identified travel time as the most significant attribute, followed by cost and safety. Sinha and Modi (2019) argue that when service quality is low, users tend to prioritize basic attributes such as access-egress times, wait times, time spent in vehicles, and cost. However, as service quality improves and meets user expectations in these basic aspects, users begin to value higher-order attributes such as safety, cleanliness, and customer service. As service quality further improves, user expectations increase, making them more sensitive to various aspects of the transportation experience. Li (2003) asserts that punctuality and reliability are higher on commuters' priority lists than cost, as full-time workers often face time constraints that outweigh monetary expenditures.

Hansson et al. (2019) conducted several studies on regional public transport and identified frequency, comfort, reliability, travel time, and network coverage as important

quality attributes. Behrens et al. (2018) also observed that users expressed satisfaction with trip times, highlighting its significance. Mouwen (2015) examined public transport from a customer perspective and found that on-time performance, travel speed, and service frequency were the most influential factors in overall satisfaction with public transportation. Driver behaviour and vehicle cleanliness were also important considerations. De Ona, de Ona, Eboli, and Mazzulla (2013) reported in their study that user satisfaction was significantly influenced by the speed, frequency, punctuality, and quality of information provided by public transportation. Arora and Joti (2016) discovered that factors such as "Ease of getting on and off the bus" and "Travel time to cover the distance you travel" exhibited significant correlations with almost all other factors. Overall, these findings emphasize the significance of travel time, punctuality, reliability, frequency, as key quality attributes influencing user perceptions and satisfaction with public transportation. Understanding these preferences can assist transportation planners and providers in enhancing the quality of their services to better meet the needs and expectations of users.

5.1.2 Cost or fares

The study findings reveal that the cost or ticket price is considered the second most important quality attribute in public transportation modes. Passengers prioritize quantitative factors such as time, cost, bus route information, and crowding levels when evaluating the key features of public transportation (Sinha et al., 2019).

Zeithaml, Parasuraman, and Berry (1990) explain that customers' perception of value is influenced by the sacrifices they make while using a service, which encompasses both monetary and non-monetary costs. The customer's frame of reference also plays a significant role in shaping their perception of value. Consequently, differences in customers' value perception can arise from various factors, including costs, attitudes towards services, past experiences, situational circumstances, sociodemographic characteristics, and behavioural traits (Mouwen, 2015).

5.1.3 Direct service

Based on the results of this study, participants identified direct service as the third most important quality attribute in regional public transport modes. This finding aligns with the

emphasis placed by Pavlína (2015) on factors such as station proximity, service continuity (which is linked to direct service), and frequency as determinants of passenger satisfaction in the Czech Republic. Direct service offers several advantages, including reliable schedules, reduced travel time, and a decreased risk of losing baggage.

5.1.4 Information

In the study conducted by Bachok et al. (2011), it was found that easily comprehensible public transport information is crucial, particularly for frequent travellers. Similarly, Iseki and Smart (2019) identified information and connectivity as moderately significant factors. For individuals who are using public transportation for the first time, Bachok et al. (2011) recommend the importance of knowing the destination, estimated arrival time of the next bus, and estimated arrival time at the destination. Additionally, first-time users may need to inquire about tickets and the location of the nearest bus stop.

5.1.5 Service transfers

In their study, Grise & El-Geneidy (2019) found that bus route transfers were the most dissatisfying type of transfer for travellers. While different types of transfers affect trip satisfaction in different ways, transfers in general have a negative perception among public transportation users. Imaz, Habib, Shalaby, & Idris (2015) found that trips with two or more transfers had a negative effect on customer loyalty. To improve customer experience, public transport agencies should reduce the number of trips with multiple transfers, or work to minimize waiting times by increasing service frequency or synchronizing transfers. Cascajo et al. (2019) point out that waiting and walking times are factors that affect the "transfer experience". Additionally, unfamiliarity with the trip can increase uncertainty and deter people from choosing public transportation.

5.1.6 Security

In this study, participants have indicated that in-vehicle security is ranked as the least important factor in regional public transport. Hansson et al. (2019) note that security appears to be of lesser concern in regional public transport compared to factors like comfort and network coverage, which are given higher priority. However, this does not imply that security is not important in public transportation. It could indicate that security measures are effectively implemented in public transport modes, resulting in a satisfactory level of security compared to other attributes, and users are content with the current situation. In this study, "security" refers specifically to security while using the mode of transportation and should not be confused with security at stations or while walking to a public transport mode.

Cozens et al. (2002) suggest that areas perceived as unsafe may not necessarily have high crime rates. Instead, people may have a heightened perception of crime in certain neglected or uninviting areas. Feelings of insecurity can deter individuals from using public transportation and related areas such as subways and bus stops in urban settings (Deniz, 2019). According to Alford (1996), the fear of crime is influenced by environmental and social factors, and individuals with regular opportunities to engage in unlawful activities are more likely to commit crimes.

6. Conclusions and Recommendations

The conclusions drawn in this study provide a concise overview of the research findings, results, and achievements in relation to the study's objectives. They encapsulate the key insights and implications derived from the research process. Additionally, the recommendations put forward in this study highlight areas for further investigation and suggest relevant aspects that should be considered in future studies. These recommendations aim to guide future research endeavours and contribute to the ongoing advancement of knowledge in the field.

6.1 Conclusions

In conclusion, our research involved surveying 282 daily commuters during peak hours from various areas in Cape Town, including Bellville, Khayelitsha, and Mitchells Plain. Each area had 75 users surveyed, and we examined the modes of transport they used, including minibus taxis, buses (GABS and My Citi), and trains.

The objective of our study was to explore the concept of a "user quality pyramid" for public transport modes using the Best-Worst Scaling (BWS) method. Based on our findings, we concluded that travel time and affordability are the most important service attributes in regional public transport modes, while security and service transfers are of lesser importance to users.

We also discovered that the perception of public transportation varies significantly based on customer characteristics, situational conditions, and past experiences, such as negative safety incidents. Furthermore, our research confirmed the existence of the theoretical user quality pyramid, which highlights users' priority needs, as demonstrated in Figure 20 to Figure 23.

Although there were slight variations in perceived service quality among different regions and modes, certain features consistently received high ratings across modes. For example, direct service and ease of use were identified as the most important attributes in Golden Arrow bus services, while affordability and vehicle cleanliness were deemed crucial in minibus taxi services in the Cape Town area.

It is important to note that some attributes were equally important to users, indicating that they were unwilling to compromise on one over the other. However, our analysis consistently revealed that travel time and affordability were the most important quality

features across all modes of transportation and areas, while security and information were consistently rated as less important.

This does not imply that security is not essential or a concern for users. Instead, it suggests that in-vehicle security may be adequately addressed in public transport modes or that it is not prioritized when compared to other attributes, indicating user satisfaction with the current situation. It is also possible that security concerns may be viewed as a broader community issue rather than solely a public transport issue, as security incidents often occur while individuals are traveling to or from public transportation stations or stops.

6.1.1 Achievement of objectives

The following objectives were met in accordance with the specific research objective:

- Review literature related to public transport modes, customer satisfaction, user quality perception, and preference. **The review indicates that public transport user quality preference and perception has not been widely studied. As a result, several studies only investigate transport performance measures instead of user-related and softer projects such as improving quality and accessibility.**
- Investigate the existence of a user quality pyramid and quantify quality attributes that have the most influence on public transport users' choice when selecting a public transport mode. **Based on the empirical data, it is now confirmed that a quality pyramid exists in public transport mode users.**
- Explore the use of the BWS method in measuring user quality preference and perception on public transport modes in Cape Town. **The BWS approach is more efficient in measuring preference as it compels a respondent to make a trade-off, forcing discrimination between two or more items.**
- Make recommendations to engineers, planners, researchers, decision-makers, and other professionals on a state-wide basis in the development and review of public transport planning. **Planners and engineers are encouraged to consider the user's perspective and preference when designing and offering public transport services.**

6.1.2 Major contributions to the literature

By successfully achieving its objectives, this study has made a significant contribution to the existing literature in the transportation field. It has advanced the understanding of user perceptions in public transport by developing a comprehensive hierarchical model

that incorporates various quality dimensions. Moreover, this study has provided empirical evidence supporting the effectiveness of the hierarchical model in conceptualizing and measuring customers' perceptions of service quality in public transport modes. As a result, the outcomes of this research are expected to have practical implications for the public transport industry, marketers, and transport planning practitioners, enabling them to devise and implement effective policies and business strategies.

A distinguishing aspect of this thesis is the utilization of the Best-Worst Scaling (BWS) method for data collection and estimation of user perceptions and preferences in public transport. In contrast to previous studies that relied on rating and ranking scales, which often lack the ability to capture trade-offs among items, the BWS method employed in this study ensures a more accurate measurement of user preferences. Unlike rating scales where multiple items can receive similar ratings, making it difficult to determine the best among them, BWS forces respondents to make choices and explicitly identify the most preferred and least preferred items. This approach enhances the precision and reliability of capturing user preferences, making BWS the preferred method for measuring user preferences in public transport research.

Overall, this study's adoption of the BWS method, coupled with the development of a hierarchical model, has significantly advanced the understanding of user perceptions and preferences in the public transport context. Its findings are expected to contribute to the improvement of service quality, customer satisfaction, and decision-making processes within the public transport industry.

6.2 Recommendations

To ensure the validity and robustness of our research findings, we propose several recommendations for further validation and expansion:

1. **Conduct comparative studies:** To enhance the credibility of our study, we suggest conducting similar research using the Best-Worst Scaling (BWS) method in public transport studies in different regions or countries around the world. Comparing the results from diverse contexts will provide valuable insights into the generalizability of our findings and help identify any variations or similarities in user preferences across different cultural and geographical settings.
2. **Explore other metropolitan areas:** While our research focused on Cape Town, it would be beneficial to extend the study to include other major metropolitan areas in South Africa. This will allow for a broader understanding of user perceptions and preferences in different urban contexts. By examining multiple cities, we can identify common trends and patterns as well as any unique factors that may influence public transport quality attributes. This will contribute to a more comprehensive understanding of user needs and inform policymakers and operators in various regions.
3. **Enhance the quality of service:** To improve public perception of public transport and enhance user satisfaction, it is crucial for operators and decision-makers to prioritize the improvement of service quality in public transport modes. This includes addressing the key quality attributes identified in our study, such as travel time, affordability, direct service, and ease of use. By investing in infrastructure, technology, and operational strategies, public transport providers can work towards enhancing these attributes and meeting the expectations of their users. This may involve optimizing routes, increasing frequency, ensuring affordability, implementing reliable information systems, and prioritizing security measures. Continual monitoring and assessment of service quality will help identify areas for improvement and enable targeted interventions.
4. **Stakeholder collaboration:** Collaboration among various stakeholders, including public transport operators, government authorities, urban planners, and community representatives, is essential for implementing the recommended improvements. By working together, these stakeholders can share knowledge, resources, and expertise to enhance the quality of public transport services.

Regular communication channels and feedback mechanisms should be established to gather input from users and incorporate their perspectives in the decision-making process. This collaborative approach will ensure that the efforts to improve public transport align with the needs and expectations of the communities they serve.

In conclusion, by conducting further research, expanding the study to other metropolitan areas, and focusing on improving service quality, we can validate and build upon the findings of our research. These recommendations aim to contribute to the development of more reliable and user-centric public transport systems, ultimately enhancing the overall quality of transportation and improving the experiences of passengers.

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doi:DOI: 10.5897/AJBM10.1586

Appendices

Appendix A. General Service Quality Attributes

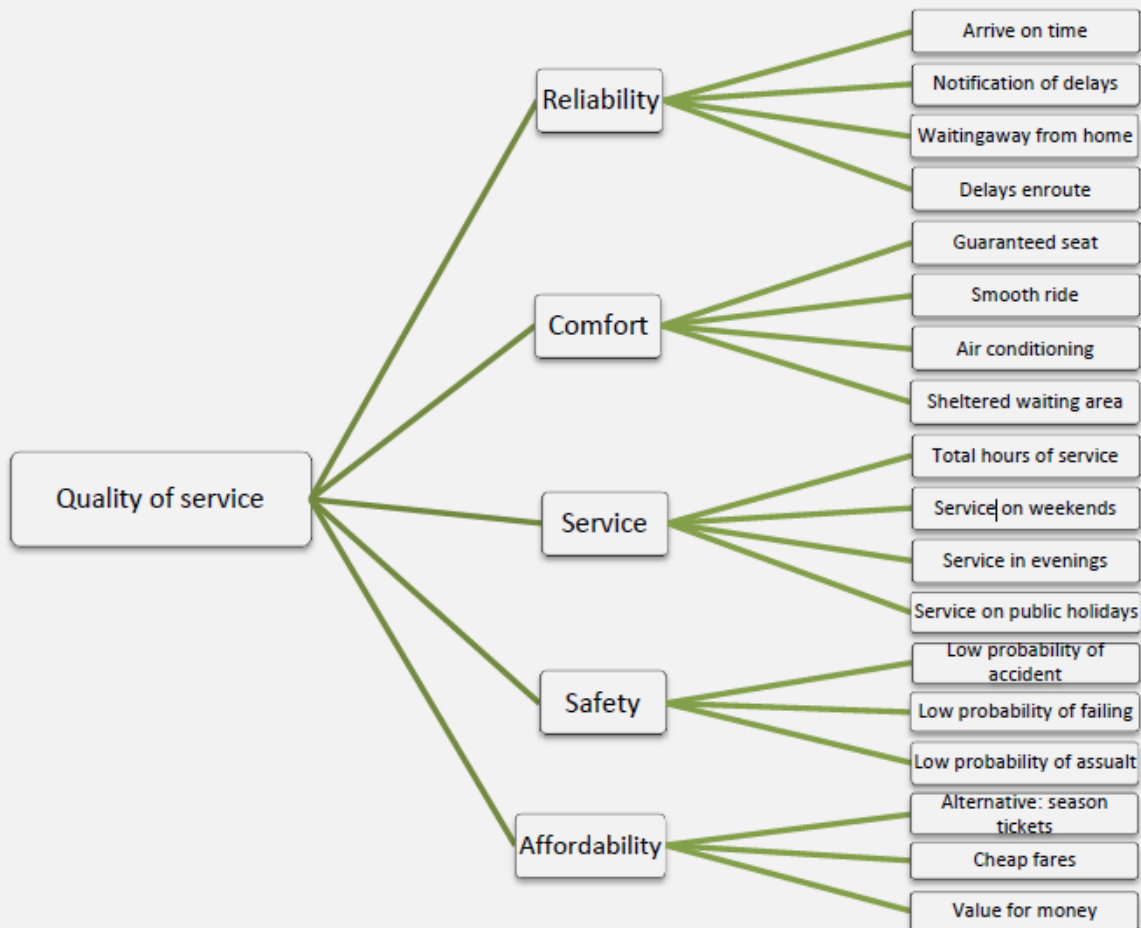


Figure 23: Quality service attributes, RCSSA (McKnight, et al., 1986)

Appendix B. Research Ethics Application Form

Application for Approval of Ethics in Research (EIR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

ETHICS APPLICATION FORM

Please Note:

Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: <http://www.ebe.uct.ac.za/ebe/research/ethics1>

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant	Sandisile Walaza WLZSANO0	
Department	EBE – Transport Studies	
Preferred email address of applicant:	walazasp@gmail.com	
If Student	Your Degree: e.g., MSc, PhD, etc.	MSc
	Credit Value of Research: e.g., 60/120/180/360 etc.	120
	Name of Supervisor (if supervised):	Mark Zuidgeest
If this is a research contract, indicate the source of funding/sponsorship	—	
Project Title	Public Transport Modes: Measuring user quality perception & preference in Cape Town.	

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Sandisile Walaza	Signed	10/11/2020
SUPPORTED BY	Full name	Signature	Date
Supervisor (where applicable)	MHP Zuidgeest	Signed	10/11/2020
APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).			
Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.	R Behrens	Signed	27 Dec 2020

Appendix C. Public Transport Quality Attributes Selected for Evaluation in this Project

Table 22: Specific service attributes to be measured/ evaluated in Cape Town

Attributes	Issue to be assessed
Affordability/ Ticket price/ fare	Is public transport price/ fare affordable?
Station/service proximity	Are public transport stations accessible without any problem?
Comfort	How comfortable the journey is regarding access to seat, noise levels, driver handling, air conditioning?
Service frequency	How often the service operates during a given period?
Direct service	Is the route network coverage sufficient? No transfers?
Service Transfers	Are transport changes not complicated?
Easy to Use	Is it easy to find about routes and easy to change from one mode to the other?
Information	Is the information in the public transport vehicles (maps, station signals) sufficient?
Vehicle cleanliness	Is the public transport mode clean and maintained?
Flexibility to travel	Is there a provision of long service period (also in off-peak)?
Travel time	Is the travel time in the vehicle reasonable? Short or quicker?

Appendix C Public Transport Quality Attributes Selected for Evaluation in this Project

Security	Are users feeling personal security while using the public transport mode?
Safety	Are users feeling safe from accidents and injuries while using public transport?
Reliability	Is the public transport reliable in terms of schedules?

Appendix D. Research Questionnaire



18/02/2021

Faculty of Engineering & the Built Environment Transport Studies Programme

Centre for Transport Studies
c/o Department of Civil Engineering
University of Cape Town
Private Bag
Rondebosch
7701

Dear Mr/Mrs/Ms:

You are invited to participate in a research study titled "**Public transport modes: Measuring user quality perception and preference in Cape Town**". This study is being conducted by Sandisile Paul Walaza as a Master of Science student in Civil engineering department at the University of Cape Town. Sandisile is under the supervision of Professor Mark Zuidgeest together with Mr Pieter Onderwater as a co-supervisor from the Faculty of engineering and the built environment at University of Cape Town and from Hatch public transport innovations, in Umhlanga respectively.

The purpose of this study is to measure user quality perception and preference on various modes of transport in Cape Town in order to verify the existence of user quality pyramid on public transport modes. This will aid us in gaining better understanding on the general public transport user quality perception and to investigate as to which service quality attribute/s has the most influence to customer satisfaction and trip decision making process in public transport modes.

In this study, you will be asked to choose the best and the worse/ least important attribute to you when choosing a public transport mode.

The estimated time to complete this survey is roughly 20 minutes of your time. This survey has been submitted to the research ethics committee for review and approval at the University of Cape Town as a result, approval has been gained in this regard.

While you will not experience any direct benefits from participation, information collected in this study may benefit the field of transportation planning and government officials in future by understanding public transport user quality preference and perception.

Your participation in this study is voluntary and you are welcome to withdraw your involvement from this study at any time however there are no risks associated with participating in this study as the survey collects no identifying information of any respondent. All responses in the survey will be recorded anonymously.

For any queries regarding the survey or this research project, please contact Sandisile Walaza or his Supervisor Professor Mark Zuidegeest at walazasp@gmail.com or mark.zuidegeest@uct.ac.za respectively.

By completing this survey, you are indicating your consent to participate in this study.

Your participation is appreciated.





Appendix A. Public Transport Quality Attributes Selected for Evaluation in this Project

Table 1: Specific service attributes to be measured/ evaluated in Cape Town

Attributes	Issue to be assessed
Affordability/ Ticket price/ fare	Is public transport price/ fare affordable?
Station proximity	Are public transport stations accessible without any problem?
Comfort	How comfortable the journey is regarding access to seat, noise levels, driver handling, air conditioning?
Service frequency	How often the service operates during a given period?
Direct service	Is the route network coverage sufficient? No transfers?
Service Transfers	Are transport changes not complicated?
Easy to Use	Is it easy to find about routes and easy to change from one mode to the other?
Information	Is the information in the public transport vehicles (maps, station signals) sufficient?
Vehicle cleanliness	Is the public transport mode clean and maintained?
Flexibility to travel	Is there a provision of long service period (also in off-peak)?
Travel time	Is the travel time in the vehicle reasonable? Short or quicker?
Security	Are users feeling personal security while using the public transport mode?
Safety	Are users feeling safe from accidents and injuries while using public transport?
Reliability	Is the public transport reliable in terms of schedules?

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Consent		
I hereby consent to participate in this survey	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>

Please indicate a Public transport Mode you use frequently or have used recently			
My Citi <input type="checkbox"/>	Mini Bus taxi <input checked="" type="checkbox"/>	Train <input type="checkbox"/>	Golden Arrow bus <input type="checkbox"/>
			

Please tell us, which suburban area is closest to you or are you from. Mark with an X			
Cape Town <input checked="" type="checkbox"/>	Bellville <input type="checkbox"/>	Khayelitsha <input type="checkbox"/>	Mitchells Plain <input type="checkbox"/>

Please tell us the purpose of your trip or travel, mark with an X				
Work <input type="checkbox"/>	School <input type="checkbox"/>	Leisure <input type="checkbox"/>	Shopping or business <input checked="" type="checkbox"/>	Other <input type="checkbox"/>

Please indicate your gender.			
Male <input checked="" type="checkbox"/>	Female <input type="checkbox"/>	Prefer not to specify <input type="checkbox"/>	Other

Please indicate which range includes your age?	
18 - 24	<input type="checkbox"/>
25 - 34	<input type="checkbox"/>
35 - 44	<input type="checkbox"/>
45 - 54	<input checked="" type="checkbox"/>
55 - 64	<input type="checkbox"/>

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Affordability/Ticket price/ Fare	<input type="checkbox"/>
<input type="checkbox"/>	Station proximity	<input type="checkbox"/>
<input type="checkbox"/>	Service frequency	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Direct service	<input type="checkbox"/>
<input type="checkbox"/>	Service transfers	<input checked="" type="checkbox"/>

|

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input checked="" type="checkbox"/>	Easy to use	<input type="checkbox"/>
<input type="checkbox"/>	Information	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Vehicle cleanliness	<input type="checkbox"/>
<input type="checkbox"/>	Flexibility to travel	<input type="checkbox"/>
<input type="checkbox"/>	Travel time	<input type="checkbox"/>

2.

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input checked="" type="checkbox"/>	Security	<input type="checkbox"/>
<input type="checkbox"/>	Safety	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Reliability	<input type="checkbox"/>
<input type="checkbox"/>	Comfort	<input type="checkbox"/>
<input type="checkbox"/>	Affordability/Ticket price/ Fare	<input type="checkbox"/>

3

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Station proximity	<input type="checkbox"/>
<input type="checkbox"/>	Service frequency	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Direct service	<input type="checkbox"/>
<input type="checkbox"/>	Service transfers	<input type="checkbox"/>
<input type="checkbox"/>	Easy to use	<input checked="" type="checkbox"/>

CF :

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Information	<input type="checkbox"/>
<input type="checkbox"/>	Vehicle cleanliness	<input type="checkbox"/>
<input type="checkbox"/>	Flexibility to travel	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Travel time	<input type="checkbox"/>
<input type="checkbox"/>	Security	<input checked="" type="checkbox"/>

5

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Safety	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Reliability	<input type="checkbox"/>
<input type="checkbox"/>	Comfort	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Affordability/Ticket price/Fare	<input type="checkbox"/>
<input type="checkbox"/>	Station proximity	<input type="checkbox"/>

6

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Service frequency	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Direct service	<input type="checkbox"/>
<input type="checkbox"/>	Service Transfers	<input type="checkbox"/>
<input type="checkbox"/>	Easy to use	<input type="checkbox"/>
<input type="checkbox"/>	Information	<input checked="" type="checkbox"/>

7

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Vehicle cleanliness	<input type="checkbox"/>
<input type="checkbox"/>	Flexibility to travel	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Travel time	<input type="checkbox"/>
<input type="checkbox"/>	Security	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Safety	<input type="checkbox"/>

8

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Reliability	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Comfort	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Affordability/ Ticket price/ Fare	<input type="checkbox"/>
<input type="checkbox"/>	Station proximity	<input type="checkbox"/>
<input type="checkbox"/>	Service frequency	<input type="checkbox"/>

9

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input checked="" type="checkbox"/>	Direct service	<input type="checkbox"/>
<input type="checkbox"/>	Service transfers	<input type="checkbox"/>
<input type="checkbox"/>	Easy to use	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Information	<input type="checkbox"/>
<input type="checkbox"/>	Vehicle cleanliness	<input type="checkbox"/>

10

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Flexibility to travel	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Travel time	<input type="checkbox"/>
<input type="checkbox"/>	Security	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Safety	<input type="checkbox"/>
<input type="checkbox"/>	Reliability	<input type="checkbox"/>

11

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Comfort	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Affordability/ Ticket price/ Fare	<input type="checkbox"/>
<input type="checkbox"/>	Station proximity	<input type="checkbox"/>
<input type="checkbox"/>	Service frequency	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Direct service	<input type="checkbox"/>

12

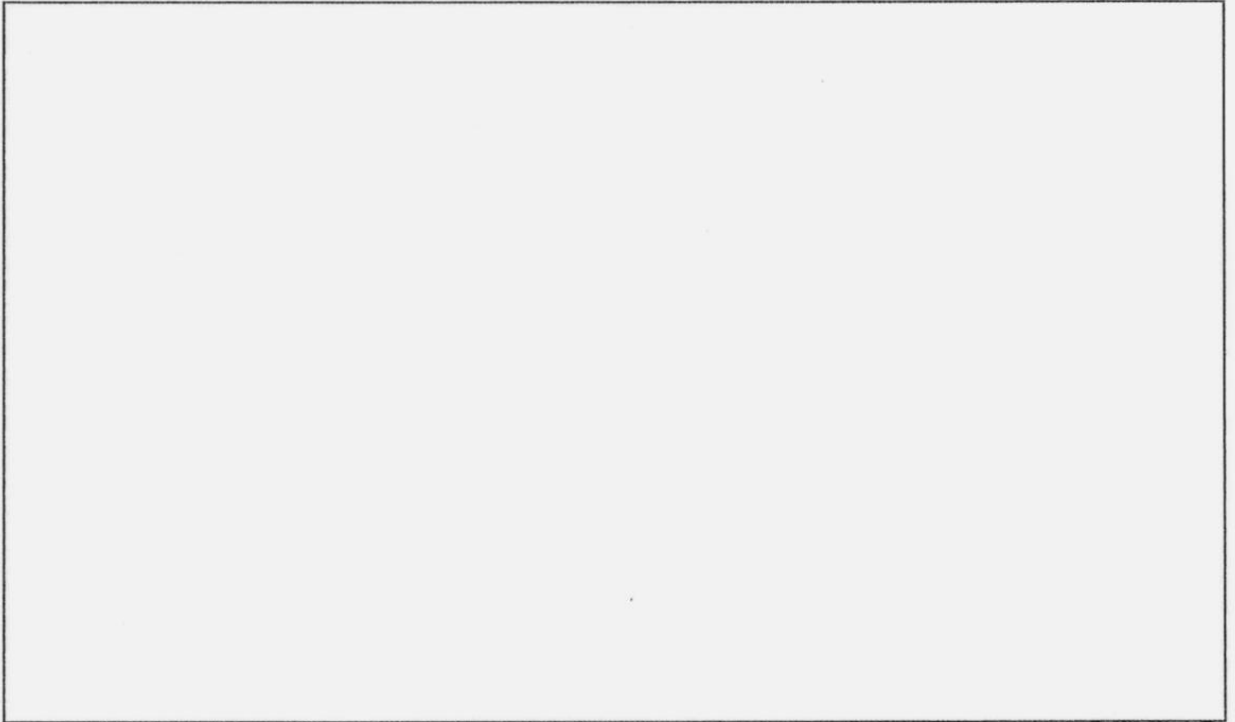
In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input type="checkbox"/>	Service Transfers	<input type="checkbox"/>
<input checked="" type="checkbox"/>	Easy to use	<input type="checkbox"/>
<input type="checkbox"/>	Information	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Vehicle cleanliness	<input type="checkbox"/>
<input type="checkbox"/>	Flexibility to travel	<input type="checkbox"/>

13

In the following list, please rank what you consider as the most important and least concerning attribute to you when choosing a public transport mode.		
Most Important	Attribute	Least concerning/ Not important
<input checked="" type="checkbox"/>	Travel time	<input type="checkbox"/>
<input type="checkbox"/>	Security	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Safety	<input type="checkbox"/>
<input type="checkbox"/>	Reliability	<input type="checkbox"/>
<input type="checkbox"/>	Comfort	<input type="checkbox"/>

14

Do you have any suggestions or comments with regards to this survey for improvement?

A large, empty rectangular box with a thin black border, intended for respondents to provide suggestions or comments regarding the survey for improvement.

Appendix E. Activity Scheduling and Critical Tasks

Activities on the Critical path

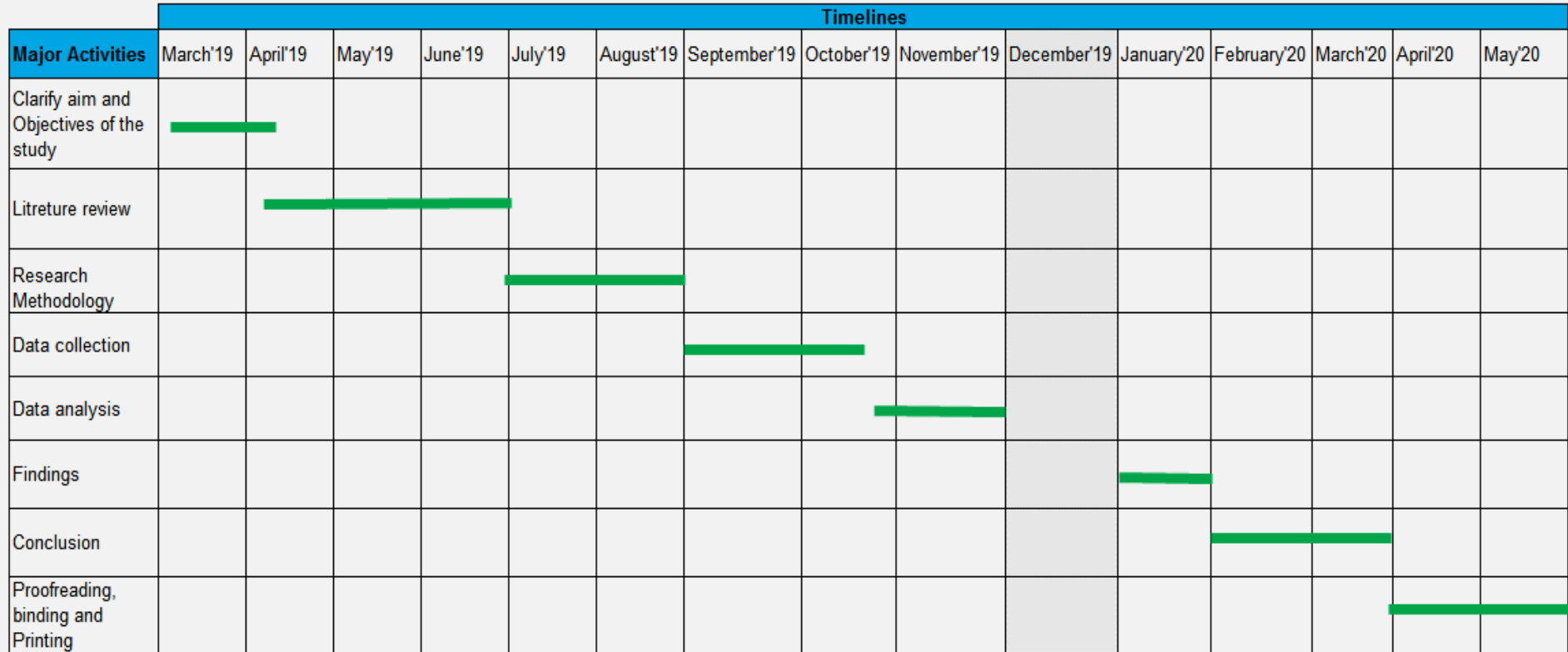


Figure 24: Critical path

Appendix F. Time allocation to Major activities

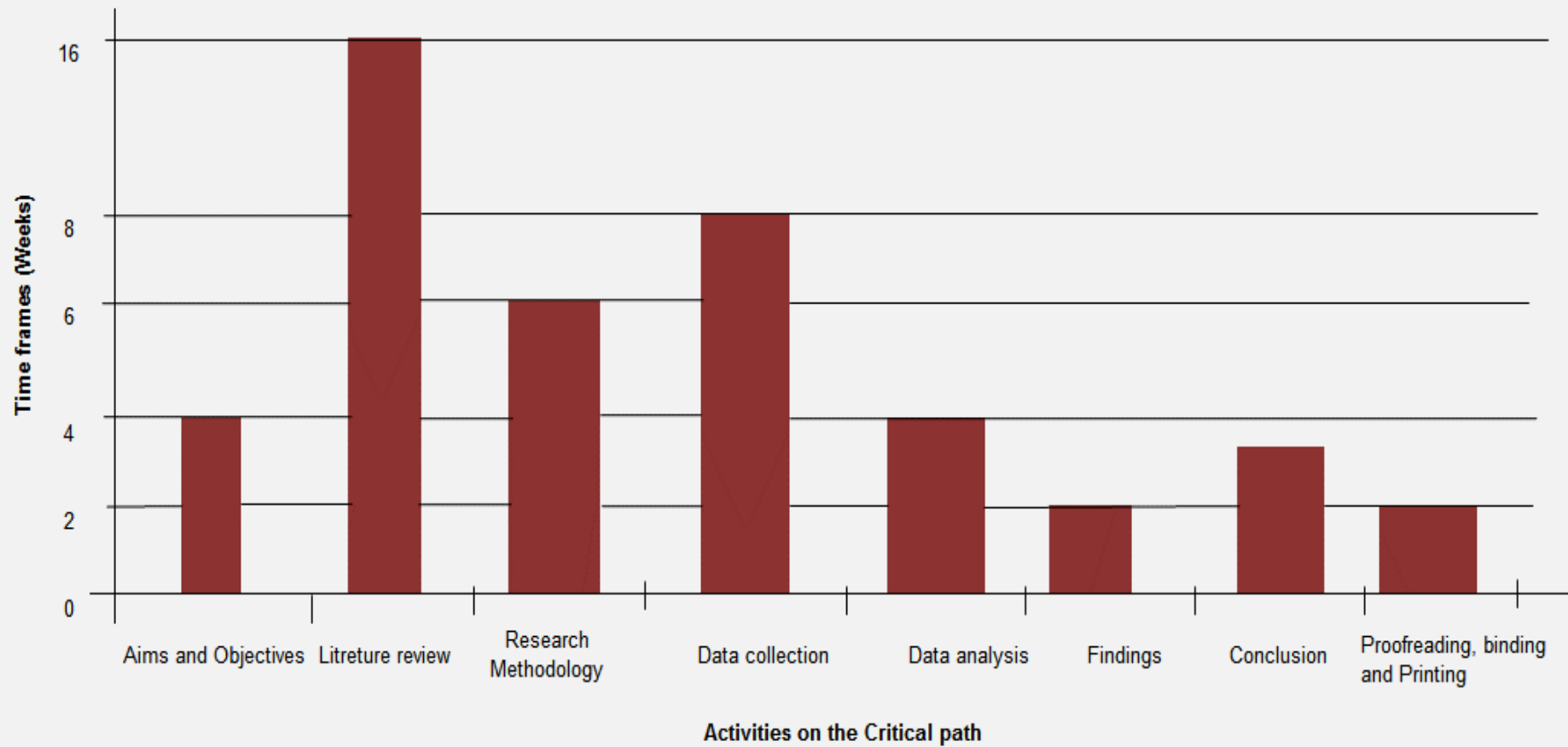


Figure 25: Time frames for major activities

Appendix G. Survey Design and Data Collection Process

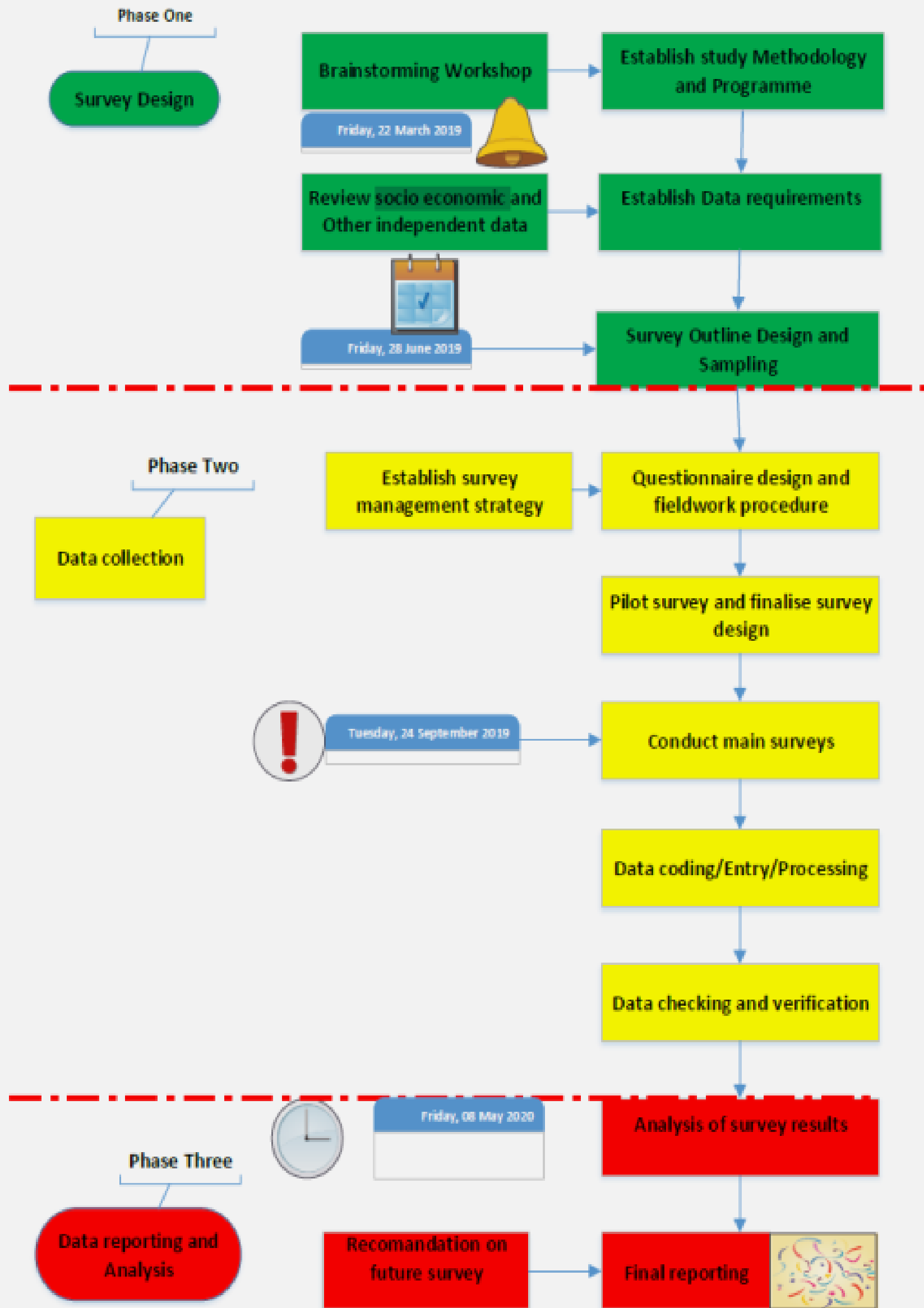


Figure 26 Survey Process

Appendix H. BWS Design Report

DEMO MODE. This report shows the information for your design, as would be generated by the professional (rather than demo) version of the software. The design actually used in demo questionnaires (when previewing or testing/running the survey) is simply the items appearing in sequential order, for all respondents.

Design Parameters

Items	14
Items per Question (Set)	5
Questions (Sets) per Respondent	14
Versions	1
Iterations	0
Random Seed	0
Prohibitions	0
Chosen Iteration	1

One-Way Frequencies

Item	Times Used
1	5
2	5
3	5
4	5
5	5
6	5
7	5
8	5
9	5
10	5
11	5
12	5
13	5
14	5
Mean	5.00
Standard Deviation	0.00

Two-Way Frequencies

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	5													
2	4	5												
3	3	4	5											
4	2	3	4	5										
5	1	2	3	4	5									
6	0	1	2	3	4	5								
7	0	0	1	2	3	4	5							
8	0	0	0	1	2	3	4	5						
9	0	0	0	0	1	2	3	4	5					
10	0	0	0	0	0	1	2	3	4	5				
11	1	0	0	0	0	0	1	2	3	4	5			
12	2	1	0	0	0	0	0	1	2	3	4	5		