Measuring Public Transport Preferences in Cape Town using Best-Worst Scaling

by

Maxine Nokuthula Thanjekwayo

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Master of Engineering

Supervisor:

Prof. Mark Zuidgeest

Prof. Roger Behrens

Department of Civil Engineering

Faculty of Engineering and the Built Environment

UNIVERSITY OF CAPE TOWN

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Abstract

Commuter preference and service satisfaction influences transport mode choice and even when there is no choice (captive travellers) there is dignity in providing minimal quality. It has been proven that a shift from private transport towards public transport is rare. It is therefore easier to improve satisfaction or perceptions of captive public transport users than to move car users to public transport. Except in Greece where well-timed transport improvement during an economic downturn resulted in an increase in public transport use. The national fiscus has competing priorities it supports infrastructure, health, education, public transport and many other government services. Justification for funding public transport in lieu of other government priorities is linked to commuter demand. Commuter demand is measured by the number of passengers per mode or trip. The goal for public transport modes is full occupancy of vehicles. Higher occupancy rates justify the trip and by implication the fiscal investment on the trip and or mode. Commuters choose transport modes based on a number of attributes such as: cost, travel time, access time, frequency of service, comfort, safety etc. Therefore, improving public transport users preference capture may lead to better informed public transport improvement investments decisions.

Case 2 best worst scaling is a survey method that compares varying attributes to one another by soliciting a ranking of one best and one worst. The method allows for at least three attributes per domain of investigation. Each attribute's attribute level is compared, in a choice set, to other attributes' attribute level.

Commuters seek a transport service from origin to destination that is safe, economical and comfortable. Commuter studies show that needs and levels of satisfaction vary from person to person and mode choices are usually restricted by affordability. However, as soon as there is affordability for better options, commuters always choose the most responsive mode. In urban areas this choice is evidenced by higher percentage of low-occupancy private car commute. The aim of this research was to determine the applicability of case 2 best worst scaling; and commuter preferred service attribute levels for travel, safety and comfort for Bus, Minibus Taxi, MyCiTi and Train commuters in Cape Town.

The study used attributes and dissatisfaction data from the National Household Travel Survey to identify key attributes and attribute levels for investigation. Case 2 best worst scaling surveys were designed as follows: three domains – travel, safety and comfort; three to four attributes

per domain; and each attribute tiered into attribute three levels. The field work was intercept surveys to Cape Town commuters.

Data were analysed using R and yielded the following key findings: Case 2 best worst scaling is applicable for preference studies in South Africa and beyond; paying more, experiencing sudden braking and overcrowding were least preferred (disutility); there were nuanced variations for other attribute levels based on mode and demographic groups.

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1. Introduction

The provision of public transport and transport infrastructure is generally a government function (Farrar et.al, 2019). However, there are cases where a Public-Private-Partnership model is used to provide public transport. In South Africa varying degrees of Government involvement in Public Transport are observed in regulation, subsidisation, and operations.

According to Statistics South Africa(2021) the work bound transport modes breakdown countrywide are: train (1.1%), bus (5.8%), taxi (28.1%), private transport – car/truck (43.5%), walking all the way (20.3%), other (1.2%). Commute for work or school are the main generator of trips. However, unrestrained car-reliant development is unsustainable. In the Western Cape, the commuter modal split is minibus-taxi (20.3%), train (2.2%), bus (6.5%), private transport (56.0%), walking (14.0%) and other (1.0%) (Statistics South Africa, 2021). There is no disaggregated modal comparison between the 2013 and 2020 statistics. According to Statistics South Africa(2022), the mode split for work trips in the City of Cape Town is minibus-taxi (25.5%), train (3.2%), bus (8.9%), private transport (45.8%), walking (6.6%) and other (0.5%) (*Table 1.1)*. It is worth noting that bus in the City of Cape includes the MyCiti (bus rapid transport service) and other operators like the Golden Arrow Bus services.

Table 1.1 Modal Split (Source: Statistics South Africa, 2021,2022)

Mode	**South Africa (NHTS 2021)**	**Western Cape (NHTS 2022)**	**Cape Town (NHTS 2022)**
Walking	20.3%	14%	6.6%
Train	1.1%	2.2%	3.2%
Bus	5.8%	6.5%	8.9%
Minibus Taxi	28.1%	20.3%	25.5%
Private car	43.5%	56%	55.3%
Other	1.2%	1%	0.5%
Total	**100%**	**100%**	**100%**

Statistics South Africa (2022), in the National Household Travel Survey (NHTS) records that only 6.7% of City of Cape Town commuters have no transport problems. This implies that 93.3% are plagued by one or more transport-related problems. The following issues were highlighted: congestion, crime, rude drivers, overloading and poor road conditions these and mode specific problems. Attributes that influence Cape Metro commuters transport mode selection (in order of importance) are travel cost, comfort, reliability, travel time, flexibility, security from crime, distance from home to mode (accessibility), safety from accidents, timetable availability (inaccurate information), and drivers' attitude. The above attributes account for 99% of mode choice factors while the rest is mode specific issues (Statistics South Africa, 2022).

Government seeks to promote mass transit which uses less space per person when compared to private motor vehicle. Investment in Public Transport is justified by number of passengers per trip (pax). One of the NATMAP 2050's vision is, "A much-improved sustainable public transport system that is appropriately funded, with a reduction in the subsidy burden, with better and safer access, more frequent and better-quality services and facilities to an agreed standard" (Department of Transport, 2017). Unless the better-quality services are adequately quantified, the prevalent urban transport investment model that favours the private motor vehicle may continue unabated (Gössling, 2016; Abenoza et.al, 2017).

Commuter preference and service satisfaction influences transport mode choice and even when there is no choice (captive travellers) there is dignity in providing minimal quality. It has been proven that a shift from private transport towards public transport is rare, it is easier to improve satisfaction or perceptions of captive travellers (Gao and Sun, 2017; Mokonyama and Venter, 2018) except in Greece where well-timed transport improvement during an economic downturn resulted in an increase in public transport use (Efthymiou and Antoniou, 2017). Well informed investment in public transport improvements might delay the shift to private passenger car (Mokonyama and Venter, 2018). Various studies have explored the significant attributes and preference informing transport mode choice in South Africa however the extent to which an improvement in the attribute would be meaningful to a captive traveller is not always conspicuous (Farrar et.al, 2019; Mokonyama and Venter, 2019; Behrens et.al, 2018; Hayes and Venter, 2016)

There have been numerous studies on commuter satisfaction for various modes using analysis such as: qualitative analysis (Luke and Heyns, 2020), importance-performance analysis (Farrar et.al. 2019; Behrens et.al 2019), discrete choice model analysis (Gao and Sun, 2017) and case 1 best-worst analysis (Teffo et.al 2019, Beck and Rose 2016, Echaniz et.al. 2019). Farrar et.al (2019) found conflicting outcomes that suggests that the gap score method might result in an erroneous underestimation of attributes when their analysis resulted in safety from crime being deemed of low importance. Behrens et.al. (2019) confirmed importance of safety and security yet concedes that a network-wide comparison may necessitate data collection at the same time. Luke and Heyns (2020) found varying levels of expectations and satisfaction for the main PT modes in Johannesburg, but the analysis of the Likert scale rating doesn't reveal the willingness to pay for nor willingness to accept for attribute quality.

The national fiscus has competing priorities (National Treasury, 2022) improving public transport users preference capture may lead to better informed public transport improvement investments decisions. Gao and Sun (2017) explored the sensitivity to attributes improvements while Echaniz et.al (2019) and Beck and Rose (2016) proved that best worst scaling is resource efficient for comparing attributes. Teffo et.al. (2019) explored the case 1 best-worst scaling in the Cape Town, South Africa to rank service quality preferences. A comparison of BWS cases point towards potential for broader insights from case 2 and 3 (Beck and Rose, 2016; Beck et.al. 2017); case 2 ranks the levels of service quality preference. To date in the South African context, the preferred attribute levels have not been compared to each other.

1.1. Rationale for the Study

In the preceding paragraphs it was evident that public transport operation is a melting pot for at least three stakeholder group namely: passengers, operators and government; interacting under the unfortunate paradigm of Economics, that is based in the law of scarcity. This therefore necessitates a careful balance to maintain optimum conditions developed through well founded solutions. To that effect this section explores the research problem, objectives and questions.

1.1.1. Research Problem

For the government, transport systems (infrastructure, policies, resources and operations) are the catalyst to economic growth, which then leads to increased government revenue (Chitate, 2016 and Goosen, 2016). The government facilitates this economic growth through policies, subsidies, concessions and infrastructure outlay at the opportunity cost of other objectives and increasing debt (Department of Transport, 2017 and National Treasury, 2022) .

The operators (private or parastatal) seek sustainability where the passenger demand is met by their supply at a profitable price. Each vehicle (for all modes) has a minimum number of required passengers that determine the break-even point, where the operating cost is equal to the revenue collected. Peak periods are characterised by high predictable passenger demand and the struggle to supply before the passenger's waiting time informs a mode shift. Offpeak presents lower and unpredictable passenger demand and an equally unpredictable supply.

Passengers seek a service from origin to destination that is safe, economical and comfortable. Commuter studies show that needs and levels of satisfaction vary from person to person and mode choices are usually restricted by affordability (De Oña, 2022). However, as soon as there is affordability for better options, commuters always choose the most responsive mode. In urban areas this choice is evidenced by higher percentage of low-occupancy private car commute (Statistics South Africa, 2021 and 2022). Low occupancy private car use contributes to congestion and pollution (NDOT, 2017). These increase the burden to the health, environment and economic productivity. It is therefore important to study commuter preferences to inform responsive public transport service improvements. This study seeks to improve the articulation of a commuter preference studies.

1.1.2. Research Objectives

Though the public transport problem is multifaced, it is clear that understanding the passengers' needs is imperative. This research is limited to the following objectives:

- Exploring the applicability of case 2 best-worst scaling for passenger preference.
- Comparing passenger preference across modes for minimal performance standards of reliability, travel time and cost.
- Determining the preferred attribute levels per mode and domain.

1.1.3. Research Questions

In order to meet the research objectives and partially solve the research problem, this study explored the following questions:

- When is case 2 best-worst scaling applicable for passenger preference studies in South Africa?
- What is the attribute level required by passenger across modes for reliability, travel time and cost?
- How can safety from crashes and security be measured for passengers across modes?
- What comfort levels are expected by passengers across modes?

The research scope is 200 adult transport users of the following land transport modes: Golden Arrow Bus, MyCiti (BRT), Metrorail train, minibus taxi (van) across all associations in Cape Town. Research excludes exclusive e-hailing, private shuttle or transfer transport modes. The intercept surveys were conducted at the Cape Town CBD transport nodes.

1.2. Outline of Chapters

The layout of the dissertation is as follows: introduction, literature review, research methodology, data analysis, discussion and recommendation, conclusion, reference, and annexures.

Chapter 1: Introduction to give an overview of the research, research problem, research objectives and research questions.

Chapter 2: Literature Review to provide the academic foundation for the study and identify the gap in literature for case 2 best worst scaling.

Chapter 3: Research Methodology to describe case 2 best worst scaling questionnaire design and demonstrate the domain, attributes and attribute levels selection.

Chapter 4: Data Analysis to analyse the data and present key results.

Chapter 5: Discussion to explain the key results, insights, applicability of the findings and the limitations of the research.

Chapter 6: Conclusion to reflect on the research findings in light of the research objectives and questions.

Chapter 7: Recommendations to highlight any areas of further articulation for similar future studies.

Chapter 8: Reference to provide a list of consulted literature.

Annexures: To share the questionnaires used for the research.

2. Literature Review

2.1. Introduction

Preference studies are conducted in many industries. In the medical fraternity they are sometimes used to solicit patients' willingness to accept possible side-effects of treatments (Tatar et.al, 2022). In the services industries they are used to optimise client experiences in order to gain or retain clients (Gupta, 2018). In product development they are used them to determine the best permutation of product features that would satisfy clients (Wankmuller et.al, 2020).

This section summarises relevant literature on commuter preference studies, insights and gaps in knowledge. Commuter preference studies are important for transport policy makers, transport operators, transport planners, transport investment funders, transport economists, development practitioners, statisticians, commuters and other affected practitioners. In commuter preference studies commuter have an opportunity to communicate their likes or dislikes and in some cases the reasons for their choices (Abenoza et.al 2017; Anciaes et.al, 2018; Bansal et.al, 2022; De Oña, 2022). Statisticians capture a snapshot in time of the state of the transport according to the commuter based off a certain criteria (Statistics South Africa 2021, 2022). Development practitioners determine possible interventions for a desired future state informed by current commuter sentiments and expressed expectations (Abenoza et.al, 2017; Paulo et.al, 2018). Transport economists use them to inform transport demand-supply estimates (De Oña, 2022). Transport investment funders use them postulate what would be a better return on investment for the available funds in the transport sector (Abenoza et.al, 2017, Veeneman and Mulley, 2018) . Transport planners use them to forecast future demand (Abenoza et.al, 2017). Transport operators use them to identify the most efficient improvements to maximise number of commuters per vehicle (Abenoza et.al, 2017; De Oña , 2022). Transport policy makers use them to identify areas of necessary policy changes (Su et.al, 2017, Anciaes et.al, 2018, Curl et.al, 2018). The remaining sections will illustrate some of these studies and insights.

2.2. Types of preference studies

Preference studies can be divided into two kinds observed expressed or revealed preferences and stated or aspirational preference. In transport, the most basic form of preferences studies are basic counts. For example counting the number of commuters using a specific transport mode. Basic count methods only confirms what has taken place yet it doesn't provide insights into the decision making. Next level is engaging the observed decision-maker and soliciting some reasons for the decision to use a particular mode (Venter, 2016; Vanderschuren et.al, 2019; Luke and Heyns, 202). This engagement might be in a form of questions that require absolute binary choices (yes or no). The binary choices provide information on the extremes and doesn't provide individual level ranking of elements in question. In most scenarios a pattern only emerges when the sample's collective results are analysed. In order to detail a rank a Likert scale is presented to commuters. Likert scale provide a range only when the respondents do not respond in extremities or neutral answers. This method provides more data points and potentially more insights (Behrens et.al, 2018; Luke and Heyns, 200). The most insightful engagements are those which present open ended questions. These require more time for the same number of question in comparison to Likert scale surveys. Not only is engaging the commuters time consuming, the data analysis and themes formulation is time intensive. In some cases the open ended questions are not only presented to an individual, they are presented to a focus group. Focus group discussions allow for differing views to be expressed and discussed with follow-up or probing questions. This method is time intensive at both data collection and analysis stages. The shortcoming of this method is the potential emergence of group think or dominance by few strong communicators. Researchers seeking affordable data collection and analysis use a combination of methods (Behrens et.al, 2018; Luke and Heyns, 2020; Wankmuller et.al, 2020).

Scholars propose best-worst scaling as a tool for capturing respondent's perceptions that eliminates traditional bias i.e. acquiescence, extreme response, social desirability and endogeneity bias (Beck and Rose, 2016; Chrzan and Peitz, 2019; Teffo et.al. 2019; Wankmuller et.al 2020). Best worst scaling has three cases (Beck and Rose, 2016). Case 1 best worst scaling is a survey method that compares varying attributes to one another (Teffo et.al, 2019; Chrzan and Peitz, 2019). The method allows for at least three attributes to be compared at a time. When the individual's responses are analysed a pattern and ranking emerges. The sample's data analysis may lead to generalisable results. Case 2 best worst scaling is a survey method that

compares varying attributes to one another by soliciting a ranking of one best and one worst (Beck et.al, 2017; Chrzan and Peitz, 2019). The method allows for at least three attributes per domain of investigation. Each attribute's attribute level is compared, in a choice set, to other attributes' attribute level. Case 3 best worst scaling is a discrete choice experiment compares choices (profiles) with preset attribute levels (Beck et.al, 2017; Chrzan and Peitz, 2019). The choices may all be busses but with varying comparable attributes e.g. energy source, capacity, frequency, price etc. This dissertation investigates the Case 2 best worst scaling for reasons explained in the next sections.

2.3. Transport studies and tools

De Oña (2022) investigated car users' public transport service quality satisfaction and behavioural intentions. The study compared two cities, one questionnaire with 14 service quality attributes, four (4) satisfaction indicators, four (4) behavioural intention indicators. Confirmatory factor analysis was used to determine the most important service quality. Furthermore, to identify similarities between the two cities with differing geographical and sociodemographic traits, multi-group analysis (MGA) and multiple-indicator and multiple-causes (MIMIC) were used. MGA and MIMIC did not show important differences in sociodemographic characteristic. MIMIC however showed differences between cities for some sociodemographic traits. This study shows that different analyses can sometimes yield nuanced results.

Echaniz et.al (2020) researched whether the partial survey information is comparable to complete surveys. They estimated ordered probit models. First a 'base' model with the complete database. Then they added the prevalent response (value) for the missing information database and estimated the model. Second the imputed missing information using multiple imputations and modelled that too. They found that partial models with multiple imputation behave similarly to the 'base' model. This finding supports reduced survey length questionnaires.

Echaniz et al (2019) compared ordered logit and best-worst for commuter satisfaction. The study used case 1 best worst scaling. Compared it to a revealed preference survey estimated with a probit/logit model. They derived a regression model for every attribute in the Best Worst

(BW) model. They found that satisfaction levels were similar yet the relative importance differed. Even though the relative importance differed, the BW results were consistent with public transport commuter satisfaction literature. This finding holds promise for improved data quality and potentially well-informed decisions.

Beck et.al (2017) studied attitudes towards electric cars using both discrete choice (also known as case 3 best worst scaling) and case 2 best worst scaling modelling. Case 3 was used to rank car preferences and case 2 was used to solicit attitudes and beliefs. Their findings were that consumer attitudes drive behaviour as well as externalities like vehicle range availability or cost. This study showed that the outcome from both methods corroborate each other.

Song et.al (2020) synthesised stated-choice (case 3 best worst scaling), case 1 best worst scaling and case 2 best worst in their study of attitudes towards an new transport mode. They found that joint estimation revealed a consistency in perceived importance of attributes. However, the results did not yield a one-to-one relationship between the survey methods and they caution on how the attributes are evaluated between the methods.

The different studies and methods explored in this section illustrate that there is room for exploring preference studies using best worst scaling.

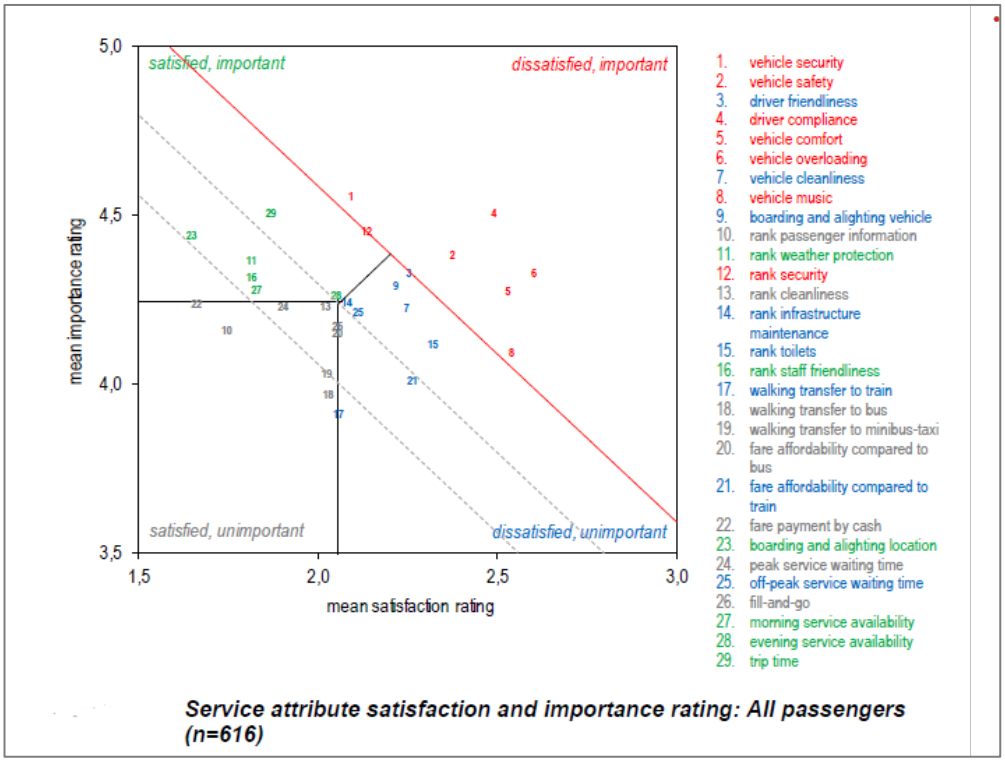
2.4. South African Public Transport Studies

The National Household Travel Survey investigated household transport patterns and choices. Ten attributes emerged as key influencers of household mode choice (Statistics South Africa, 2022). The importance ranking of the ten attributes (i.e. the first is most important and the last is least important) is as follows: cost, comfort, reliability, travel time, flexibility, security from crime, accessibility, safety from accidents, timetable/information, and drivers' attitude (Statistics South Africa, 2022). Furthermore, the extent of most important transport-related problems was captured, in Cape Town less than 7% had no transport-related problems. The highlighted problems in the order of severity include: Congestion, no trains available, crime, reckless driving by taxi drivers, no buses available, buses too far (accessibility), buses too expensive, rude drivers, trains are not available, overloading, no buses at specific times, trains too far (accessibility), poor condition of roads, reckless driving by bus drivers, taxis too

expensive, taxis too far (accessibility), no taxis available, no taxis at specific times, and no trains at specific times. A study of the statistical finding does not immediately expose the relationship between importance of attributes and level of satisfaction therefrom.

In a case study on minibus commuters, Behrens et al (2018) used a Likert scale rating of attribute satisfaction and the level of importance (*Figure 1 and 2*). Data were collected on attributes that are similar to those surveyed in the 2013 and 2020 National Household Travel Survey. Further attribute list clarification was obtained from discussions with minibus taxi association members. Data were analysed using a modified diagonal quadrant model which reduced the chances of any key attributes being deemed dissatisfactory and unimportant because of the position of the centroid, which could skew recommendations.

An example of such a shift occurs on between all passengers versus transferring passengers on an attribute that is unanimously ranked as most important, vehicle security; on one plot it is rated as satisfactory while on the other plot it is dissatisfactory (see figure 1 and figure 2 below). The position of the attribute in reference to the centroid might be elucidated through qualitative data. Behrens et.al. further cautiously compared the satisfaction levels of the different modes, the types of surveys conducted for these different modes show a gap that exists in multi-mode commuter satisfaction data.



Service attribute satisfaction and importance rating: All passengers (n=616)

Figure 1: Satisfaction and importance rating diagram for All passengers (source: Behrens et.al 2018)

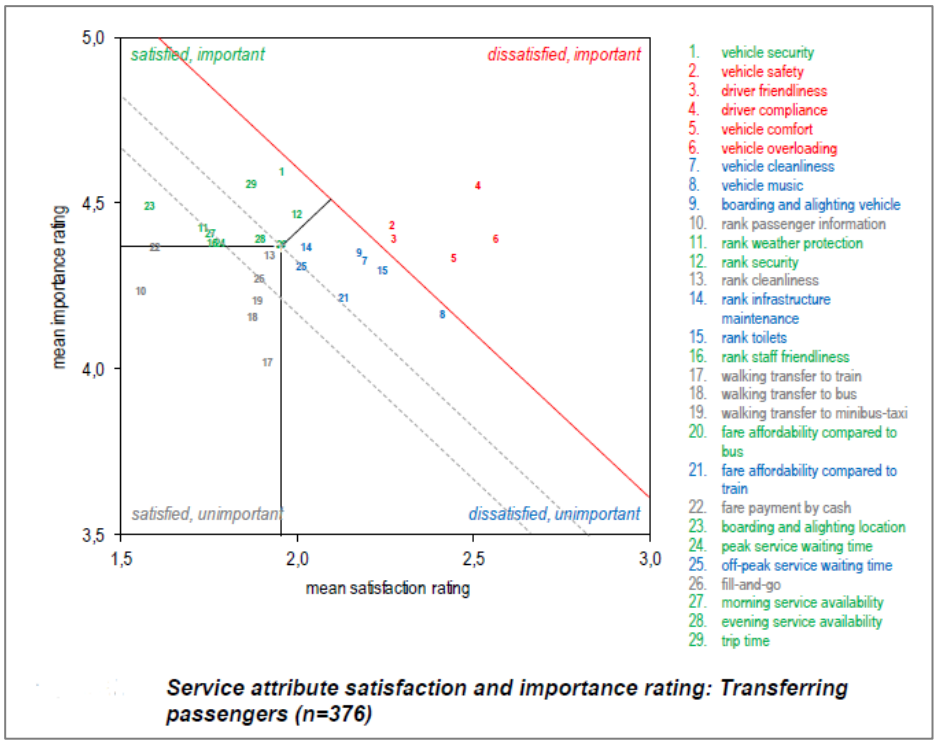


Figure2: Satisfaction and importance rating diagram for transferring passengers (source: Behrens et.al 2018)

Farrar et al. (2019) conducted intercept surveys to test perceived service quality of a subsidised bus service and the data were analysed using an importance-performance analysis (IPA). Out of the 20 service attributes measured and analysed though the outcome of the attributes perceived to be most satisfactory the interpretation of the attributed importance to the least satisfactory attributes was questioned. Farrar, et al. (2019) "It must be conceded that assigning low importance to these items, especially safety from crime, is counterintuitive and conflicts with some qualitative data collected in the same survey via open-ended questions. This calls into question the effectiveness of the gap score technique relative to a conventional, direct measure of importance." Though the IPA is powerful in extracting it seems to miss the interviewee insight on what may be important, yet dissatisfactory. Farrar et.al (2019) observations highlight a gap for direct importance and satisfaction observation of each attribute.

Teffo et.al. (2019) explored commuter perceptions using case 1 best-worst scaling using 13 in and out of mode attributes and concluded that, “The research has also shown that the BWS method can be an effective way to engage with communities to understand their prioritised areas of needs and to identify specific areas of concern.”. Soekhai et.al (2021) proves that when mixing negative and positive attributes may lead to dominance that assimilates extreme response bias, therefore care should be exercised when setting levels of attributes especially for complex attributes like safety. In the South African context, there is evidence of modal shift based on gender safety perceptions (Vanderschuren et.al. 2019).

2.5. Conclusion

The existing literature provides insights on the required areas of improvement for each of the studied modes, however, there remains a gap for concurrent studies across different modes. Furthermore, there is also an opportunity for a case 2 best-worst scaling study that could show the levels of attributes preferred per mode, among the surveyed demographic groups and overall. An improvement in commuter preference studies could lead to astute transport investment decisions.

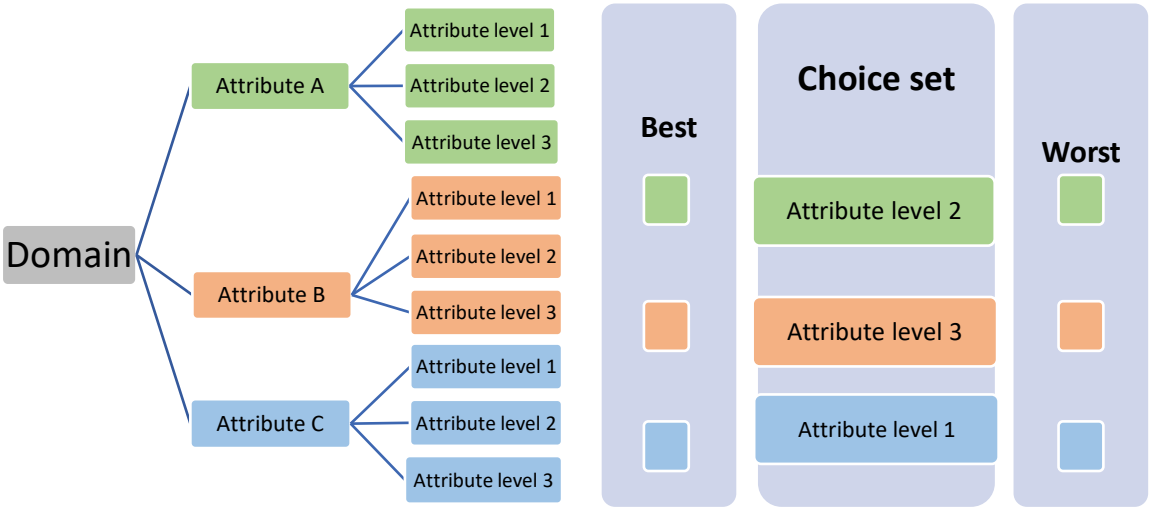
3. Research Methodology

The main methodologies and research techniques used in determining public transport user preference are mode specific surveys. This study also used surveys and the case 2 best worst scaling.

Case 2 best worst scaling is a survey method that compares varying attributes to one another by soliciting a ranking of one best and one worst. The method allows for at least three attributes per domain of investigation. Each attribute's attribute level is compared, in a choice set, to other attributes' attribute level. Each domain allows for determining, per choice set, the ranking (best or worst) of attribute A's levels against attribute B's, C's and/or D's levels. The results allow for ranking an attribute's attribute levels as well as overall attributes, this by implication what is important to the respondent for the presented domain.

The research frame is designed as follows: the attributes under investigation are tiered into attribute levels, minimum three levels; attributes to be compared are grouped into a domain; questionnaires are designed with choice sets the present varying combinations of attribute levels as illustrated in *Diagram 1* below.

Diagram 1: Domain and choice set example



The selection of attributes and attribute levels was based on the NHTS attributes and levels of dissatisfaction relevant to the attributes (expanded upon in section 3.1). The constitution of the domains was based on the necessary groupings to respond to the research questions.

Sampling was random. A minimum of 50 adults were intercepted at the four transport mode stops in Cape Town. The questionnaire included some anonymous demographical information and the case 2 best worst scaling choice sets. the section below details the attribute selection process.

3.1. Attribute selection

Statistics South Africa (2022), in the National Household Travel Survey (NHTS) confirmed the attributes for selecting a transport mode in the Cape Metro. Those attributes account for 99% of mode choice factors, disaggregated below. The remaining 1% is mode specific issues.

Even though the NHTS did not disaggregate between the bus and bus rapid transit mode, a mode specific attribute discussion will ensue. Before delving into mode-specific attributes here is a definition of these attributes:

- Travel cost affecting 29.4% of mode choice is the monetary measure of trips undertaken.
- Comfort affecting 18.4% of mode choice is a subjective measure of physical ease usually communicated as overcrowding, excessive heat, ride quality etc.
- Reliability, influences 15.9% of mode choice and measures travel time reliability, that is the assurance on destination arrival time, the extent of deviation from schedule (where there is a schedule), mode frequency/headway consistency of service quality etc.
- Travel time influences 15.7% of mode choice and measures the duration of the trip.
- Flexibility influences 10.5% of mode choice, it observes the extent to which a service is not limited to fixed routes and schedules.
- Security from crime influences 5.3% of mode choice, it measures safety from criminal activities both personal and property safety within vehicle or around the mode.
- Accessibility which influences 2.3% of mode choice, is a function of distance from home to first public transport mode. Best practice and NATMAP 2050 goal is 1km to a bus stop which is measured by up to 15 minutes' walk.

- Safety from accidents influences 0.9% of mode choice and is solely concerning in vehicle safety from accidents. This is a function of vehicle conditions, road design, surface conditions, road user behaviour, and prevailing operations among others.
- Timetable/information influences 0.4% of mode choice and is solely concerned with the availability of schedule information.

3.1.1. Bus

As reported in the NHTS for the City of Cape Town, the reasons for not using the bus were: reasons relating to service attributes (44.9%), prefer private transport (22.5%), busses not available (13.5%), prefer taxi (9.3%), don't travel much (5.2%), can walk (2.9%), prefer train (0.2%), and a further 1.4% assigned for expensive fare, overcrowding, and lateness (Statistics South Africa, 2022). When considering those that prefer other public transport modes, those not pleased with some bus service attributes, there is potentially 55,8% public transport commuters that could be influenced by well-informed improvements to the bus service offering.

3.1.1.1. Travel cost

Based on the NHTS expensive transport cost has been a consistent attribute for mode choice. In the City of Cape Town, it was expressed as dissatisfactory factor by 21.3% of the respondents (Statistics South Africa, 2022), this could be affected by other demographical data or travel budget associated with of alternative transport modes.

3.1.1.2. Comfort

The NHTS states that inside the bus, comfort is represented by the extent of overcrowding (30%). However, facilities at the bus stop (63.8%), behaviour of bus drivers towards passengers (10.0%) and other road users, and bus service overall (30.0%) stated as part of dissatisfactory elements of the bus service could undermine the sense of comfort (Statistics South Africa, 2022).

3.1.1.3. Reliability

Travel time reliability can be affected by vehicular performance (rate of breakdown), road conditions (adverse effect on travel speed), congestion (affects headway). In the NHTS, Statistics South Africa (2022) captured punctuality of busses (26.3%), frequency of busses during peak (16.3%) and frequency of busses off-peak (32.5%) as some such dissatisfaction.

3.1.1.4. Travel time

Hayes and Venter (2016) posit that commuters have a travel time budget beyond which a transport mode becomes a disutility. According to the NHTS 25.0% of City of Cape Town respondents are dissatisfied the duration of the bus trip, this is largely affected by congestion.

3.1.1.5. Flexibility

Bus routes are fixed with a few exceptions of express services which omit some stops. therefore flexibility is neither a consideration for the Bus nor the MyCiTi surveys.

3.1.1.6. Security from crime

Security from crime is a prevalent concern in South Africa. Statistics South Africa (2022), in the NHTS stated three areas of dissatisfaction on security, namely: security on the walk to/from the bus stop (51.3%); security at the bus stop (51.3%); and security on the busses (38.8%).

3.1.1.7. Distance from home to mode (accessibility)

NHTS reports that in the City of Cape Town 76.8% of commuters are within 15 minutes' walk to the bus stop. 18.1% are between 16 to 30 minutes' walk, 3.2 % are between 31 to 45 minutes, while the remaining 1.9% walk up to 60 minutes (Statistics South Africa, 2022).

3.1.1.8. Safety from accidents

In the NHTS safety from accidents was mentioned as part of the dissatisfactory aspects of the bus services however at the City of Cape Town only 5% tabled it (Statistics South Africa, 2022). Other than threat to bus commuter that this risk presents, there are external outcomes such as injury/death of other road users with the resultant traumas and travel delays.

3.1.1.9. Timetable availability

Availability of information was presented by 5.0% of City of Cape Town respondents as dissatisfactory matter on the bus service in the NHTS (Statistics South Africa, 2022). Some of the challenges presented on the Golden Arrow bus services Facebook page are commuters asking about the whereabouts of the bus, these do not usually get responded to at the morning peak hour, at least not on comments sections. However, there are service provider-initiated announcements on services on the very Facebook page. This means of communication faces two limiting factors in communities: risk of crime in using smartphones at bus stops (and on some bus routes), as well as the prohibitively high cost of cellphone data to access the information.

3.1.1.10. Drivers' attitude

Behaviour of bus drivers towards passengers has been presented as one of the dissatisfactory service attributes by 10.0% of Cape Town respondents in the NHTS (Statistics South Africa, 2022). On the Golden Arrow bus services Facebook page complaints about drivers not stopping at designated bus stops was one of the objective complaints, the remaining ones are subjective.

3.1.2. Minibus Taxi (MBT)

Minibus taxi services in the City of Cape Town is provided by several independent taxi association operating on various routes. In the NHTS, reasons for not using the taxi were: reasons relating to service attributes (45.2%), prefer private transport (37.6%), don't travel much (7.4%), prefer bus (3.4%), can walk (3.3%), not available (1.3%), prefer train (0.3%) and other reasons including expensive fare, crime, overcrowding, accidents, reckless drivers etc.

account for 1.5% (Statistic South Africa, 2022). Emanating from the above statistics there are potentially 50.4% of public transport users that could be influenced by well-informed improvements to the minibus taxi services.

3.1.2.1. Travel cost

According to the NHTS, 24.7% of City of Cape Town respondents are dissatisfied with the taxi fare in the City of Cape Town (Statistics South Africa, 2022).

3.1.2.2. Comfort

The NHTS province-wide records for the City of Cape Town 47.1% of the respondent being dissatisfied with the levels of crowding in the taxi, 61.4% dissatisfied with facilities at the taxi rank, 46.0% with behaviour of taxi drivers towards passengers, and 26.3% with the taxi service overall these factors could undermine the sense of comfort (Statistics South Africa, 2022).

3.1.2.3. Reliability

According to the NHTS these are the levels of dissatisfaction that affect travel time reliability in the City of Cape Town: 14.8% waiting time for taxi; 14.8% frequency of taxi during off-peak period, 11.0% frequency of taxi during peak period (Statistics South Africa, 2022)

3.1.2.4. Travel time

Statistics South Africa (2022) records 14.0% dissatisfied with travel time by taxi in the NHTS. This is affected by taxi operations, vehicle condition, congestion.

3.1.2.5. Flexibility

Of all public transport modes, minibus taxis are the most flexible, as such there has not been any dissatisfaction recorded therefrom and this attribute was tested in this study.

3.1.2.6. Security from crime

Security from crime is a prevalent concern in South Africa. Statistics South Africa (2022), in the NHTS state three areas of dissatisfaction on security, namely: 51.8% security on the walk to/from the taxi rank; 37.8% security at the taxi rank; and 33.4% security on the taxis.

3.1.2.7. Distance from home to mode (accessibility)

According to the NHTS 88.7% of taxi commuters live within 15 minutes of the taxi rank/route. Furthermore 8.7% are between 16 to 30 minutes, while only 2.7% are between 31 to 60 minutes from a taxi rank or route. Due to the minibus taxis unique selling proposition of flexibility a percentage of those who are beyond 60 minutes from the taxi rank/route is negligibly low, however 14.3% registered a dissatisfaction with the distance from taxi rank/rout to their home (Statistics South Africa, 2022).

3.1.2.8. Safety from accidents

NHTS recorded the following dissatisfactions that affect in vehicle safety: 42.2% safety from accidents and 27.1% road worthiness of taxis (Statistics South Africa, 2022).

3.1.2.9. Timetable availability

There have been attempts to predict frequency of taxis, however that is a function of factors such as congestion, available fleet. The only predictable information is the first and last taxis for the day, as such the NHTS doesn't capture timetable availability as a point of dissatisfaction on taxis.

3.1.2.10. Drivers' attitude

NHTS records 46.0% of City of Cape Town respondents dissatisfied with behaviour of the taxi driver towards passengers, while 26.3% are dissatisfied with the taxi service overall (Statistics South Africa, 2022). Initiatives like the blue dot taxi are aimed at improving user-experience (Western Cape Government, 2022)

3.1.3. Train

The respondents who have not used train services in the City of Cape Town provided the following reasons: reasons relating to service attributes (36.9%), train not available (27.1%), prefer private transport (18.7%), prefer taxi (8.0%), don't travel much (3.5%), can walk (1.5%), prefer bus (1.2%) and other reasons 3.0% as reported in the NHTS (Statistics South Africa, 2022). Emanating from the above statistics there are potentially 49.1% of public transport users that could be influenced by well-informed improvements to the train services.

3.1.3.1. Travel cost

NHTS posits that only 7.3% of the respondents in the City of Cape Town were dissatisfied with train fare (Statistics South Africa, 2022). The train has been known as the most affordable public transport mode.

3.1.3.2. Comfort

According to the NHTS, the following dissatisfactory factors that have a bearing on comfort are recorded: 87.8% level of crowding in the train; 51.2% facilities at the train station; while 80.5% train service overall.

3.1.3.3. Reliability

According to the NHTS these are the levels of dissatisfaction that affect travel time reliability in the City of Cape Town: 95.1% waiting time for train; 95.1% frequency of train during off-peak period, 92.7% frequency of train during peak period (Statistics South Africa, 2022).

3.1.3.4. Travel time

Statistics South Africa (2022) in the NHTS records 87.8% dissatisfied with travel time by train. This is affected by power failures, component failures and cable theft.

3.1.3.5. Flexibility

The train is restricted to the track. therefore no flexibility attributes or attribute levels were considered.

3.1.3.6. Security from crime

Security from crime is a prevalent concern in South Africa. In the NTHS, Statistics South Africa (2022), stated three areas of dissatisfaction on security, among the City of Cape Town respondents namely: 87.8% security on the walk to/from the train station; 70.7% security at the train station; and 75.6% security on the trains.

3.1.3.7. Distance from home to mode (accessibility)

According to the NHTS these are the distance breakdown in the City of Cape Town: 31.8% are within 15 minutes' walk; 36.4% are between 16 to 30 minutes' walk; 28.6% are between 31 to 45 minutes' walk; only 3.1% are up to 60 minutes' walk from home to train station.

3.1.3.8. Safety from accidents

Only 41.5% City of Cape Town residents mentioned safety from accidents as one of the dissatisfactory factors as reports in the NHTS (Statistics South Africa, 2022).

3.1.3.9. Timetable availability

The NHTS doesn't capture timetable availability as a point of dissatisfaction for trains (Statistics South Africa, 2022).

3.1.3.10. Drivers' attitude

Train drivers' attitude are not captured as a point of dissatisfaction in the NHTS and was therefore not investigated in this study.

3.2. Attributes for investigation

Based on the mode specific discussion of the attributes above, a table with modes, attributes and levels was be collated for the City of Cape Town.

Even though the NHTS doesn't disaggregate between the MyCiti and Golden Arrow Bus Services, there are observed similarities in the operations. The MyCiti services on some routes has the advantage of a dedicated lane which benefits the passenger's punctuality.

Herewith the attributes for investigation in total: 9 attributes for a bus, 10 attributes for a taxi, 8 attributes of a train as explored in *Table 3.1: Attributes for investigation for the bus, minibus taxi and trains* below:

Attribute	Bus	Minibus Taxi (MBT)	Train
Travel cost (29,4%)	Dissatisfaction captured (21.3%): A pivot price of 10% above or below current fare will be investigated	Dissatisfaction captured (24.7%): A pivot price of 10% above or below current fare investigated	Dissatisfaction captured (7.3%): A pivot price of 10% above or below current fare investigated
Comfort (18.4%)	Facilities at bus stop (63.8%), Overcrowding (30%), Overall service (30%), Driver attitude (10.0%) The following levels will be investigated: - Facilities at bus stops - Overcrowding - Ventilation in bus	Facilities at taxi rank (61.4%), Overcrowding (47.1%), Overall service (26.3%), Driver attitude (46.0%) The following levels will be investigated: - Facilities at taxi ranks - Overcrowding - Ventilation in taxi	Facilities at train station (51.2%), Overcrowding (87.8%), Overall service (80.5%), The following levels will be investigated: - Facilities at train stations - Overcrowding - Ventilation in train
Reliability (15.9%)	Punctuality of busses (26.3%), frequency of busses during peak (16.3%) and frequency of busses off-peak (32.5%). The following levels will be investigated: - Frequency at peak hour - Frequency off-peak - Acceptable margin of delay in minutes	Waiting time for taxi (14.8%), frequency of taxi during off-peak period (14.8%), frequency of taxi during peak period (11.0%). The following levels will be investigated: - Frequency at peak hour - Frequency off-peak - Delay margin in minutes	Waiting time for train (95.1%), frequency of train during off-peak period (95.1%), frequency of train during peak period (92.7%). The following levels will be investigated: - Frequency at peak hour - Frequency off-peak - Delay margin in minutes
Travel time (15.7%)	Trip duration (25%) The following levels will be investigated: - 10 % reduction in travel time - Same time - 10% increase in travel time	Travel time by taxi (14.0%). The following levels will be investigated: - 10 % reduction in travel time - Same time - 10% increase in travel time	Travel time by train (87.8%). The following levels will be investigated: - 10 % reduction in travel time - Same time - 10% increase in travel time
Flexibility (10.5%)	Bus routes are fixed with a few exceptions of express services which omit some stops. There will be no investigation in this regard.	Flexibility is one of the minibus taxis unique selling propositions. The following levels will be investigated: - route deviation to avoid congestion - route deviation to collect passengers away from main road - no route deviation whatsoever.	Trains are on a fixed track. There will be no investigation in this regard.
Security from crime (5.3%)	Security on the walk to/from the bus stop (51.3%), security at the bus stop (51.3%), and security on the busses (38.8%). The following will be investigated: - Visible patrols along the route to bus stops - Visible security personnel at the bus stops - Security personnel in busses.	Security on the walk to/from the taxi rank (51.8%), security at the taxi rank (37.8%), and security on the taxis (33.4%). The following will be investigated: - Visible patrols along the route to taxi ranks - Visible security personnel at the taxi ranks - Security personnel in taxis	Security on the walk to/from the train station (87.8%), security at the train station (70.7%) and security on the trains (75.6%). The following will be investigated: - Visible patrols along the route to train stations - Visible security personnel at the train stations - Security personnel in trains
Distance from home to mode (2.3%)	76.8% of commuters are within 15 minutes' walk to the bus stop. 18.1% are between 16 to 30 minutes' walk, 3.2 % are between 31 to 45 minutes, while the remaining 1.9% walk up to 60 minutes. The following will be investigated: - 5 minutes more to the bus stop, - Same distance - 5 minutes less.	88.7% of taxi commuters live within 15 minutes of the taxi rank/route. Furthermore 8.7% are between 16 to 30 minutes, while only 2.7% are between 31 to 60 minutes from a taxi rank or route. The following will be investigated: - 5 minutes more to the taxi rank/route, - Same distance - 5 minutes less.	31.8% are within 15 minutes' walk; 36.4% are between 16 to 30 minutes' walk; 28.6% are between 31 to 45 minutes' walk; only 3.1% are up to 60 minutes' walk from home to train station. The following will be investigated: - 5 minutes more to the taxi rank/route, - Same distance - 5 minutes less.
Safety from accidents (0.9%)	Safety from accident (5%) The following will be investigated: - Sudden braking - Swerving to avoid crashes - Fender bender	Safety from accidents (42.2%) and road worthiness of taxis (27.1%). The following will be investigated: - Sudden braking - Swerving to avoid crashes - Roadworthiness of taxis	Safety from accidents (41.5%) The following will be investigated: - Sudden braking - Between station stopping to avoid accidents - Longer platform stops to avoid accidents.
Timetable availability (0.4%)	Availability of information (5.0%) The following sources will be investigated: - Call centres (GABS or TIC) - Other commuters - Bus stop	NHTS doesn't capture timetable availability as a point of dissatisfaction on taxis. The following sources of information could be investigated: - Family/friends - Social media - Taxi rank	NHTS doesn't capture timetable availability as a point of dissatisfaction on trains. The following sources of information will be investigated: - Family/friends - Social media/apps - Train station
Drivers' attitude (0.1%)	Bus driver behaviour towards passengers (10.0%) The following will be investigated: - Knowledge of complaints procedure - Experience a rude driver - Experience a rude passenger	Behaviour of the taxi driver towards passengers (46.0%), taxi service overall (26.3%). The following could be investigated: - Knowledge of complaints procedure - Experience a rude driver - Experience a rude passenger	Train drivers' attitude are not captured as a point of dissatisfaction. The warning whistle and time to door closing has however been an issue of discontent among commuters attempting to exit or align an overcrowded train. This might require a separate investigation and will be left out in this study.

Table 3.1: Attributes for investigation for the bus, minibus taxi and trains

3.3. Domains of attributes and levels

According to Tatar et.al (2022) the study explored domains containing three or four attributes, while the attributes had three to four levels. In this study we will start with the attributes measured in NHTS and the insights on perceived problems to determine domains, attributes, and levels. Recent relevant perception studies in Cape Town have been mono-mode studies and the attributes were responsive to the mode performance and infrastructure. This research was aimed at the four main public transport modes and will seek some level of comparability with mode distinctive preferences. Similarly, Luke and Heyns (2020) conducted a service perception study and grouped the measured service attributes into five main categories: reliability, comfort, extent of service, safety, and affordability with further delineation.

Literature covers plethora of attributes, from vehicle related, service related, infrastructure related and more. Farrar, et.al (2019) and Behrens et.al (2018) showed that safety and security perceptions have not been adequately captured in their studies. Case 2 best worst method allows for presenting safety and security as a domain and thereby soliciting preferred attribute levels exclusively. Furthermore, mode performance will be studied to potentially uncover the willingness to accept/pay for some attribute levels. Finally, information has proven to be one of the barriers to public transport use, that too will be a domain. Three to four attributes with varying levels will be considered. Even though best-worst scaling can accommodate many attributes, Chrzan and Peitz (2019) warns against loading the survey and thereby leading to respondent fatigue and poor-quality responses.

In this study the following domains will be considered:

- Travel: consists of travel costs, travel time and reliability
- Safety and security: consist of safety from accidents, accessibility, safety from crime, and driver attitude (where applicable),
- Comfort: comprised of comfort, travel costs, timetable availability (where applicable), and flexibility (where applicable).

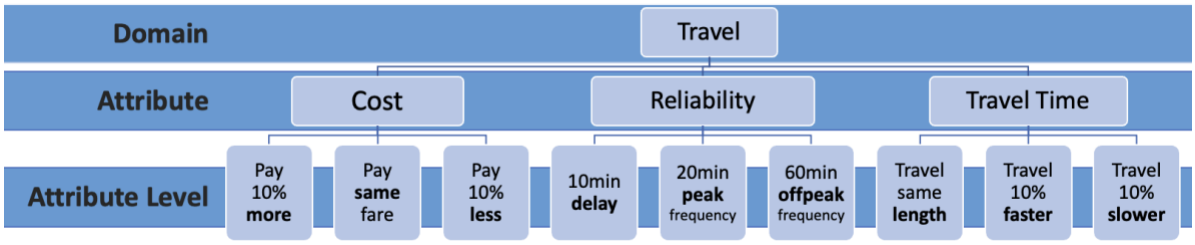
3.4. Questionnaire

Case 2 BWS tests levels of attributes against each other to reduce the possible choice sets for the selected attributes (10 for bus, 10 for MyCiti, 9 for taxi, 9 for train), a maximum of three levels per attribute were tested. The questionnaires had tasks of maximum 4 choices. A limit of 15 tasks (choice sets). Questionnaire design was conducted using the Orthogonal main effect design (OMED) methodology on R software package (Aizaki and Fogarty, 2019).

3.4.1. One-Mode questionnaire

In a single mode questionnaire, the following domains were set: Domain A – TRAVEL (cost, reliability, travel time); Domain B – SAFETY (accessibility, safety from accidents, safety from crime, driver attitude (where applicable)); and Domain C – COMFORT (overcrowding, timetable/information availability, travel cost, flexibility (where applicable)). The attributes were then distributed as shown in *Diagram 3.1 to 3.3* below.

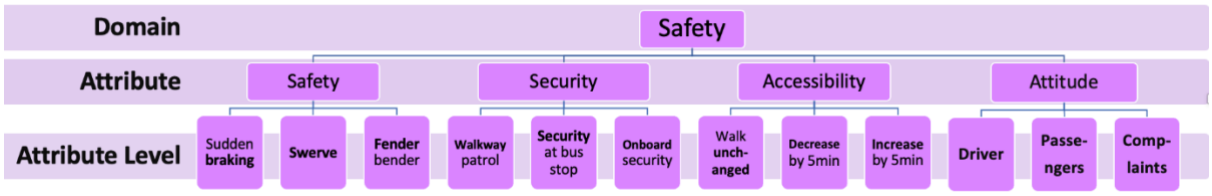
Diagram 3.1: Travel domain



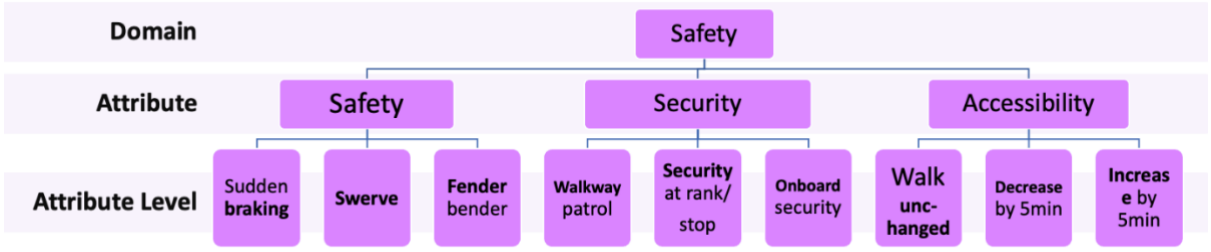
Travel domain attributes and attribute levels

The **Travel** domain comprised of cost, reliability and travel time attributes. the subsequent attribute levels were: cost – pay 10% more, pay same fare, and pay 10% less; reliability – 10min delay, 20min peak frequency, and 60min offpeak frequency; and travel time – travel same length, travel 10% faster, and travel 10% slower. All passengers across all modes were presented with the same attributes, attribute levels and subsequently choice sets.

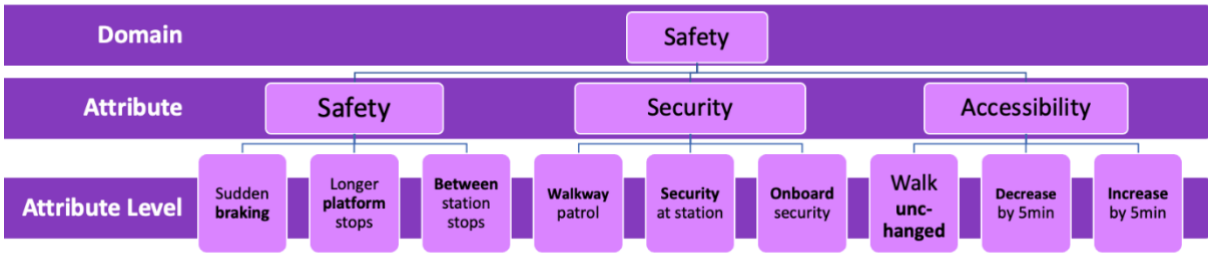
Diagram 3.2: Safety domain



Bus and MyCiTi – safety domain attributes and attribute levels



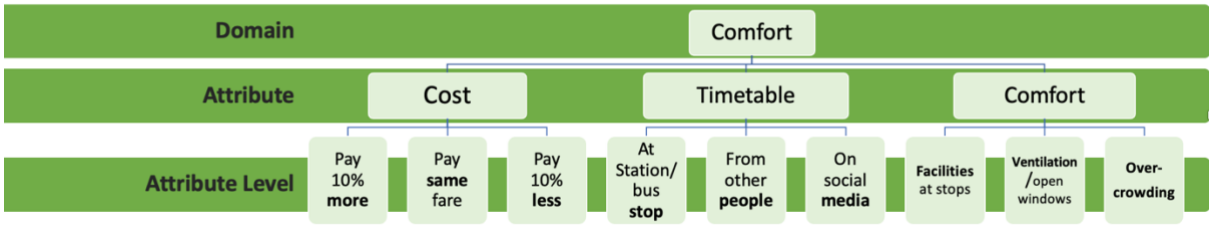
MBT – safety domain attributes and attribute levels



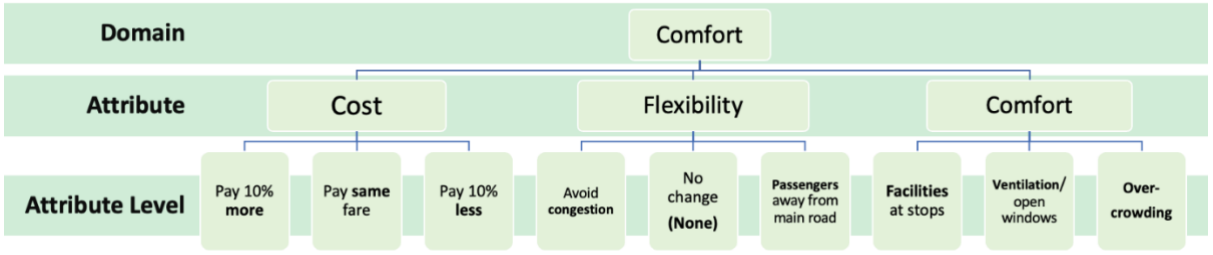
Train – safety domain attributes and attribute levels

On the **Safety** domain the attributes were different across modes. Bus and MyCiTi were similar with the following attribute and attribute levels studied: safety – sudden braking, swerve, and fender bender; security – walkway patrol, security at bus stop, and onboard security; accessibility – walk unchanged, walk decrease by 5min, and walk increase by 5min; and attitude – driver, passenger, and complaints procedure. For MBT the following attribute and relevant attribute levels were investigated: safety – sudden braking, swerve, and fender bender; security – walkway patrol, security at bus stop, and onboard security; and accessibility – walk unchanged, walk decrease by 5min, and walk increase by 5min. Finally for train these were the attributes and attribute levels: safety – sudden braking, longer platform stops and between station stops; and security – walkway patrol, security at bus stop, and onboard security; accessibility – walk unchanged, walk decrease by 5min, and walk increase by 5min.

Diagram 3.3: Comfort Domain



Bus, MyCiTi and Train - comfort domain attributes and attribute levels



MBT - comfort domain attributes and attribute levels

On the **Comfort** domain the attributes were different between traditionally scheduled and unscheduled modes. For Bus, MyCiTi and train following attribute and attribute levels studied: cost – pay 10% more, pay same fare, and pay 10% less; timetable availability – at station/bus stop, from other people, and on social media; and comfort – facilities at stops, ventilation/open windows, and overcrowding. For MBT the following attribute and relevant attribute levels were investigated: cost – pay 10% more, pay same fare, and pay 10% less; flexibility – route change to avoid congestion, no route change, and fetching passengers away from main road; and comfort – facilities at stops, ventilation/open windows, and overcrowding.

Even though the questionnaires were mode specific, there is a comparison between modes on cost which may insinuate the willingness to pay, or willingness to accept for the surveyed mode's performance.

3.4.2. Data collection, storage, and analysis methods

The challenges to this study were possible language/cultural barriers between the data collectors (survey administrators) and the survey respondent; questionnaire fatigue; and

unobserved attributes effect. To mitigate these, the data collectors were trained and consequently the questionnaires were blocked into domains.

Data were collected using intercept surveys of public transport users in Cape Town. The sample frame (n = 200 respondents) was split equally between modes i.e., 50 bus, 50 MyCiTi, 50 train and 50 minibus taxi commuters. A mix of quantitative and qualitative data was be collected. The data measuring respondents' preferences on transport modes was collected on paper. The data was coded and transferred to MS Excel. The data was backed-up onto the UCT Google Drive and UCT OneDrive account. A final backup was uploaded onto ZivaHub for the final dissertation draft for examination. Data were analysed using R.

3.4.3. Ethical considerations

An ethics application was submitted and approved by the EBE Ethics Committee (Annexure A). The research involves voluntary unremunerated participation from adult members of the public. The data collectors were remunerated. Permission from each respondent was be sought at the commencement of the interview. Some biographical data (age, household income, origin and destination, purpose of trip) were collected and the handling and storing thereof will be in line with the Protection of Personal Information Act prescripts. Data was anonymous and stored on the server to be in line with the POPIA and Data Management Plan.

4. Data Analysis

4.1. Introduction

Data collection was conducted at the Cape Town CBD Public Transport nodes with the intended respondents being users of the different public transport modes. The surveys were administered by surveyors one-on-one on 17th March 2023, 3rd and 12th April 2023. There were 780 respondents; 774 completed questionnaires across the following modes: 193 bus, 191 minibus taxi, 190 MyCiTi, and 200 train commuters. A questionnaire was considered completed when all demographic and at least one domain questions were answered.

Three domains were explored, namely: travel, safety and comfort. The modal split per domain, summarised in *Table 4.1* below was as follows:

Table 4.1: Observations per mode and domain

Mode	Observations	Travel	Safety	Comfort
Bus	193	61	60	72
Taxi	191	62	64	70
MyCiTi	190	60	65	65
Train	200	65	64	71
	TOTAL	**248**	**253**	**278**

Data were collated cleaned and analysed. The data was collected per domain for each mode. The travel domain with cost, travel time and reliability as attributes across all modes. The safety domain with different attributes for the various modes. For bus and MyCiTi have safety, security, accessibility and attitude as attributes. The MBT attributes are safety, security and accessibility. Finally, train has safety, security and accessibility as attributes. The Comfort domain for the bus, MyCiTi and train modes comprises of cost, timetable information and comfort. The MBT comfort domain has cost, flexibility and comfort as attributes. Data were analysed in two ways. A frequency counts and a model estimation. Data analysis was conducted on R using the *support.BWS2* packages.

4.1.1. Data analysis by frequency count

ach domain questionnaire had nine (9) choice sets with varying levels of attributes. All attributes levels appeared three times in choice sets, therefore frequency (f) is 3. Analysis by counting computes the difference of the attribute level selected as best and worst, as shown in the *equation 4.1* below:

$$BW_{in} = B_{in} - W_{in} \quad (4.1)$$

Where, $\boldsymbol{i}$ - is the attribute level and $\boldsymbol{n}$ is respondent.

$\boldsymbol{B}$ – is Best , $\boldsymbol{W}$ – is Worst and $\boldsymbol{BW}$ – is Best-Worst.

A positive $\boldsymbol{BW}$ value shows that the frequency of the attribute level chosen as the best attribute level is greater that the frequency of it being chosen as the worst attribute level. These results will be represented in both tabular form and barplots.

Furthermore, the respondent's preference are revealed by the standardised variant of difference, as in the *equation 4.2* below:

$$std.BW_{in} = \frac{BW_{in}}{f_i} \quad (4.2)$$

Where, $\boldsymbol{i}$ - is the attribute level and $\boldsymbol{n}$ is respondent.

$\boldsymbol{BW}$ – is Best-Worst as calculated in *equation 4.1* above
$\boldsymbol{f}$ - is frequency
$\boldsymbol{std.BW}$ – is the standardised variant of the difference.

The $\boldsymbol{std.BW}$ range is **[-1:1]**. The greater the numerical value, the more important the attribute level. If the attribute level is a closer to -1 the least favoured the attribute level overall, that is it was the worst or a disutility. The closer an attribute level's $\boldsymbol{std.BW}$ is to +1 the most preferred the attribute level and therefore best or a utility.

In subsequent sections the modes' results will be tabled and the findings discussed.

4.1.2. Data analysis by model estimation

For estimating models, the bws2 package was used. The code uses conditional logistic regression to model preferences as a based on the respondents' utility of attributes levels and by association attribute (Aizaki and Fogarty, 2019). The marginal model was selected based on the assumption that respondents evaluated all attribute- levels on a choice set for best and the worst attribute-level (Aizaki and Fogatry, 2019; Tatar et.al, 2023).

According to Aizaki and Fogatry (2019) the marginal model is computed as:

$$\Pr(best = i,\ worst = j) = \frac{\exp(v_i)}{\sum_{p \subset C} \exp(v_p)} \frac{\exp(-v_j)}{\sum_{p \subset C} \exp(-v_p)} \quad (4.3)$$

While marginal sequential is computed as:

$$\Pr(best = i,\ worst = j) = \frac{\exp(v_i)}{\sum_{p \subset C} \exp(v_p)} \frac{\exp(-v_j)}{\sum_{q \subset C-i} \exp(-v_q)} \quad (4.4)$$

And the utility function is computed as follows:

$$v = \beta_{Ak} D_{Ak} + \beta_{Bk} D_{Bk} + \beta_{Ck} D_{Ck} \ldots \quad (4.5)$$

Where:

$\beta_{Ak,} \ldots \beta_{Ck\ldots} = are\ corresponding\ coeffients$

$D_{Ak} \ldots = are\ attribute\ variables$

For the purposes of this study no dummy-coding or effect coding were explored. The most direct analysis is used because there are no historic case 2 BWS experiments in South Africa. Estimation of the models included both attribute levels and attributes.

The estimation was based on a possible permutation of responses based on nine (9) choice sets presented to each respondent. A simplified model estimation formula in R is:

$$pr <- clogit\left(RES \sim \sum_{i=0}^{j} a_i x_i + b_i y_i + strata(STR), data = pr.data1\right) \quad (4.6)$$

$Where:\quad pr = probability\ estimate$

$clogit = the\ conditional\ logistic\ regression\ function$

$$RES = variable\ result\ of\ respondents'\ selection\ in\ the\ dataset$$
$$i = option\ identifier$$
$$j = total\ options$$
$$a = coefficient\ for\ attribute$$
$$x_i = attribute$$
$$b = coefficient\ for\ attribute\ levels$$
$$y_i = attribute\ level$$
$$strata(STR) = a\ function\ to\ identify\ stratification\ variables$$
$$data = identifies\ the\ relevant\ dataset\ for\ estimation$$
$$pr.data1 = the\ input\ dataset\ created\ for\ estimation$$

The input database for model estimation is created using the parameters set out at questionnaire design stages, respondents' responses to the questionnaire, and the type of model being estimated.

The dataset was created as follow:

$$pr.data1 <- bws2.dataset\ (data, id, response, choice.sets, attribute.levels, reverse, base.level, lev, model) \quad (4.7)$$

$Where: pr.data1 = the\ input\ dataset\ created\ for\ estimation$

$$bws2.dataset = dataset\ identifier\ for\ bws2\ computation$$
$$data = dataset\ be\ computed$$
$$id = first\ coloum\ identifier, usually\ id = id$$
$$response = response\ type\ identifier$$
$$choice.sets = choice\ sets\ identifier, in\ this\ case\ as\ per\ questionnaire\ design$$
$$attribute.levels = attribute\ levels\ identifier, set\ at\ questionnaire\ deign$$
$$reverse = choice\ of\ sign\ change\ for\ worst\ attribute, intuitively\ set\ as\ true$$
$$base.level = attribute\ levels\ set\ as\ baseline\ or\ fixed\ \ in\ the\ model$$
$$model = model\ identifier, in\ this\ case\ marginal$$

The model estimation output is the following:

- the loglikelihood test – a reduction in the value denotes an improvement in model estimated and is therefore preferred.
- degrees of freedom – the number of variables estimated.
- p-value – a measure of the statistical significance of the results.
- N – sample size
- No. of events – the iterations conducted to estimate the model
- coefficient – the log odds coefficient value of the estimated attribute or attribute level
- exp (coef) – the exponentiated coefficient value of the estimated attribute/attribute level which is odds.
- se (coef) – is the standard error of coefficient value of the estimated attribute/attribute level.
- z – shows the z-score of the estimated attribute/attribute level.

In the analysis the coefficients, if statistically significant, are used to compute utility and likelihood to the attribute or attribute level to influence the commuter's choices based on preference. In the next sections all three domains (travel, safety and comfort) will be discussed.

4.2. Travel domain results

This results section summarises the results of the travel domain. The travel domain is made up the travel time, cost and reliability attributes. The attribute levels were set at follows:

- Travel time - travel the same **length** of time, travel 10% **faster**, and travel 10% **slower**.
- Cost – pay **same** fare, pay 10% **less** fare, and pay 10% **more** fare.
- Reliability – experience 10 minutes **delay**, 20 minutes **peak** frequency, 60 minutes **off-peak** frequency.

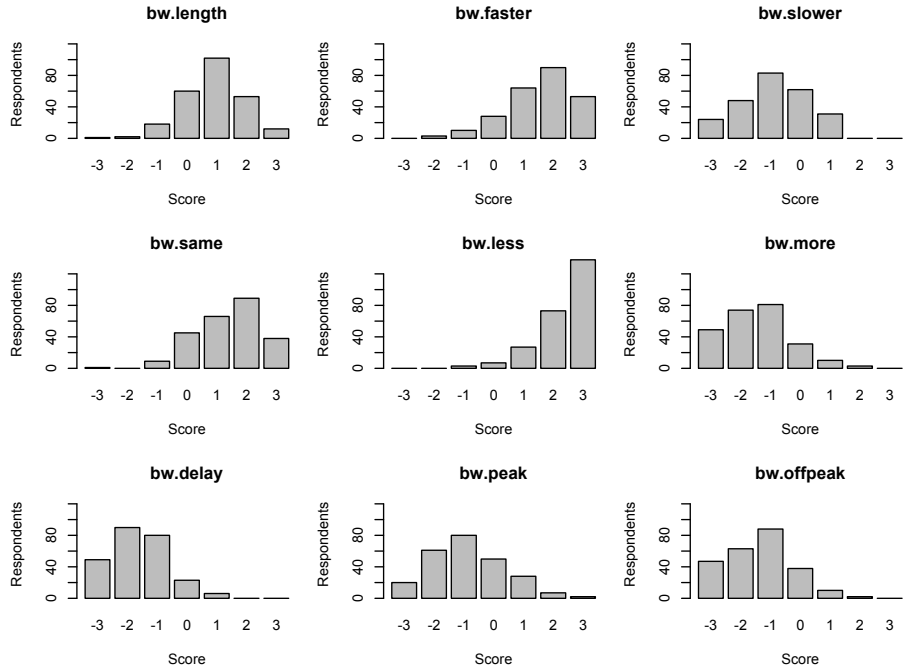
The overall travel results are split into the following subsections: BW-barplots, Best-Worst (BW) Count, and Models.

4.2.1. Travel domain BW-barplots

Prior to exploring the nuances in models between the modes, a schematic of the nuances as represented by the overall travel domain BW-barplots will be discussed. *Barplot 4.1* below the shows the following barplots per attribute level:

- **bw.length –** for *travel the same length of time*
- **bw.faster –** for *travel 10% faster*
- **bw.slower –** for *travel 10% slower*
- **bw.same –** for *pay the same fare*
- **bw.less –** for *pay 10% less fare*
- **bw.more –** for *pay 10% more fare*
- **bw.delay –** for *experience 10 minutes delay*
- **bw.peak –** for *20 minutes peak frequency*
- **bw.offpeak –** for *60 minutes offpeak frequency*

These barplots were based on the sum of best and best counts of the various attribute levels. The x-axis is representing the respondent's choice. The y-axis is the sum of respondents represented by the attribute choice. For example, if an attribute was chosen as worst three (3) times in all three (3) choice sets it appears to a respondent – then it will be on negative (-3) on the x-axis. If another respondent doesn't choose attribute at all, they will be on zero (0) on the x-axis. The number of respondents on their respective x-axis positions are summed up to determine the height of the of bar in the barplot



Barplot 4.1: Travel All Modes

Barplot 4.1 above summarises the whole travel data count. The rest of the barplots in section 4.2 will be mode specific. As expected, there are visible skews in the attribute levels. In the first row the same trip length is preferred (most of the selections are positive, that is best) at the peak of 1, a faster trip is skewed to the positive (preferred/desired) at the peak of 2, and a slower trip is a disutility (undesired/worst) with a peak of -1. In the second row paying the same fare is preferred with a peak of 2, while paying less is most preferred with the greatest peak skewed to the right with a peak of 3, and paying more is a disutility with a peak of -1. The last row shows all the reliability attribute levels as disutility. The 10-minute delay with a peak -2, the 20 min frequency with a peak of -1, and the 60 min off-peak frequency with a peak of -1.

4.2.2. Travel domain BW Count

The travel attributes and attribute levels were the same across all modes. *Table 4.2* below shows the following columns: Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardized variant (stdBW).

Table 4.2: Travel BW-table

Attribute	Attribute level	Best	Worst	BW	stdBW
Time	Same **length**	295	76	219	0.2944
	Travel 10% **faster**	438	51	387	0.5202
	Travel 10% **slower**	125	345	-220	-0.2957
Cost	Pay **same** fare	412	66	346	0.4651
	Pay 10% **less**	612	28	584	0.7849
	Pay 10% **more**	60	420	-360	-0.4839
Reliability	Experience 10min **delay**	26	427	-401	-0.5390
	20min **peak** frequency	105	319	-214	-0.2876
	60min**off-peak** frequency	114	455	-341	-0.4583

As shown in *Table 4.2* the prominent attribute levels for each attribute are the following:

- Travel time – travel 10% **faster** as the best attribute level.
- Cost – pay 10% **less** fare as the best attribute level.
- Reliability – experience 10 minutes **delay** as the worst attribute level.

The sum of attribute levels BW per attribute (e.g. Time = +386) will be consistent with the overall schematic of the BW-barplots, that is either negative or positive. The sum of all the attribute levels across all attributes sum up to zero (0). The sum of the standardized attribute levels per attribute will also maintain the positive or negative slant as seen in the barplots. For an illustration the stdBW attribute level values in

table 4.2 add up the following per attribute: time = 0.5189; cost = 0.7661; and reliability = -1.2849. the sum of all stdBW values sums up to zero (0). Overall, as attributes *cost* and *time* are consistently chosen as best while *reliability* is chosen as worst. At attribute level, *cost – pay 10% less* was the largest utility while reliability – experience 10min delay was the worst disutility. This is consistent with existing transport studies literature. Paying less is preferred while in-vehicle delays are worst (Hayes and Venter, 2016; Behrens et.al, 2018; Mokonyama and Venter, 2018; Gao and Sun, 2018; Farrar et.al, 2019; Teffo et.al, 2019; Luke and Heyns, 2020; Statistics South Africa, 2021, 2022)

4.2.3. Travel domain model comparison

The travel domain model estimates the attributes and attribute levels for travel time, cost and reliability. In this initial analysis equation *4.7* described in section *4.2.1* above was computed with a marginal model and marginal sequential.

Table 4.3 highlights what varies between models with column one as labels, and columns two and three are model 1 and model 2 detail/outputs respectively. Row 1, **Name,** shows the names of the different models, for Model 1 mr.data1 and Model 2 sql.data1. Row 2, **Reverse**, shows whether the signs setting for worst choice (false if sign reversed) as stated in *equation 4.7* description they are both true. Row 3, **Model**, denotes the type of model computed whether: paired, marginal or sequential. For Model 1 a marginal model and Model 2 a marginal sequential model. Row 4, **LL test,** shows the result of the log likelihood test. Row 4, **df**, denotes the degrees of freedom, i.e. showing how many attributes were estimated in the model. Row 5, **p-value,** shows the degree of statistical significance of the resultant model. Row 6, **n,** shows the sample size. Row 7, **No. of events,** the iterations conducted by the model.

Table 4.3: Travel Models

	Model 1	Model 2
Name	mr.data1	sql.data1
Reverse	TRUE	TRUE
Model	Marginal	Sequential
LL test	3513	2437
Df	8	8
p-value	<2e-16	<2e-16
N	13392	11166
No. of events	4458	4419

In *Table 4.3* above it is noted that both models are statistically significant (p <2e-16). Model 2, the sequential marginal model, is an improved model when compared to Model 1, in terms of the loglikelihood. However, there is a reduction in the population size and number of events that the model is estimated for therefore Model 2 does not explain the data better than Model 1. The initial assumption that a marginal model is the best option, because the respondent assesses all the attribute levels presented for both best and worst in every choice set holds.

A comparison of the outputs for attributes and attribute levels of the models is summarised in *Tables 4.4* below. In *Table 4.4*, the heading first row denotes the **model number**. The heading second row is **labels** for the columns. Column 1, **Attribute**, shows the attributes or attribute levels that were estimated. Column 2 and 7, **Coef**, shows coefficient values for the estimated attribute/attribute level. Column 3 and 8, **Exp (coef)**, shows the exponentiated coefficient value of the estimated attribute/attribute level. Column 4 and 9, **Se (coef)**, is the standard error of coefficient value of the estimated attribute/attribute level. Column 5 and 10, **z**, shows the z-score of the estimated attribute/attribute level. Column 6 and 11, **p-value**, show the level of significance of the estimate attribute/attribute levels coefficient.

Table 4.4: Travel Domain Models

	Model 1 – Marginal					Model 2 – Marginal Sequential				
Attribute	Coef	Exp (coef)	Se (coef)	Z	p-value	coef	Exp (coef)	Se (coef)	Z	p-value
Time	1.24	3.44	0.05	26	<2e-16	1.14	3.13	0.05	23	<2e-16
Cost	1.47	4.37	0.05	28	<2e-16	1.38	3.99	0.05	25	<2e-16
Faster	1.16	3.20	0.06	19	<2e-16	1.09	2.98	0.06	17	<2e-16
Slower	-1.48	0.23	0.06	-26	<2e-16	-1.38	0.25	0.06	-23	<2e-16
Less	1.80	6.05	0.07	26	<2e-16	1.69	5.41	0.07	24	<2e-16
More	-2.24	0.11	0.06	-37	<2e-16	-2.02	0.13	0.06	-32	<2e-16
Delay	-0.42	0.66	0.06	-7	1,00E-12	-0.35	0.71	0.06	-6	1,00E-08
Peak	0.50	1.65	0.06	9	<2e-16	0.44	1.55	0.06	7	1,00E-13

The models were estimated with the following constants: for attributes – reliability: for attribute levels – travel time (same length), cost (same fare), and reliability (60min offpeak frequency). The improvement in *LL* between *Model 1* and *Model 2* is at the cost of coefficients' statistical significance (the *experience 10min delay* and *20min frequency)*. This is corroborated by an earlier observation on the sample size (n) and number of events in the overall model estimation.. Therefore *Model 1* explains the data better,

Model 1 had the following statistically significant coefficients in order of magnitude: utility *pay 10% less (1.80 x pay same fare), cost (1.47 x reliability)*, *time (1.24 x reliability), travel 10% faster (1.16 x travel same length), 20min frequency (0.50 x 60min offpeak frequency);* disutility from worst to least *pay 10% more (-2.24 x pay same fare), travel 10% slower (-1.48 x travel same length)* and *experience 10min delay (-0.42 x 60min offpeak frequency).*

4.2.4. Travel domain per mode

This section analyzes the mode specific results. considering the result for a joint model above, this section captures the mode disaggregated outputs.

4.2.4.1. Bus

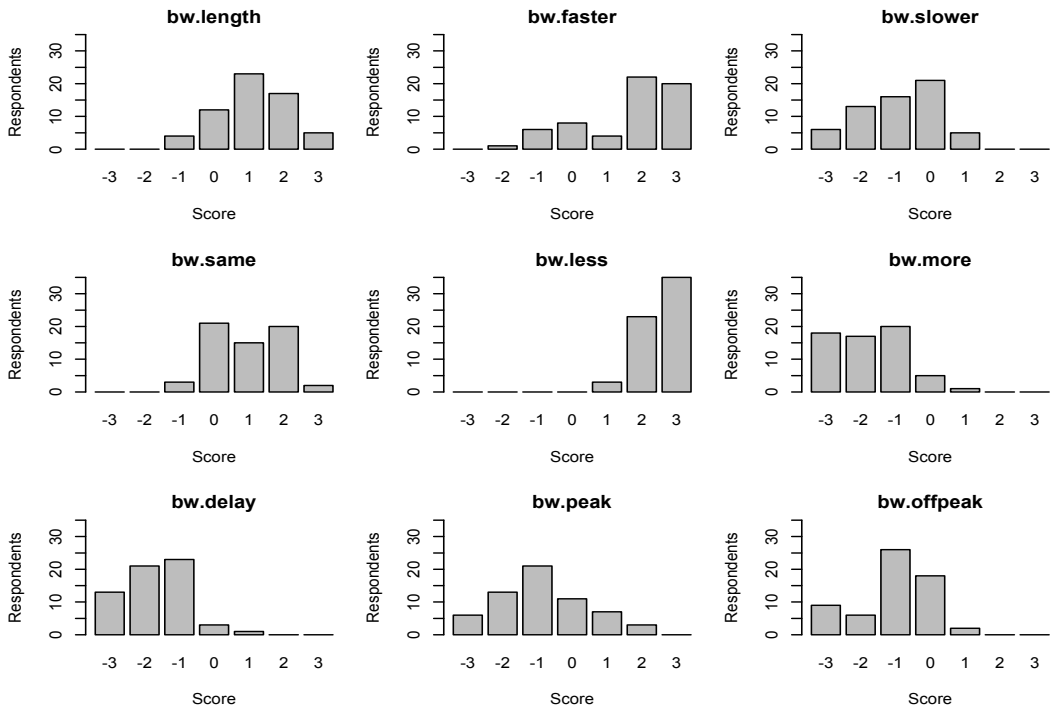
The Bus is subsidised and scheduled with operation during peak and off-peak periods. The summary of the 61 intercepted commuter details is as follows:

- 55 respondents were Employed
- Longest trip length: 120 minutes, 10% variation = 12 minutes
- Average trip length: 63 minutes, 10% variation = 6,3 minutes
- Shortest trip length: 25 minutes, 10% variation = 2,5 minutes
- Highest trip fare: > R100 (potentially weekly cost), 10% variation = R10
- Average trip fare: R30, 10% variation = R3
- Lowest trip fare: R12, 10% variation ~ R1
- None of the respondents reported a household income lower than R1,250

The subsequent sections will detail the bus mode data in terms of Barplot, BW-table, and Model.

4.2.4.1.1. Bus travel barplots

The Bus barplots *(Barplot 4.2)* below skews are consistent with those of the overall travel domain barplot above *(Barplot 4.1)*. However, the intercepted bus commuters considered paying more fare as the greatest disutility, they accounted for most of the overall cost disutility. This outcome is also consistent with what was expressed on the NHTS (Statistics South Africa, 2021) where buses were considered expensive.



Barplot 4.2: Bus

4.2.4.1.2. Bus travel BW Count

Bus travel attributes levels Best and Worst count is summarised in *Table 4.5 below*. The columns are namely: Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardized variant (stdBW). The signs of each attribute levels stdBW are consistent with that of the overall travel domain as detailed in *section 4.2.2* above.

Table 4.5: Bus Travel BW-table

Attribute	Attribute level	Best	Worst	BW	stdBW
Time	Same **length**	81	13	68	0.3716
	Travel 10% **faster**	114	14	100	0.5464
	Travel 10% **slower**	30	85	-55	-0.3005
Cost	Pay **same** fare	92	34	58	0.3169
	Pay 10% **less**	155	1	154	0.8415
	Pay 10% **more**	4	111	-107	-0.5847
Reliability	Experience 10min **delay**	12	115	-103	-0.5628
	20min **peak** frequency	28	80	-52	-0.2842
	60min **off-peak** frequency	32	95	-63	-0.3443

As shown in *Table 4.5* stdBW the following insights emerged:

- Travel time is overall best (0.6175) with travel 10% **faster** as the best attribute level (0.5464).
- Cost is overall best (0.5737) with pay 10% **less** fare is the best attribute level (0.8415).
- Reliability is overall worst (-1.1913) with experience 10 minutes **delay** as the worst attribute level (0.3443).

Overall, the *cost – pay 10% less* was the largest utility while *reliability – experience 10min delay* was the worst disutility. This is consistent with existing transport studies literature (Hayes and Venter, 2016; Behrens et.al, 2018; Mokonyama and Venter, 2018; Gao and Sun, 2018; Farrar et.al, 2019; Teffo et.al, 2019; Luke and Heyns, 2020; Statistics South Africa, 2021, 2022)

4.2.4.1.3. Bus travel model

The Marginal model was estimated with the following constants: for *attributes – reliability*: for attribute levels – *travel time (same length), cost (same fare),* and *reliability (60min offpeak frequency).* The attributes and attribute levels that are set as baseline are therefore not estimated in these models.
The marginal model results are as follows:

- Likelihood ratio test = 959,
- Degrees of freedom = 8,
- p-value = <2e-16,
- Sample size, n = 3294,
- Number of events = 1098.

The Likelihood ratio test result is a fraction of the complete travel mode model. I propose that this is not only because the data sample size is almost a quarter of the one discussed in *Section 4.2.3* but also that the dataset is slightly more homogeneous because one bus operator with an approximately common level of service per trip. The same degrees of freedom were maintained as the model in *section 4.2.3*. The p-value is statistically significant.

The coefficients are disaggregated in *Table 4.6* below.

Table 4.6. Bus Travel Marginal Model

Attribute	Coef	exp(coef)	se(coef)	Z	p-value
Time	1.30	3.68	0.10	13	<2e-16
Cost	1.39	4.01	0.11	13	<2e-16
Faster	1.22	3.37	0.13	9	<2e-16
Slower	-1.67	0.19	0.12	-14	<2e-16
Less	2.37	10.73	0.16	15	<2e-16
More	-2.50	0.08	0.13	-19	<2e-16
Delay	-0.67	0.51	0.12	-5	6,00E-08
Peak	0.44	1.55	0.12	4	2,00E-04

The Model's coefficients (coef) magnitude and sign are intuitive. The *z* values are large, showing the skew in attribute and attribute level preferences, p-values remain significant. The coefficients of *time (1.30 x reliability)* and *cost (1.39 x reliability*) attributes are both positive and of the same magnitude. This is potentially a result of the respondents' *time* and *cost* 10% variations being low and may not have exceeded the commuters' threshold for acceptable changes (~ 6 minutes and R3) when compared with a 10-minute delay disutility with a coefficient (-0,67).

From *Table 4.6* results we can postulate that a bus commuter values travel time 1.3 times more than *reliability* and *cost* 1.36 times more than *reliability*. The weight of these propensities is informed by an apprehension to the following: having a *10% cost increase* by 2.5 times the cost of *paying the same fare*; *10% slower travel time* by 1,67 times the cost of *same travel time;* and to an insignificant degree *experiencing 10minutes delay* 0,67 times *60 minutes offpeak frequency.* In conclusion for the majority of the intercepted bus commuters the bus service quality would have to exceed 36% of its current reliability for the commuter to accept a 10% increase in fare. Alternatively, the bus must exceed 30% of its current reliability for the commuter to accept a *10% slower travel time.*

4.2.4.2. Minibus Taxi (MBT)

The MBT are unscheduled and operates mostly during peak period, with reduced services off-peak. The summary of the 62 intercepted commuter details is as follows:

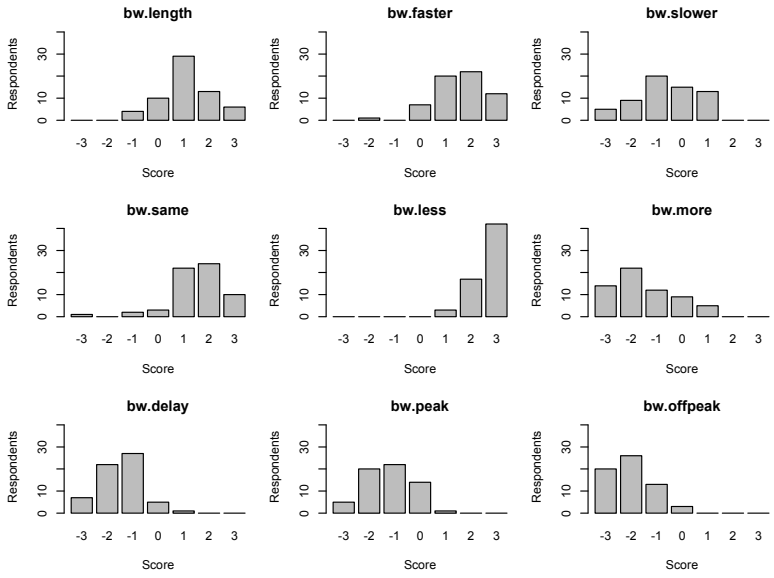
- 55 respondents were Employed
- Longest trip length: 70 minutes, 10% variation = 7 minutes
- Average trip length: 38 minutes, 10% variation ~ 4 minutes

- Shortest trip length: 15 minutes, 10% variation ~ 2 minutes
- Highest trip fare: > R25, 10% variation ~ R3
- Average trip fare: R23.40, 10% variation ~R2.
- Lowest trip fare: <R12, 10% variation ~R1
- None of the respondents reported a household income lower than R1,250

The subsequent sections will detail the MBT mode data in terms of Barplot, BW-table, and Model.

4.2.4.2.1. MBT travel barplot

MBT barplots skews (*Barplot 4.3)* are consistent with the overall modes *(barplot 4.1)*. Furthermore, they confirm the off-peak frequency dissatisfaction as captured in the NHTS (Statistics South Africa, 2021).



Barplot 4.3: MBT Travel

The intercepted MBT commuters considered paying less fare as the best attribute level. This outcome is also consistent with what was expressed on the NHTS (Statistics South Africa, 2021) where taxis were considered expensive. The 60min off-peak frequency is the worst attribute level. This is consistent with literature and the unscheduled nature of the MBT services and unavailability off-peak (Behrens et.al, 2018; Teffo et.al, 2019; Statistics South Africa, 2021, 2022)

4.2.4.2.2. MBT Travel BW count

MBT travel attributes levels Best-Worst count is summarized in *Table 4.7* below. The columns are namely: Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardized variant (stdBW). The signs of each attribute levels stdBW are consistent with that of the overall travel domain as detailed in *section 4.2.2* above.

Table 4.7: MBT Travel BW-table

Attribute	Attribute level	Best	Worst	BW	stdBW
Time	Same **length**	85	16	69	0.3710
	Travel 10% **faster**	110	12	98	0.5269
	Travel 10% **slower**	43	83	-40	-0.2151
Cost	Pay **same** fare	106	11	95	0.5108
	Pay 10% **less**	164	1	163	0.8763
	Pay 10% **more**	18	111	-93	-0.5000
Reliability	Experience 10min **delay**	2	93	-91	-0.4892
	20min **peak** frequency	8	84	-76	-0.4086
	60min **off-peak** frequency	6	131	-125	-0.6720

As shown in *Table 4.7* stdBW the following insights emerged:

- Travel time is overall best (0.6828) with travel 10% **faster** as the best attribute level (0.5269).
- Cost is overall best (0.8871) with pay 10% **less** fare as the best attribute level (0.8763).
- Reliability is overall worst (1.5698) with 60 minutes **off-peak** frequency as the worst attribute level (0.6720).

Overall, the *cost – pay 10% less* was the largest utility while *reliability – 60 minutes off-peak frequency* was the worst disutility. Paying less is preferred and is consistent with literature (Luke and Heyns, 2020; Statistics South Africa, 2021, 2022). Consistent with literature and the unscheduled nature of the MBT services and unavailability off-peak, 60 minutes off-peak frequency is the worst attribute level (Behrens et.al, 2018; Teffo et.al, 2019; Statistics South Africa, 2021, 2022).

4.2.4.2.3. MBT travel model

The Marginal model was estimated with the following constants: for *attributes – reliability*: for attribute levels – *travel time (same length), cost (same fare),* and *reliability (60min offpeak frequency).* The attributes and attribute levels that are set as baseline are therefore not estimated in these models. The marginal model results are in *Table 4.8* below. The marginal model results are as follows:

- Likelihood ratio test =1107,
- Degrees of freedom = 8,
- p-value = <2e-16,
- Sample size, n = 3348,
- Number of events = 1114.

The Likelihood ratio test result is a fraction of the complete travel mode model. I propose that this is not only because the data sample size is almost a quarter of the one discussed in *Section 4.2.3* but also that the dataset is slightly more homogeneous because taxis have some degree of flexibility with an approximately common level of service per trip. The same degrees of freedom were maintained as the model in *section 4.2.3*. The p-value is statistically significant.

Table 4.8: MBT Travel Marginal Model

Attribute	Coef	exp(coef)	se(coef)	z	p-value
Time	1.73	5.65	0.11	16	<2e-16
Cost	2.05	7.73	0.12	16	<2e-16
Slower	-1.62	0.20	0.12	-13	<2e-16
Faster	1.17	3.24	0.14	9	<2e-16
Less	2.31	10.11	0.17	14	<2e-16
More	-2.70	0.07	0.14	-20	<2e-16
Delay	0.16	1.17	0.12	1	0.2
Peak	0.50	1.65	0.12	4	5,00E-05

The coefficients (coef) magnitude and sign of the model results are intuitive. The *z* values are large, showing the skew in attribute and attribute level preferences, p-values remain significant except for experience *10min delay.* The coefficients of *time (1.73 x reliability)* and *cost (2.05 x reliability*) attributes are both positive. This is potentially a result of the respondents' *time* and *cost* 10% variations being low and may not have exceeded the commuters' threshold for acceptable changes (~ 4 minutes and R3).

From *Table 4.8* results we can postulate that a MBT commuter values travel time 1.73 times more than *reliability* and *cost* 2.05 times more than *reliability*. The weight of these propensities is informed by an apprehension to the following: having a *10% cost increase* by 2.7 times the cost of *paying the same fare*; *10% slower travel time* by 1,62 times the cost of *same travel time;* and to an insignificant degree *experiencing 20min peak frequency* 0,5 times *60 minutes offpeak frequency.* In conclusion the majority of the intercepted MBT commuters the MBT would have to exceed 100% of its current reliability for the commuter to accept a 10% increase in fare. Alternatively, the MBT must drop its current reliability by 62% for the commuter to experience a *10% slower travel time.*

4.2.4.3. MyCiTi

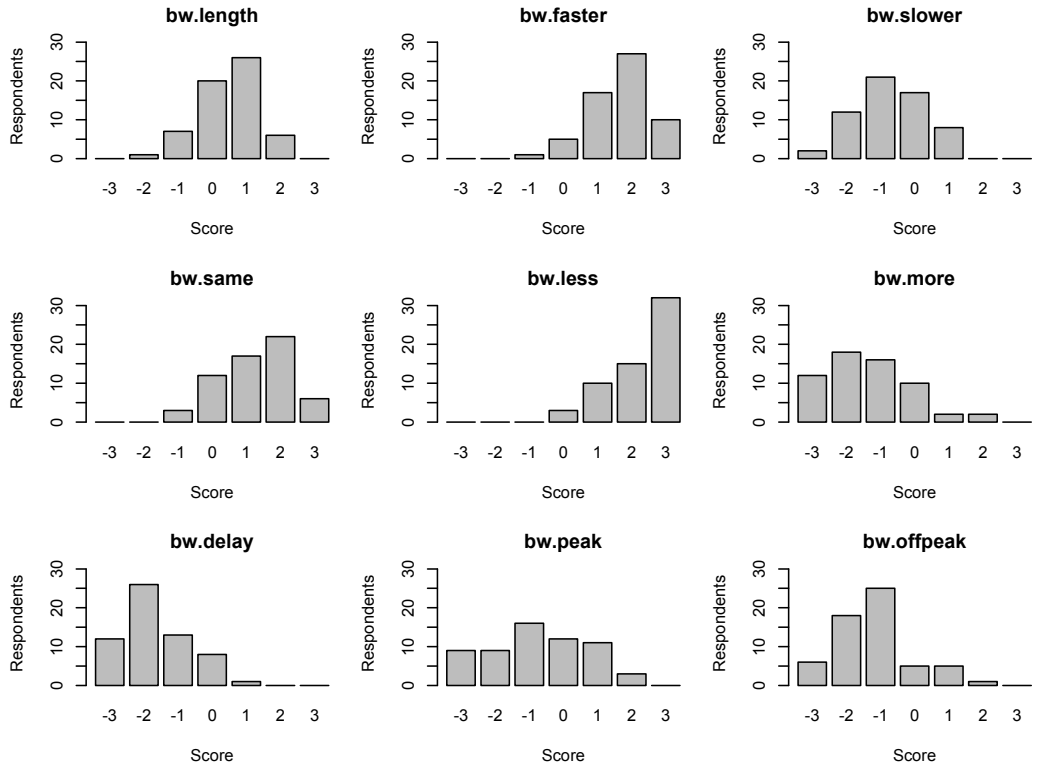
The MyCiTi is subsidised and scheduled peak and off-peak periods rapid but service. It mostly operates most routes on dedicated lanes and is the newest mode with no reference in the NHTS (Statistics South Africa, 2021). The summary of the 60 intercepted commuter details is as follows:

- 53 respondents were Employed
- Longest trip length: > 45 minutes, 10% variation ~ 5minutes
- Average trip length: 28 minutes, 10% variation ~ 3 minutes
- Shortest trip length: 5 minutes, 10% variation ~ 1 minutes
- Highest trip fare: > R45, 10% variation = R5
- Average trip fare: R24, 10% variation = R2
- Lowest trip fare: R8, 10% variation ~ R1
- None of the respondents reported a household income lower than R1,250

The subsequent sections will detail the MyCiTi mode data in terms of Barplot, BW-table, and Model.

4.2.4.3.1. MyCiTi travel barplot

The skews on MyCiTi barplots *(Barplot 4.4)* are like the overall modes *(Barplot 4.1)*. However, the respondents considered a 10-minutes delay a greater disutility than paying more. This is linked to the level of service experienced on most route where dedicated lanes optimized signaling leads to increased predictability and frequency of service.



Barplot 4.4: MyCiTi Travel

4.2.4.3.2. MyCiTi travel BW count

MyCiTi travel attributes levels Best-Worst count is summarised in *Table 4.9 below*. The columns are namely: Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardized variant (stdBW). The signs of each attribute levels stdBW are consistent with that of the overall travel domain as detailed in *section 4.2.2* above.

Table 4.9: MyCiTi Travel BW-table

Attribute	Attribute level	Best	Worst	BW	stdBW
Time	Same **length**	56	27	29	0.1611
	Travel 10% **faster**	108	8	100	0.5556
	Travel 10% **slower**	26	69	-43	-0.2389
Cost	Pay **same** fare	90	14	76	0.4222
	Pay 10% **less**	144	8	136	0.7556
	Pay 10% **more**	19	101	-82	-0.4556
Reliability	Experience 10min **delay**	6	106	-100	-0.5556
	20min **peak** frequency	37	81	-44	-0.2444
	60min **off-peak** frequency	34	106	-72	-0.4000

As shown in *Table 4.9* stdBW the following insights emerged:

- Travel time is overall best (0.4778) with travel 10% **faster** as the best attribute level (0.5556).
- Cost is overall best (0.7222) with 10% **less** fare as the best attribute level (0.7556).
- Reliability is overall worst (-1.2) with experience 10 minutes **delay** as the worst attribute level (0.5556).

In *Table 4.9,* attribute level *cost – pay 10% less* was the largest utility while *reliability – experience 10min delay* was the worst disutility, consistent with the overall travel results. MyCiTi services are newer, and the level of service is higher. On some routes, operate on a dedicated lane, the MyCiTi commuters are almost as sensitive to a *10min delay* as they are to *60 min off-peak frequency*. At the time of research there was no explicit studies for the MyCiTi. However, these outcomes are consistent with existing transport studies literature (Hayes and Venter, 2016; Behrens et.al, 2018; Mokonyama and Venter, 2018; Gao and Sun, 2018; Farrar et.al, 2019; Teffo et.al, 2019; Luke and Heyns, 2020; Statistics South Africa, 2021, 2022).

4.2.4.3.3. MyCiTi travel model

The model was estimated with the following constants: for attributes – reliability: for attribute levels – travel time (same length), cost (same fare), and reliability (60min offpeak frequency). Similarly, with the MyCiTi data the marginal model fits better with the following results:

- Likelihood ratio test = 757,
- Degrees of freedom = 8,
- p-value = <2e-16,
- Sample size, n = 3240,
- Number of events= 1078

The Likelihood ratio test result is a fraction of the complete travel mode model. I propose that this is not only because the data sample size is almost a quarter of the one discussed in *Section 4.2.3* but also that the dataset is slightly more homogeneous because one bus operator with an approximately common level of service per trip. The same degrees of freedom were maintained as the model in *section 4.2.3*. The p-value is statistically significant. *Table 4.10* below disaggregates the attributes and attribute levels

coefficients. Reliability, same (cost), same length (time) and off-peak (reliability) are set as base levels and therefore not estimated in these models.

Table 4.10: MyCiTi Travel Marginal Model

Attribute	Coef	exp(coef)	se(coef)	z	p-value
Time	1.12	3.06	0.09	12	<2e-16
Cost	1.33	3.78	0.10	13	<2e-16
Faster	1.30	3.66	0.12	11	<2e-16
Slower	-1.22	0.29	0.11	-11	<2e-16
Less	1.68	5.39	0.14	12	<2e-16
More	-2.04	0.13	0.12	-17	<2e-16
Delay	-0.54	0.58	0.12	-5	3,00E-06
Peak	0.51	1.67	0.11	5	3,00E-06

The Model's coefficients (coef) magnitude and sign are intuitive. The *z* values are large, showing the skew in attribute and attribute level preferences, p-values remain significant. The coefficients for *time (1.12 x reliability)* and *cost (1.33 x reliability*) attributes are both positive and of the same magnitude. This is potentially a result of the respondents' *time* and *cost* 10% variations being low and may not have exceeded the commuters' threshold for acceptable changes (~ 3 minutes and R2) when compared with a *10min delay* disutility with a coefficient (-0,54).

4.2.4.4. Train

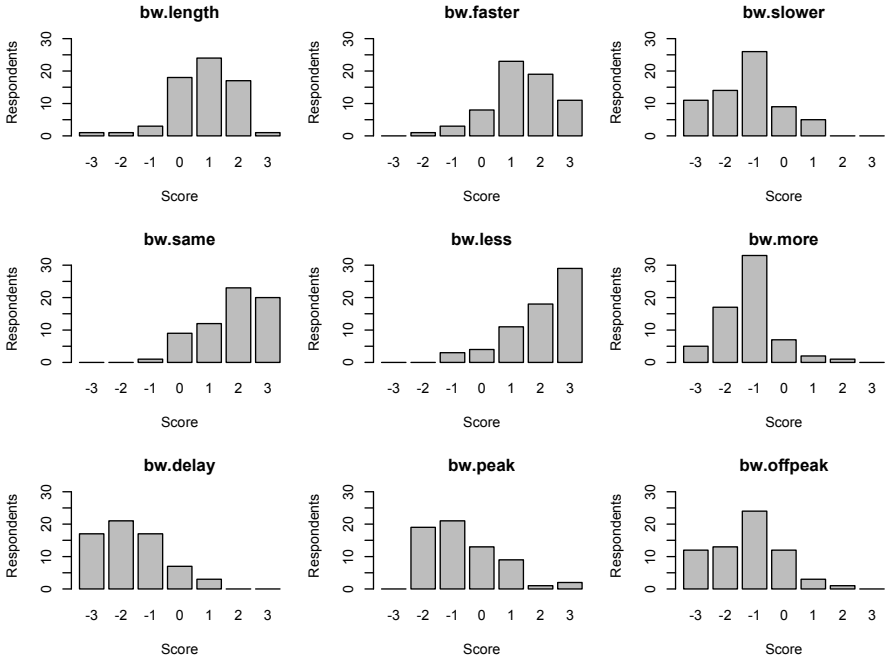
The Train is subsidized and scheduled peak and off-peak periods. It operates on dedicated infrastructure that has been plagued with problems varying from lack of maintenance, vandalism and loadshedding (Statistic South Africa, 2021). The summary of the 65 intercepted commuter details is as follows:

- 53 respondents were Employed
- Longest trip length: > 45 minutes, 10% variation ~ 5minutes
- Average trip length: 45 minutes, 10% variation ~ 5 minutes
- Shortest trip length: 5 minutes, 10% variation ~ 1 minutes
- Highest trip fare: > R45, 10% variation = R5
- Average trip fare: R14, 10% variation = R1
- Lowest trip fare: R7, 10% variation ~ R1
- Some respondents reported a household income lower than R1,250 per month.

The subsequent sections will detail the Train mode data in terms of Barplot, BW-table, and Model.

4.2.4.4.1. Train travel barplot

In *Barplot 4.5,* below skews are consistent with those of the overall travel domain barplot above *(Barplot 4.1)*.



Barplot 4.5: Train Travel

The intercepted Train commuters considered *10min delay* the greatest disutility, this has been a driver of the churn from rail to road for Cape Town commuters over the past few years (Statistic South Africa, 2021). Train commuters considered *paying 10% less fare* as the greatest utility. While *10 minutes delay* was the worst attribute level. These outcomes are consistent with what was expressed on the NHTS (Statistics South Africa, 2021).

4.2.4.4.2. Train travel BW count

Train travel attributes levels Best-Worst count is summarised in *Table 4.11* below.

The Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardized variant (stdBW). The signs of each attribute levels stdBW are consistent with that of the overall travel domain as detailed in *section 4.2* above.

Table 4.11: Train Travel BW-table

Attribute	Attribute level	Best	Worst	BW	stdBW
Time	Same **length**	73	20	53	0.2718
	Travel 10% **faster**	106	17	89	0.4564
	Travel 10% **slower**	26	108	-82	-0.4205
Cost	Pay **same** fare	124	7	117	0.6000
	Pay 10% **less**	149	18	131	0.6718
	Pay 10% **more**	19	97	-78	-0.4000
Reliability	Experience 10min **delay**	6	113	-107	-0.5487
	20min **peak** frequency	32	74	-42	-0.2154
	60min **off-peak** frequency	42	123	-81	-0.4154

As shown in *Table 4.11* the prominent attribute levels for each attribute are the following:

- Travel time is overall best (0.3077) with travel 10% **faster** as the best attribute level (0.4564).
- Cost is overall best (0.8718) with pay 10% **less** fare as the best attribute level (0.6718).
- Reliability is overall worst (-1.1795) with experience 10 minutes **delay** as the worst attribute level (-0.5487).

Overall, the *cost – pay 10% less* was the largest utility while *reliability – experience 10min delay* was the worst disutility. This is consistent with existing transport studies literature (Hayes and Venter, 2016; Behrens et.al, 2018; Mokonyama and Venter, 2018; Gao and Sun, 2018; Farrar et.al, 2019; Teffo et.al, 2019; Luke and Heyns, 2020; Statistics South Africa, 2021, 2022).

4.2.4.4.3. Train travel model

Similarly, like all the travel domain models, the marginal model was also estimated for train. The train travel model was estimated with the following constants: for attributes – *reliability*: for attribute levels – *travel time (same length), cost (same fare),* and *reliability (60min offpeak frequency)*. The marginal model results are as follows:

- Likelihood ratio test = 846
- Degrees of freedom = 8
- p-value = <2e-16
- Sample size, n = 3510
- Number of events = 1168

Table 12 below details the results. The coefficients (coef) magnitude and sign are intuitive. Some *z* values large, showing the skew in attribute and attribute level preferences, all p-values are significant however *10 min delay* and *time* much less so. The coefficients of *time (-0.5 x reliability)* and *cost (-0.6 x reliability*) attributes are both negative and of the same magnitude as *10min delay (-0.5)* disutility. This is potentially a result of the respondents' *time* and *cost* 10% variations being low and may not have exceeded the commuters' threshold for acceptable changes (~ 5 minutes and R1) when compared with a 10-minute delay disutility with a coefficient (-0,5).

Table 4.12: Train Travel Marginal Model

Attribute	Coef	exp(coef)	se(coef)	Z	p-value
Time	-0.5	0.6	0.2	-3	0.001
Cost	-0.6	0.6	0.2	-3	7,00E-04
Length	2.1	7.9	0.2	11	<2e-16
Faster	2.7	14.6	0.2	14	<2e-16
Same	2.9	17.6	0.2	15	<2e-16
Less	3.2	24.2	0.2	16	<2e-16
Delay	-0.5	0.6	0.2	-3	0.009
Peak	0.7	1.9	0.2	4	4,00E-04

From *Table 4.12* results we can postulate that a bus commuter values travel time -0.5 times more than *reliability* and *cost -0.*6 times more than *reliability*. The weight of these propensities is informed by the overwhelming desire for a decrease in travel time, a decrease in fare, and a desire for 20min peak frequency. However, since both time and cost are negative, it seems like the improvements in scheduling/reliability among the respondents have overshadowed the low cost of travel and the dedicated track benefit, not traffic.

In conclusion the majority of the intercepted train commuters the train would have to far exceed more than 100% (3 times more) of its current reliability for the commuter to accept the current

fare. Alternatively, far exceed 100% (almost 3 times more) of its current reliability for the commuter to attain a desired faster travel time.

The NHTS (2019, 2022) captured dissatisfaction for the train services, this study shows it too. A multi-pronged approach on service reliability may need to be employed to attain a positive coefficient for cost and time in comparison with reliability.

4.2.5. Dominated choice set

Choice sets that rank less or the same fare against any deterioration in other attributes are scored in favour of reduced cost. According to Soekhai et.al (2021) where there is a comparison of good and bad in a choice set, such extremities will occur. However, they also present the willingness to accept insights on the worst (rejected) attribute levels.

The most glaring of these choice set was the following:

- Pay 10% less than current fare = 100% Best
- 10 minutes delay = Worst
- 10% slower = Worse

In *Chart 4.1,* the median trip duration for the surveyed population was 37,5 minutes while the average was 43,7 minutes an increase of 10 minutes in travel time as measured by delay is evidently worse than a 10% increase in trip length which explains the overall ranking.

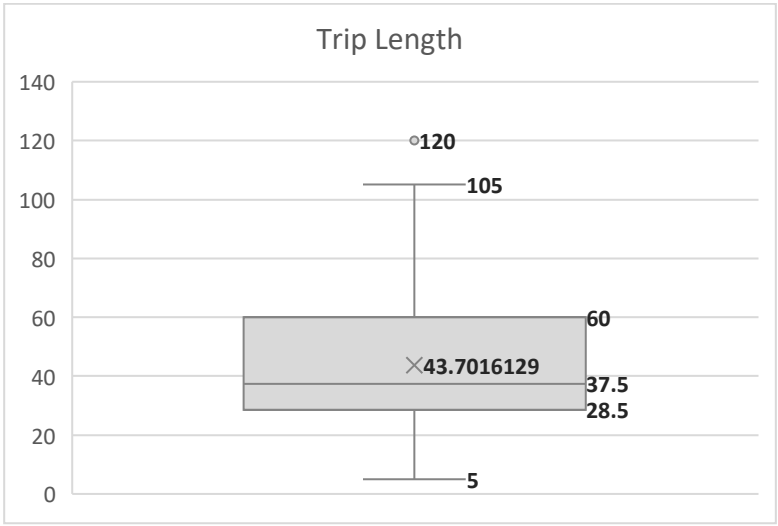


Chart 1: Box plot dominated choice sets

4.2.6. Travel domain conclusion

There are interesting and intuitive findings from the survey. **Bus** commuters expects at least 30% improvement in the reliability of the bus before either travel time or fare could increase by 10%. **MBT** commuters expect at least complete reliability before they can accept a 10% fare increase, this mimics a desire for some form of scheduling. Also a 62% drop in reliability will result is 10% slower travel time, it seems like the route flexibility to avoid congestion has a positive bearing on the sense of being on the best mode during peak. **MyCiTi** commuters expect a higher level of service and are more satisfied than the other modes. An improvement of 100% in service reliability is required for a 10% fare increase or a 30% improvement in reliability for them to travel 10% faster. **Train** commuters seem to be unhappy. They require complete reliability to even accept the current fare and are dissatisfied with current travel time.

4.3. Safety domain results

The safety domain attributes were not the same across the modes. Only the Bus and MyCiTi safety attributes were similar because of similarity in operational conditions. The available statistics from the NHTS only reports on bus without disaggregating for MyCiTi (Statistics South Africa, 2021, 2022). Even though MBT operates on the road like Bus and MyCiTi they are operated by different taxi associations and may not have homogeneity. The Train has singular safety challenges that are not comparable with the other three modes. Therefore, the analysis was conducted separately.

4.3.1. Bus and MyCiTi (B&M)

This results section summarises the results of the Bus and MyCiTi (B&M) Safety domain. The B&M safety domain is made up the **safety** from crashes, **security** (personal safety), **accessibility** (access time), and **attitude** (attitude of drivers and passengers, awareness of complaints procedure) attributes. The attribute levels were set at follows:

- Safety – sudden braking, swerving, and fender bender.
- Security – walkway patrol, security at bus stop, and security on board.
- Accessibility – walk duration unchanged, walk increased by 5 min, and walk decreased by 5 min.
- Attitude – driver's attitude, passenger's attitude, and complaints procedure.

The next sections will detail the B&M Safety Barplot, BW-count and Model.

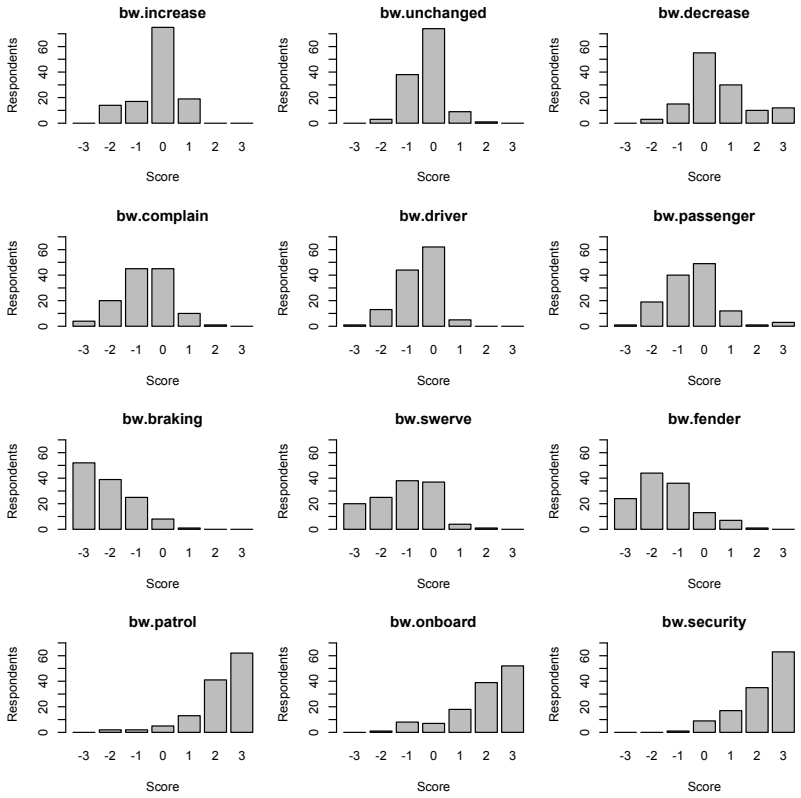
4.3.1.1. B&M safety barplot

The schematic representation of the B&M safety domain BW-barplots will be discussed. The barplot is read as described in *Section 4.1.* above. Below is the legend for *Barplot 4.6:*

- **bw.increase –** for *5 minutes increase in walk to the bus stop*
- **bw.unchanged –** for *walk to the bus stop unchanged*
- **bw.decrease –** for *5 minutes decrease in walk to the bus stop*
- **bw.complain –** for *knowledge of complaints procedure*
- **bw.driver –** for *experience a rude driver*

- **bw.passenger –** for *experience a rude passenger*
- **bw.braking –** for *experience sudden braking*
- **bw.swerve–** for *swerving to avoid a crash*
- **bw.fender –** for *experience a fender bender crash*
- **bw.patrol –** for *walkway patrols*
- **bw.onboard –** for *onboard security*
- **bw.security –** for *security at the bus stop*

The best and worst skews are apparent in *Barplot 4.6* below.



Barplot 4.6: Bus and MyCiTi (B&M) Safety

Barplot 4.6 above summarises the B&M safety data count. As expected, there are visible skews in the attribute levels. In the first row all access time attribute levels are neutral, with a peak at zero (0). The 5 minutes increase in access time, and unchanged access time with a tail towards worst, while a decrease in access time tapers towards best. In the second row the attitude attribute levels are neutral with a peak at zero (0). Knowledge of complaint procedure tapers

towards worst with twin equal peaks at negative one (-1) and zero (0). Driver attitude and passenger attitudes tapers towards worst. In the third row all attribute levels are peak on the worst part of the x-axis. Sudden braking peaks at negative three (-3), swerve peaks at negative one (-1), and fender bender peaks at negative two (-2). In the last row the security attribute levels are all best. All three attribute levels - walkway patrol, onboard security and security at bus stop - peak at three (3). From the barplots personal safety and safety from crashes were the most important attribute levels and therefrom attributes in the safety domain.

4.3.1.2. B&M BW count

B&M Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardised variant (stdBW) are shown in this section.

Safety from accidents and the security (personal) are attributes with the highest frequency. *Safety* attribute and attribute levels are collectively ranked as worst, while the *Security* attribute and attribute levels are ranked as best. The only other best attribute level ranking is a *Decrease by 5 min* in *Access Time*. The remaining attributes and attribute levels are recorded as worst. The sequential best attribute levels ranking, equally best are *Walkway patrols* and *Security at bus stops,* followed closely by *On-board security,* and lastly *Decreases by 5min.* The worst attribute levels are ranked as: *Sudden braking,* then *Fender bender,* and *Swerve.*

Even though bus driver attitude was reported as 10% of the dissatisfaction for Cape Town respondents on the National Household Travel Survey, when evaluated against safety from accidents and safety from crime reported greater than 50% in dissatisfaction the importance wanes (Statistics South Africa, 2022). Elimination cost in the domain was useful in differentiating the safety related preferences, yet the driver/passenger attitude are dominated in this domain. In order to solicit commuter preferences, attitudes would need to be evaluated with other attributes.

Table 4.13: Bus and MyCiTi (B&M) Safety BW-Table

Attributes	Attribute levels	Best	Worst	BW	stdBW
Access	**Increases** by 5 min	26	52	-26	-0.06933
	Walk **unchanged**	14	47	-33	-0.08800
	Decreases by 5 min	92	27	65	0.17333
Attitude	**Complaints**	33	118	-85	-0.22667
	Rude **driver**	12	80	-68	-0.18133
	Rude **passenger**	68	126	-58	-0.15467
Safety	Sudden **braking**	5	263	-258	-0.68800
	Swerve	14	156	-142	-0.37867
	Fender bender	16	203	-187	-0.49867
Security	Walkway **patrols**	289	14	275	0.73333
	On-board security	257	15	242	0.64533
	Stop **security**	284	9	275	0.73333

4.3.1.3. B&M safety model

B&M safety marginal and marginal sequential models were estimated with the following parameters and outputs:

Table 4.14 B&M Safety models

	Model 3	Model 4
Name	mr.data1	sq1.data1
Reverse	TRUE	TRUE
Model	Marginal	Sequential
LL test	2113	2113
Df	11	11
p-value	<2e-16	<2e-16
N	9000	9000
No. of events	2250	2250

In *Table 4.14* the columns show results of the different models. The legend is consistent with *Section 4.2.3*. *Table 4.14* further shows that all the models are statistically significant with a *p-value =<2 e-16*. There was no improvement in the *LL* from *Model 3* and *Model 4*. All models explain the data well the marginal model will be discussed.

In *Table 4.15* below, the legend is the same as in *Section 4.3.2.* The model was estimated with the following constants: for attributes – attitude; for attribute levels – access (walk unchanged), attitude (passenger), safety (fender bender), and security (security at the stop).

Table 4.15. B&M Safety Marginal Model

	Model 3 – Marginal				
Attribute	Coef	Exp (coef)	se (coef)	Z	p-value
Access	0.641	1.898	0.078	8.3	<2e-16
Crash	-0.773	0.462	0.067	-11.6	<2e-16
Safety	2.282	9.793	0.081	28.3	<2e-16
Increase	-0.295	0.744	0.085	-3.5	5,00E-04
Decrease	0.681	1.975	0.085	8.0	1,00E-15
Complain	-0.123	0.885	0.083	-1.5	0.139
Driver	-0.007	0.993	0.083	-0.1	0.929
Braking	-0.628	0.533	0.086	-7.3	2,00E-13
Swerve	0.515	1.673	0.080	6.5	1,00E-10
Patrol	0.128	1.136	0.092	1.4	0.165
Onboard	-0.262	0.769	0.088	-3.0	0.003

The B&M Safety Marginal coefficients (coef) magnitude and sign are intuitive. Some *z* values are large, showing the skew in attribute and attribute level preferences, most p-values are statistically significant except for attitude attribute levels and the attribute level *patrol along walkways*.

The coefficients for attributes are *access (0.641 x attitude)*, *crash (-0.773 x attitude*), and *safety (2.282 x attitude)*. *Crash* is intuitively negative. The attribute levels are as follows: *5min increase (-0.295 x unchanged), 5min decrease (0.681 x unchanged), knowledge of complain procedure (-0.123 x passenger attitude), driver attitude (-0.007 x passenger attitude), sudden braking (-0.628 x fender bender), swerve (-0.515 x fender bender), walkway patrols (0.128 x security at bus stop),* and *onboard security (-0.262 x security at bus stop)*.

From *Table 4.15* results we can postulate that B&M commuter values their attributes in the following sequence *safety (2.28), access(0.64)* and *crash (-0.77)* more than *attitude*. Based on the statistically significant coefficients we can deduce that B&M prefer *swerve* by a lesser magnitude than they detest *sudden braking* when compared to *fender benders (minor crashes)*.

Secondly, they prefer *5minutes decrease in access time* by a greater magnitude than they detest *5minures increase in access time* when compared to *access time unchanged*.

4.3.2. Minibus Taxi (MBT)

This section details findings of the MBT Safety domain. The MBT safety domain is made up the **safety** from crashes, **security** (personal safety), and **accessibility** (access time) attributes. The attribute levels were set at follows:

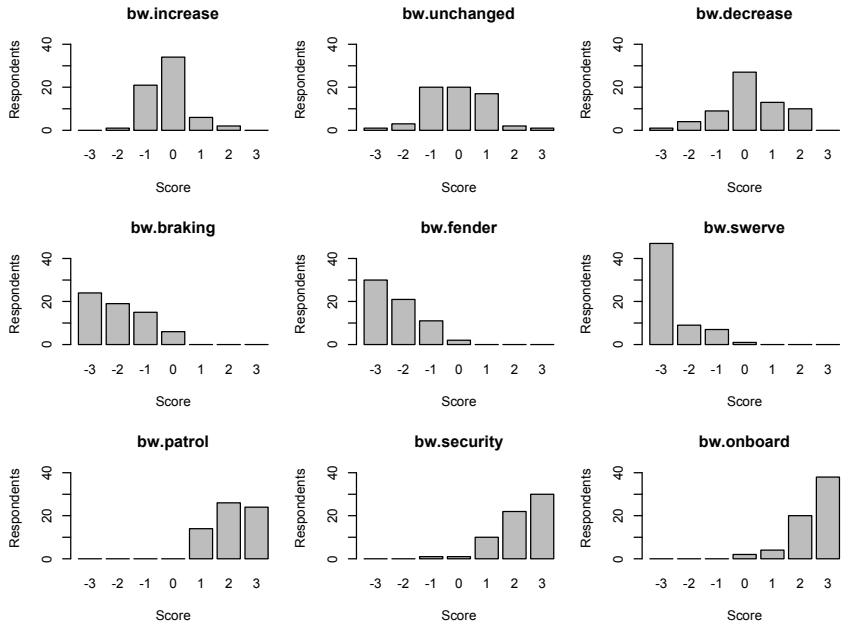
- Safety – sudden braking, swerving, and fender bender.
- Security – walkway patrol, security at bus stop/taxi rank, and security on board.
- Accessibility – walk duration unchanged, walk increased by 5 min, and walk decreased by 5 min.

Then next sections detail the MBT Safety Barplot, BW Count, and model.

4.3.2.1. MBT safety barplot

The best and worst skews are apparent in *Barplot 4.7* below. The legend for *Barplot 4.7* is as follows:

- **bw.increase –** for *5 minutes increase in walk to the bus stop*
- **bw.unchanged –** for *walk to the bus stop unchanged*
- **bw.decrease –** for *5 minutes decrease in walk to the bus stop*
- **bw.braking –** for *experience sudden braking*
- **bw.swerve–** for *swerving to avoid a crash*
- **bw.fender –** for *experience a fender bender crash*
- **bw.patrol –** for *walkway patrols*
- **bw.onboard –** for *onboard security*
- **bw.security –** for *security at the bus stop/ taxi rank*



Barplot 4.7: MBT Safety

Barplot 4.7 above summarises the B&M safety data count. As expected, there are visible skews in the attribute levels. In the first row the access time attribute levels are neutral, with a peak at zero (0). The 5 minutes increase in access time tappers towards worst, unchanged access time has equal twin peaks at negative one (-1) and zero (0) tapering to worst, while a decrease in access time tapers towards best. In the second row all safety attribute levels peak at negative three (-3) namely: sudden braking, swerve peaks, and fender bender. On the last row the security attribute levels are all best. Walkway patrol peaks at two (2), onboard security and security at bus stop - peak at three (3). From the barplots skews personal safety and safety from crashes were the most important attribute levels and therefrom attributes in the MBT safety domain.

4.3.2.2. MBT safety BW count

MBT safety Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardised variant (stdBW) are shown in *Table 4.16* below.

Table 4.16: MBT Safety BW-table

Attributes	Attribute levels	Best	Worst	BW	stdBW
Safety	Sudden **braking**	2	127	-125	-0.65104
	Fender **bender**	1	144	-143	-0.74479
	Swerve	2	168	-166	-0.86458
Security	Walkway **patrols**	140	2	138	0.71875
	Taxi rank/stop **security**	149	6	143	0.74479
	On-board security	160	2	158	0.82292
Access	Walk **unchanged**	46	17	29	0.1510
	Decreases by 5 min	52	39	13	0.06771
	Increases by 5 min	22	35	-13	-0.06771

Like the bus respondents, safety from accidents and the security (personal) are attributes with the highest frequency. *Safety* attribute and attribute levels are collectively ranked as worst, while the *Security* attribute and attribute levels are ranked as best. The other best attribute level rankings are *Walking unchanged* and *Decrease by 5 min* in *Access Time*. The remaining attributes and attribute level is recorded as worst. The worst attribute levels are ranked as: *Sudden braking,* then *Fender bender,* and *Swerve.*

4.3.2.3. MBT safety model

The model was estimated with the following constants: for attributes – security (security at the stop). The output of the MBT safety marginal model are as follows:

- Likelihood ratio test = 1174
- Degrees of freedom = 8
- P-value < 2e-16
- n = 3456
- number of events = 1152
- 108 observations deleted due to missingness

Table 4.17: MBT Safety Marginal Model

Attribute		**Marginal**			
Level	Coef	Exp (coef)	se (coef)	Z	P
Increase	-1.71	0.18	0.20	-8.6	<2e-16
Decrease	-1.22	0.30	0.19	-6.3	3,00E-10
Unchanged	-1.56	0.21	0.20	-7.9	3,00E-15
Braking	-2.57	0.08	0.20	-12.6	<2e-16
Swerve	-3.72	0.02	0.25	-14.6	<2e-16
Fender	-2.97	0.05	0.22	-13.7	<2e-16
Patrol	-0.12	0.88	0.22	-0.6	0.58
Onboard	0.44	1.55	0.24	1.8	0.07

Security attribute levels are statistically insignificant. For MBT Safety models, other than the missing data, the security related coefficients estimated are not statistically significant. This results will be discussed in the next chapter.

The MBT Safety Marginal coefficients (coef) sign is surprisingly negative for all attributes and attribute levels except for security on board. Some *z* values are large, showing the skew in attribute and attribute level preferences, most p-values are statistically significant except for security attribute levels *patrol along walkways* and *onboard security*.

The coefficients for attribute levels are as follows: *5min increase (-1.71 x access), 5min decrease (-1.22 x access), walk unchanged (-1.56 x access), sudden braking (-2.57 x safety), fender bender(-2.97 x safety), swerve (-3.72 x safety), walkway patrols (-0.12 x security at bus stop),* and *onboard security (0.44 x security at bus stop).*

From *Table 4.17* results we can postulate that MBT commuters are dissatisfied with all safety attribute levels, and all access attribute levels. If there are no other available desirable public transport modes, they are likely to move to private car use.

4.3.3. Train

This section details findings of the Train Safety domain. The Train safety domain is made up the **safety** from crashes, **security** (personal safety), and **accessibility** (access time) attributes. The attribute levels were set at follows:

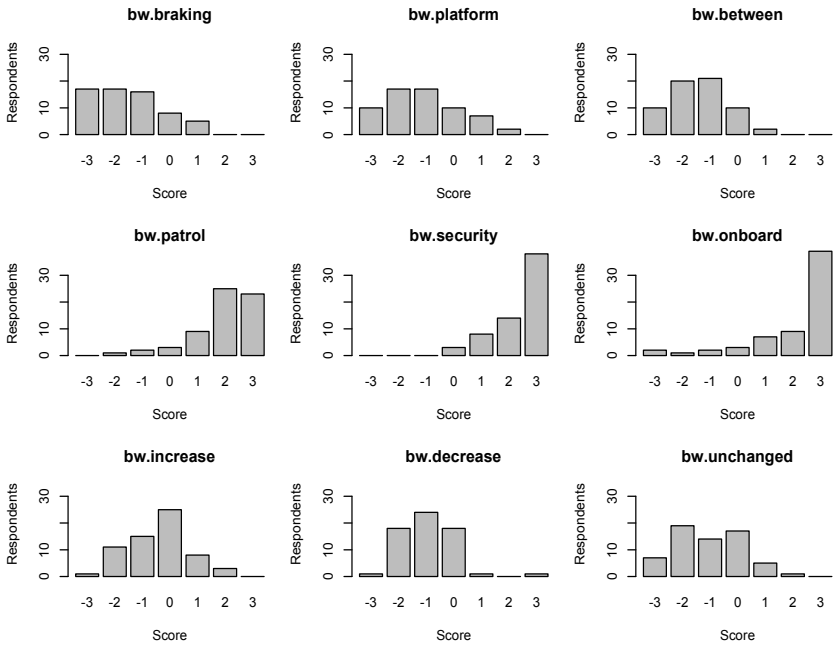
- Safety – sudden braking, longer platform stops, and between station stops.
- Security – walkway patrol, security at bus stop/taxi rank, and security on board.
- Accessibility – walk duration unchanged, walk increased by 5 min, and walk decreased by 5 min.

Then next sections detail the MBT Safety Barplot, BW Count, and model.

4.3.3.1. Train safety barplot

The best and worst skews are evident in *Barplot 4.8* below. The legend for is as follows:

- **bw.braking –** for *experience sudden braking*
- **bw.platform–** for *longer platform stops to prevent a crash*
- **bw.between –** for *between station stops to prevent a crash*
- **bw.patrol –** for *walkway patrols*
- **bw.onboard –** for *onboard security*
- **bw.security –** for *security at the bus stop/ taxi rank*
- **bw.increase –** for *5 minutes increase in walk to the bus stop*
- **bw.unchanged –** for *walk to the bus stop unchanged*
- **bw.decrease –** for *5 minutes decrease in walk to the bus stop*



Barplot 4.8:Train Safety

Barplot 4.8 above summarises the train safety data count. As expected, there are visible skews in the attribute levels. In the first row the safety attribute layers are negative. Braking has three equal peaks at three (-3), two (-2) and one (-1). In the second row the security attribute levels are all best. Walkway patrol peaks at two (2), onboard security and security at bus stop - peak at three (3). In the last row the 5 minutes increase in access time neutral with a peak at zero (0) and tappers towards worst. 5 minutes decrease in access time is worst with a peak at (-1). Lastly, walk unchanged in negative with two peaks at negative two (-2) and zero (0). From the barplots skews personal safety and safety from crashes were the most important attribute levels and therefrom attributes in the Train safety domain.

4.3.3.2. Train safety BW count

Train safety Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardised variant (stdBW) are shown in *Table 4.18* below.

Table 4.18: Train Safety BW-table

Attributes	Attribute levels	Best	Worst	BW	stdBW
Safety	Sudden **braking**	20	116	-96	**-0.5079**
	Platform stops	31	101	-70	-0.3704
	Between station stops	12	101	-89	-0.4709
Security	Walkway **patrol**	136	12	124	0.6561
	Security at station	158	8	150	0.7937
	Onboard security	148	16	132	0.6984
Access	Walk **unchanged**	18	84	-66	-0.3492
	Decrease by 5min	16	75	-59	-0.3122
	Increase by 5min	20	46	-26	-0.1376

The only best attributes are for personal security. The ranking is sequentially *Onboard security, Security at station* and *Walkway patrol.* The worst attributes are ranked as: *Sudden braking, Access Increase by 5min* and *Between station stops*. Attributes stdBW produce the following insights: *Safety (-1.3492), Security (2.1482),* and *Access(-0.799).* Security is perceived as best, and safety as worst.

4.3.3.3. Train safety model

The output of the Train safety marginal model are as follows:

- Likelihood ratio test = 534
- Degrees of freedom = 8
- P < 2e-16
- n = 3402
- number of events = 559

Table 4.19: Train Safety Marginal Model

			Marginal		
Level	Coef	exp(coef)	se(coef)	Z	p-value
Increase	-1.84	0.16	0.20	-9	<2e-16
Decrease	-2.34	0.10	0.20	-11	<2e-16
Unchanged	-2.45	0.09	0.21	-12	<2e-16
Braking	-2.71	0.07	0.21	-13	<2e-16
Between	-2.59	0.07	0.21	-12	<2e-16
Platform	-2.29	0.10	0.20	-11	<2e-16
Patrol	-0.62	0.54	0.22	-3	0.005
Onboard	-0.46	0.63	0.23	-2	0.046

Security attribute levels are statistically insignificant. Train Safety Marginal coefficients (coef) sign is surprisingly negative for all attribute levels. Some *z* values are large, showing the skew in attribute and attribute level preferences, most p-values are statistically significant except for security attribute levels *patrol along walkways* and *onboard security*.

The coefficients for attribute levels are as follows: *5min increase (-1.84 x access), 5min decrease (-2.34 x access), walk unchanged (-2.45 x access), sudden braking (-2.71 x safety), between stations (-2.59 x safety), platform stop (-2.29 x safety), walkway patrols (-0.62 x security at bus stop),* and *onboard security (-0.46 x security at bus stop).*

From *Table 4.19* results we can postulate that Train commuters are dissatisfied with all safety attribute levels, and all access attribute levels. If there are no other desirable available public transport modes, they are likely to move to private car use.

4.4. Comfort domain results

The comfort domain attributes were the same across for Bus, MyCiTi and Train because they all have timetables, while the minibus taxi has route flexibility as a differentiator. Therefore the Bus, MyCiTi and Train (BM&T) were analysed together. The MBT will be analysed separately.

This section details findings of the BM&T comfort domain. The BM&T comfort domain is made up the **safety** from crashes, **security** (personal safety), and **accessibility** (access time) attributes. The attribute levels were set at follows:

- Cost – pay 10% more fare, pay same fare, and pay 10% less fare.
- Timetable – at station/bus stop, from other people, and on social media.
- comfort – facilities at stops, ventilation/open windows, and overcrowding.

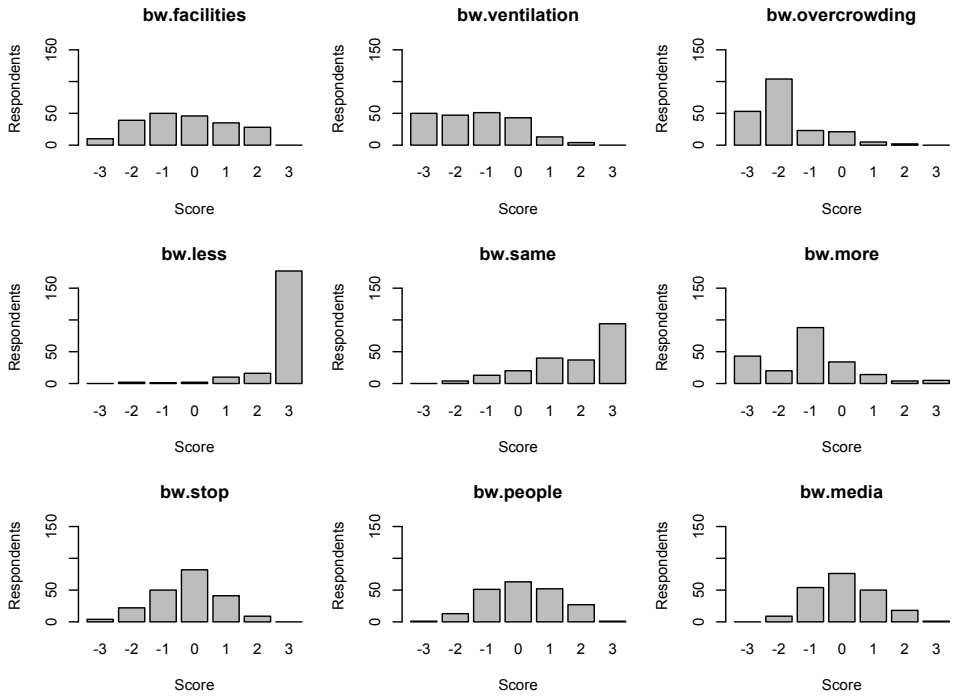
Then next sections detail the BM&T Comfort Barplot, BW Count, and model.

4.4.1. Bus, MyCiTi and Train (BM&T)

4.4.1.1. BM&T comfort barplot

Only the information attributes show a normal distribution, all others are skewed as shown in *Barplot 4.9* below. The legend for *Barplot 4.9* is as follows:

- **bw.facilities –** for *facilities at the bus stop/station*
- **bw.ventilation –** for *open windows or ventilation*
- **bw.overcrowding –** for *overcrowding*
- **bw.less –** for *paying 10% less fare*
- **bw.same–** for *paying same fare*
- **bw.more –** for *paying 10% more fare*
- **bw.stop –** for *timetable information at bus stop/station*
- **bw.people –** for *timetable information for people (friends or family)*
- **bw.media –** for *timetable information from social media platforms*



Barplot 4.9: BM&T Comfort

Barplot 4.9 above summarises the BM&T comfort data count. As expected, there are visible skews in the attribute levels. In the first row the comfort attribute levels vary. Facilities is almost

evenly distributed with a peak at negative (-1) tapering to the positive x-axis. Ventilation is almost level mostly negative with a peak at negative three (-3). Overcrowding is negative with a peak at negative two (-2). In the second row paying more is undesirable with a peak at negative one (-1). Paying less or the same fare is preferred with a peak at positive three (3). On the last row all the information attribute levels are a normal distribution with a peak at zero (0). From the barplots skews cost has the most important attribute levels and therefrom attributes in the MBT comfort domain.

4.4.1.2. BM&T comfort BW count

BM&T Comfort Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardised variant (stdBW) are shown in subsequent section.

Like the Travel domain analysis, *Table 4.20* shows: *pay less* is the most preferred attribute level. Experiencing *Overcrowding* is selected as the worst overall attribute. Overall, there is also a disutility attributed to *facilities* and *ventilation* in the comfort domain. The majority of respondents consider *paying same* fare best, while *paying more* is worst. Most of the respondents favoured getting access to timetable information from *social media* and *people* while accessing the information at the *bus stop/station* is worse.

Information as a domain seems less important when measured against cost attribute levels and physical comfort attribute levels.

Table 4.20: BM&T Comfort BW-table

Attribute	Level	B	W	BW	stdBW
Comfort	**Facilities** at bus stop	154	221	-67	-0.10737
	Bus/train **ventilation/** open windows	50	324	-274	-0.43910
	Bus/train **overcrowding**	43	424	-381	-0.61058
Cost	Pay 10% **less**	582	14	568	0.91026
	Pay **same** fare	419	44	375	0.60096
	Pay 10% **more**	157	377	-220	-0.35256
Information/ Timetable	Get timetable at the bus **stop**	117	164	-47	-0.07532
	Get timetable from other commuters/ friends and family (**people)**	147	118	29	0.04647
	Get timetable from social **media** and call centres	194	177	17	0.02724

4.4.1.3. BM&T comfort model

The best estimated BM&T models are tabulated in section below. The model was estimated with the following constants for attributes levels – timetable (from social media).

Table 4.21 below is the marginal model results. The estimated coefficients for f*acilities* and *people* are statistically insignificant. MyCiTi facilities are newer, and their importance and magnitude may be masked by cost, while the other modes have old facilities that users have complained about (Statistics South Africa, 2021, 2022).

Table 4.21: BM&T Comfort Marginal Model

Level	Coef	exp(coef)	se(coef)	Z	p-value
Facilities	0.03	1.03	0.09	0.4	0.711
Ventilation	-0.92	0.40	0.09	-9.8	<2e-16
Overcrowding	-1.51	0.22	0.10	-15.1	<2e-16
Same	1.17	3.23	0.10	12.3	<2e-16
Less	2.92	18.60	0.15	19.4	<2e-16
More	-1.30	0.27	0.09	-14.3	<2e-16
Stop	-0.30	0.74	0.10	-3.0	0.003
People	0.06	1.06	0.10	0.6	0.548

The BM&T Comfort Marginal coefficients (coef) sign are intuitive. Some *z* values are large, showing the skew in attribute and attribute level preferences, most p-values are statistically significant except for security attribute levels *facilities, information at bus stop,* and *information from people.*

The statistically significant coefficients for attribute levels are as follows: *ventilation (-0.92 x comfort), overcrowding (-1.51 x comfort), pay same fare (1.1.7 x cost), pay less fare (2.29 x cost), more (-1.3 x cost).*

From *Table 4.21* results we can postulate that BM&T commuters are dissatisfied with overcrowding, and they greatly desire to pay less. If there are no other available desirable public transport modes, they are likely to move to private car use.

4.4.2. Minibus Taxi (MBT)

This section details findings of the MBT Comfort domain. This domain is made up the **safety** from crashes, **security** (personal safety), and **accessibility** (access time) attributes. The attribute levels were set at follows:

- Cost – pay 10% more fare, pay same fare, and pay 10% less fare.
- Flexibility – avoid congestion, no route change, and passengers away from main road.
- Comfort – facilities at stop/taxi rank, ventilation/open windows, and overcrowding.

Then next sections detail the MBT Safety Barplot, BW Count, and model.

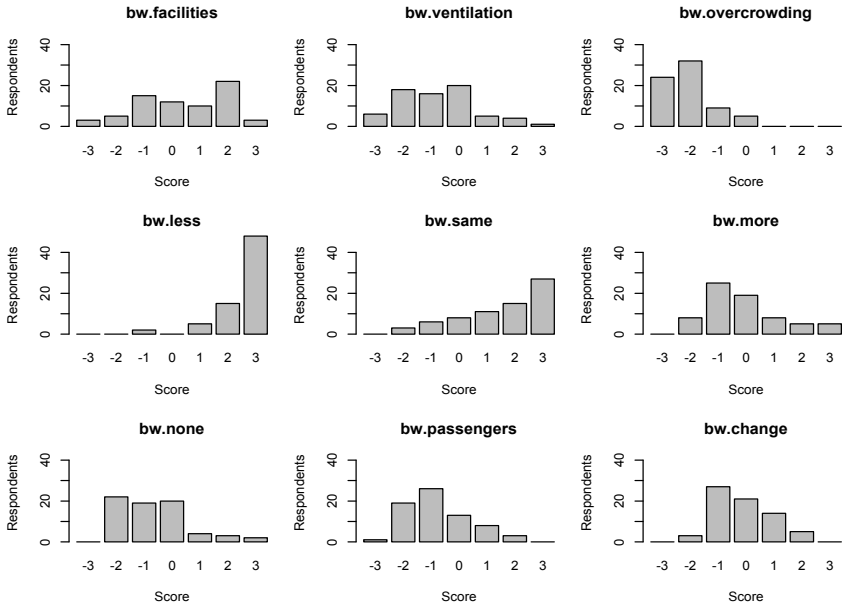
4.4.2.1. MBT comfort barplot

In *Barplot 4.10,* the best-minus-worst (BW) scores of each attribute level is plotted. The legend for *Barplot 4.10* is as follows:

- **bw.facilities –** for *facilities at the bus stop/station*
- **bw.ventilation –** for *open windows or ventilation*
- **bw.overcrowding –** for *overcrowding*
- **bw.less –** for *paying 10% less fare*
- **bw.same–** for *paying same fare*
- **bw.more –** for *paying 10% more fare*
- **bw.none–** for *no route changes*
- **bw.passenger –** for *fetch passengers away from main road*
- **bw.change–** for *change route to avoid congestion*

Barplot 4.10 below summarises the MBT data count. As expected, there are visible skews in the attribute levels except for the *taxi rank/stop facilities* which exhibits a bi-modal peaks. In the first row the facilities attribute levels vary. *Taxi rank/stop facilities* is mostly positive with two peaks at positive two (2) and negative one (-1). *Ventilation* is mostly negative with two peaks at negative two (-2) and zero (0). *Overcrowding* is negative with a peak at negative two (-2).

In the second row *pay less* and *pay more* are positive and peak at three (3). *Pay more* is negative with peak at negative one (-1). On the last row *no route change* is negative with to peaks at negative two (-2) and zero (0). *Away from main road passengers* is negative with a peak at negative one (-1). Finally, *change to avoid congestion* is mostly on positive x-axis with a peak at negative one (-1).



Barplot 4.10: MBT Comfort

From the barplots skews cost has overshadowed the other attributes. the intercepted MBT commuters are likely to leave the mode due to overcrowding.

4.4.2.2. MBT comfort BW count

MBT Comfort Attributes, Attribute levels, Best, Worst, best-minus-worst (BW) scores and the standardised variant (stdBW) are shown in subsequent section.

Like in the Travel domain analysis, *pay less* is the most preferred attribute level. Experiencing *Overcrowding* is selected as the worst overall attribute. In the comfort domain there is a disutility attributed to *ventilation,* while *facilities* are an utility. The majority of respondents consider *paying same* fare best, while *paying more* is worst. The overall outcome for the

Information domain seems less important when measured against cost attribute levels and physical comfort attribute levels.

Table 4.22: MBT Comfort BW-table

	Levels	B	W	BW	stdBW
Comfort	**Facilities** at bus stop	79	50	29	0.13810
	Bus **ventilation**/ open windows	22	76	-54	-0.25714
	Bus **overcrowding**	3	148	-145	-0.69048
Cost	Pay 10% **less**	185	8	177	0.84286
	Pay **same** fare	133	23	110	0.52381
	Pay 10% **more**	79	87	-8	-0.03810
Flexibility	No route changes (**none**)	29	76	-47	-0.22381
	Collects **passengers** away from main road	24	77	-53	-0.25238
	Change route to avoid congestion	68	77	-9	-0.04286

4.4.2.3. MBT comfort model

The model was estimated with the following constants for attribute level – flexibility (collect passengers away from main road). The MBT Comfort marginal model estimate the following:

- Likelihood ratio test = 743
- Degrees of freedom = 8
- p-value = <2e-16
- N = 3780
- Number of events = 1260

Table 4.23: MBT Comfort Marginal Model

Levels	Coef	exp(coef)	se(coef)	Z	p-value
Facilities	1.18	3.25	0.16	7.5	9,00E-14
Ventilation	0.13	1.14	0.15	0.9	0.4
Overcrowding	-1.24	0.29	0.17	-7.2	6,00E-13
Same	1.53	4.62	0.16	9.4	<2e-16
Less	2.96	19.20	0.22	13.5	<2e-16
More	0.05	1.05	0.15	0.3	0.7
None	0.11	1.11	0.17	0.6	0.5
Change	0.62	1.86	0.17	3.7	2,00E-04

In *Table 4.23* above only the *ventilation, pay 10% more* and *no route changes (none)* estimated coefficients are statistically insignificant. *Overcrowding* is the worst for all modes and *paying 10% less* is best. The intercepted MBT respondents are likely to leave the mode due to *Overcrowding* persists without a reduction in *cost.*

5. Discussion

The discussion covers the following topics: Travel domain, Safety domain, Comfort domain, Cost, and Case 2 Best Worst Scaling.

5.1. Travel domain

Increase in cost for the travel and comfort domains is the worst attribute level. In the travel domain the estimated *cost (=1.47 x reliability)* coefficient is higher than the *time (=1.24 x reliability)* coefficient when the *reliability* coefficient is set as a baseline across all modes.

5.1.1. Attribute levels

In the **reliability** measure a combination of delay and frequency at different times was explored. Even though MyCiTi commuters found delays and off-peak frequency worst, the is a general theme that delays are worst on all modes. In the overall travel model results, *20min frequency (0.50 x 60min offpeak frequency); experience 10min delay (-0.42 x 60min offpeak frequency); and cost (1.47 x reliability)*, *time (1.24 x reliability).* Therefore, 20mins frequency is almost the same magnitude in the opposite side of 10min delay when pegged on 60min off-peak frequency. At mode level like other commuters delays were undesirable. Pivoting delays in future researches may be an improvement in the measure of reliability which has some data in recent literature. Pivoting delays with travel time and frequency may be a domain that less dominated. It is known that in the South African context where transport costs are the major part of household budgets, paying less will most likely be the best (DOT, 2017; Statistics South Africa 2021, 2022).

Travel time in Cape Town varies widely the study investigated a 10% pivot in travel time. Commuters on shorter trips were responsive to these values. It emerged that on choice sets where cost was more, travel time and reliability received attention and consideration as a best. A domain permutation without cost is proposed in the paragraph on reliability.

Even in the most affordable mode, the train, commuters still preferred reduction or same **cost.** This is consistent with the economic climate of the country (DOT, 2017; Statistics South Africa 2021, 2022). Cost studies would work best on Case 3 experiments, where satisficing is linked to service attribute levels.

5.2. Safety domain

Soekhai et.al (2021) advised against including cost on a safety choice set, the safety domain was presented with attributes that excluded cost and that was prudent. Nevertheless, testing for safety attributes is challenging. There is a risk of traumatising (or re-traumatising) respondents by painting an extremely picture of danger. There is also a risk of painting the picture so mild that it no longer engages respondents who have experienced extreme danger. This study sought to test permutations of attributes and attribute levels that could solicit safety preferences and perceptions. The goal to address safety from crashes without mentioning degrees of crashes in soliciting a response was unsuccessful. However, personal safety was understood and responded to. The following was found:

B&M marginal model had the following statistically significant attributes: *access (=0.641 x attitude), safety from crash (=-0.773 x attitude), security (=2.282 x attitude), 5min increase in access time (=-0.295 x walk unchanged), 5min decrease in access time (=0.681 x walk unchanged), experience sudden braking (-0.628 x fender bender), swerve to avoid a crash (=0.515 x fender bender)* and *security personnel on board (=-0.262 x security at the stop). Safety from crashes* and *personal safety* are important attributes and as such dominated the choice sets. *Access* is an utility and intuitively an increase in access time is a disutility. *Crash* is a disutility. When a *fender bender (not estimated)* is compared to other safety attribute levels, *experience sudden braking* is a disutility while *swerve to avoid a crash* is an utility. Personal safety is the largest coefficient, however when estimated against the baseline of *personnel at the bus stop, security personnel on board* is a disutility and *community patrols* are insignificant. The B&M respondents also registered a disutility for experiencing either a *rude driver* or *passenger*, and the *knowledge of complaints process* however these were insignificant. These attribute should be considered with other attributes excluding cost.

For **MBT** the *security at taxi rank* was set as a baseline. Of the estimated coefficients the security coefficients were not statistically significant. The *access* and *crash* attribute levels were all negative. The model generated the following ranking of attribute level coefficients: *swerve (=-3.72 x security at the stop/rank), fender bender (=-2.97 x security at the stop/rank), sudden braking (=-2.57 x security at the stop/rank), 5min increase in walk (=-1.71 x security at the stop/rank), walk unchanged (=-1.56 x security at the stop/rank)* and *5min decrease in*

walk (=-1.22 x security at the stop/rank). The confirmed disutility for *crash* attribute levels are consistent with the expressed dissatisfaction in literature (Statistics South Africa, 2021, 2022).

For **Train** all the attribute levels have negative coefficients. *Access* to train stations is fixed and routes inflexible. Some commuters use other motorised transport to access the stations, those that walk are likely to walk more than the proposed *5min* variation. In contrast MBTs are very flexible, BUS may review the set stops along the route, while MyCiTi infrastructure is more recent and some developments are still taking place around some stops. There have been improvements in security with security personnel at stops and onboard, community patrols are outside of mode operations. Even though there was an error on the questionnaire that affects the model on *onboard* vs *station security,* it is still a disutility for the commuters. As far as *Safety from crash* is concerned, the coefficients are greater than those of other modes, this is likely because some of the crash prevention methods involves an in increase in travel time and reliability of the mode, thereby confirming the dissatisfaction captured in the Western Cape NHTS (Statistics South Africa, 2022). Consistent with the other modes e*xperiencing sudden braking (=-2.71 x security at the station)* has the greatest coefficient followed by *stopping between station (=-2.59 x security at the station)* this crash prevention method keeps users hostage and is therefore considered more severe than *longer platform stops (=-2.29 x security at the station)* where a commuter may exit the stationary train and explore other mode options near and around the train stations.

Access time recorded for Cape Metro places the majority of commuters within 30 minutes' walk from the stop (Statistics South Africa, 2021 and 2022), the survey respondent baseline access/egress time was not solicited. The survey respondents across all modes value personal security to a greater degree when compared to access time, nevertheless an *increase in access* time remains a disutility.

5.2.1. Gender insights

There are nuanced differences between male and female commuters. Vanderschuren et al (2019) posits that gender informs travel choices. The MBT model returned an error message on the gender disaggregated BW-count.

In *Table 5.2* and *5.3* below, both male and female bus respondents considered *braking* as the worst disutility. Females considered both *security at bus stop* and *community patrols* as an overall best attribute level, while males weighed *community patrols* best.

Table 5.2: Bus

Attributes	Male	Female
Increase	-0.08333	-0.10526
Unchanged	-0.08333	-0.08772
Decrease	0.08333	0.03509
Complain	-0.13333	-0.14035
Driver	-0.07500	-0.07018
Passenger	-0.05833	-0.10526
Braking	-0.85000	-0.84211
Swerve	-0.65833	-0.56140
Fender	-0.70000	-0.64912
Patrol	**0.89167**	**0.85965**
Onboard	0.79167	0.80702
Security	0.87500	**0.85965**

In *Table 5.3,* both male and female MyCiTi respondents considered *braking* as the worst disutility and *security at bus stop* as an overall best attribute level, this is also a constant feature at the MyCiti bigger stops.

Table 5.3: MyCiTi

Attributes	Male	Female
Increase	-0.08824	-0.02222
Unchanged	-0.10784	-0.08889
Decrease	0.21569	0.32222
Complain	-0.34314	-0.25556
Driver	-0.24510	-0.32222
Passenger	-0.23529	-0.23333
Braking	-0.61765	-0.46667
Swerve	-0.11765	-0.17778
Fender	-0.32353	-0.32222
Patrol	0.64706	0.53333
Onboard	0.55882	0.46667
Security	**0.65686**	**0.56667**

In *Table 5.4* below, both male and female bus respondents considered *security at the station* as an overall best attribute level. Females considered *braking* as the worst disutility, this may probably be linked to pregnancy safety, while males weighed *between station stops* as worst.

Table 5.4: Train

Attributes	Male	Female
Braking	-0.4086	-0.6042
Platform	-0.3656	-0.3750
Between	-0.4516	-0.4896
Patrol	0.6237	0.6875
Security	**0.7634**	**0.8229**
Onboard	0.5806	0.8125
Increase	-0.1290	-0.1458
Decrease	-0.2796	-0.3438
Unchanged	-0.3333	-0.3646

Reasons for this variation are unknown, a further investigation with qualitative questions may highlight the key reasons between modes and genders. Overall visibility of security personnel is desirable.

5.3. Comfort domain

Though comfort levels vary across modes, routes and demographics. It was estimated that *pay 10% less* coefficients were best while *experiencing overcrowding* coefficients were worst.

Flexibility of the MBT was not as prominent as expected. *Change route to avoid congestion (=0.44 x collect passengers away from the main road)* while *No route changes (=0.04 x collect passengers away from the main road)* these flexibility attribute levels were not statically significant. This domain was dominated by cost. A further discussion on comfort will be explored in *Section 5.4 Cost.*

Even among Bus, MyCiTi and Train commuters overcrowding was a statistically significant worst coefficient while reduction in cost was a statistically significant best. From this it is

evident that in cases where overcrowding is prevalent, the operators must respond with increased passenger capacity.

5.4. Cost

A comparison of the overall travel model with the different modes showed the following insights. **MyCiTi** users the *cost (=1.33 x reliability)* and *time (=1.12 x reliability)* coefficients were estimated less than the overall. This may be linked to the distance/zone-based pricing with the perception of commensurate cost to distance, and predictability of travel time mostly due to dedicated lanes and thereby reliability. **Bus** users *cost (=1.39 x reliability)* coefficient is lower than the overall, while the *time (=1.30 x reliability)* coefficient is more. This is consistent with the expressed dissatisfaction with bus fare, congestion and its resultant delays (Statistics South Africa, 2021, 2022). **MBT** users *cost (=2.05 x reliability)* and *time (=1.73 x reliability)* coefficients are higher than the overall. This is consistent with the dissatisfaction on fare affordability when compared with train, which has the lowest fare (Behrens et.al, 2018). As expressed in section 3.1.2, MBT are also adversely affected by congestion which affects travel time and consequently reliability of service. Finally, **Train** users *cost (=-0.6 x reliability)* coefficient and *time (=-0.5 x reliability)* coefficients were negative when estimated with reliability as a constant. The train has the lowest fare, dedicated aging infrastructure, and is plagued by vandalism and loadshedding woes. This affects travel time and reliability (Statistics South Africa, 2021, 2022). Even though there is a disutility for *paying 10% more*, the model output illustrates the necessity for a multi-pronged approach to the improvement of train.

A comparison of the cost on comfort model with the scheduled modes (**BM&T**) shows that *timetable information* attribute levels, and other comfort attribute levels like *facilities* and *ventilation* were less impactful than *overcrowding*. For **BM&T** *pay 10% less (=2.92 x timetable from social media)* against *pay the same (=1.17 x timetable from social media)*, *pay 10% more (=-1.30 x timetable from social media)* and *overcrowding (=-1.51 x timetable from social media)* they are all statistically significant and the mode specific comparison were: **Bus** *pay 10% less (=4.87 x timetable from social media)* against *pay the same (=0.88 x timetable from social media)*, *pay 10% more (=-1.56 x timetable from social media),* and *overcrowding (=-2.29 x timetable from social media).* **MyCiTi** *pay 10% less (=2.3 x timetable from social*

media) against *pay the same (=0.9 x timetable from social media)*, *pay 10% more (=-0.30 x timetable from social media)* and *overcrowding (=-1.70)*. **Train** *pay 10% less (=3.27)* against *pay the same (=2.27)*, *pay 10% more (=-2.40 x timetable from social media)* and *overcrowding (=-0.90 x timetable from social media).* The disaggregated coefficients data shows that **Bus** commuters are the most sensitive to cost changes when considered with comfort, specifically overcrowding, this is consistent with literature (Farrar et.al, 2019, Statistics South Africa, 2021, 2022; Luke and Heyns, 2020). **Train** commuters, are more in favour of paying less when compared with the overall BM&T while contributing the least to overcrowding. The reason for this coefficient combination is not known but the negative churn from rail to road in recent years has reduced commuter volumes on some routes (Statistics South Africa, 2021, 2022). Finally, the **MyCiTi** commuters against overall BM&T are more deterred by overcrowding than they are interested in paying less, this may not be a representation of an overall desire to pay more rather the service quality standards expected (Mokonyama and Venter 2018).

Similarly, for the **MBT** all *cost attribute level* coefficients were significant and some of the *comfort* and *route flexibility.* The uniqueness of MBT is route flexibility, the model that was generated against the baseline of *collect passengers away from main road*, yielded positive coefficients, and *change route to avoid congestion(=0.62 x collect passengers away from main road)* was statistically significant. Other statistically significant coefficients were: *facilities(=1.18 x collect passengers away from main road), overcrowding (=-1.24 x collect passengers away from main road), paying same fare (=1.53 x collect passengers away from main road)* and *paying 10% less (=2.96 x collect passengers away from main road). Paying 10% more* was positive yet statistically insignificant. The significant coefficients are consistent with existing literature, however the facilities at the taxi rank response could be a combination of being satisfied with current conditions or an aspiration for better (Statistics South Africa, 2021, 2022, Behrens et.al, 2018).

In all domains where cost was an attribute it dominated the choice sets. As shown in *Table 5.1* below, household income was not differentiator, on the travel survey questionnaire, household income tranches were disaggregated as follows: less than R1,250 (A); between R1,251 and R3,500 (B); between R3,501 and R7,500 (C); between R7,501 and R12,000 (D); more than R12001 (E); unsure (F); and rather not say (G).

Table 5.1: Test for household income heterogeneity

Attribute	A	B	C	stdBW D	E	F	G
Length	0.6667	0.3175	0.2785	0.3226	0.2099	0.1970	0.3611
Faster	0.6667	0.5714	0.4852	0.5484	0.3704	0.5000	0.6389
Slower	0.3333	-0.3016	-0.3671	-0.2366	-0.3951	-0.1515	-0.2685
Same	0.3333	0.4286	0.5021	0.5323	0.4938	0.3333	0.3148
Less	**1.0000**	**0.7619**	**0.7932**	**0.8065**	**0.8025**	**0.6818**	**0.7870**
More	-0.3333	-0.4444	-0.4304	-0.4785	-0.5679	-0.4091	-0.6204
Delay	-1.0000	-0.5556	-0.5021	-0.5323	-0.5062	-0.6364	-0.5741
Peak	-0.6667	-0.2540	-0.2954	-0.4409	-0.1358	-0.1212	-0.2315
Off-Peak	-1.0000	-0.5238	-0.4684	-0.5269	-0.2840	-0.3939	-0.4352

In heterogeneity tests, it is unanimous that paying less fare is the best attribute level, even more so for those whose household income is estimated to be less than R1,250. As far as the worst attribute level, there are some variations, the most prominent disutility being *10 minutes delay*. Surprisingly those with the highest income bracket have chosen *pay more* as their worst attribute level, that may be attributed to them being choice users who are acquiescing to current operations standard at the current opportunity cost. Those who *rather not say* also chose *pay more* as the worst attribute level, the reasons thereof are not immediately discernible, they may however be among the bus or train commuters, who are more sensitive to price increases than the other modes.

5.5. Case 2 Best-Worst scaling

This study sought to investigate user-preference using the Case 2 Best-Worst Scaling. NHTS data was used as a basis for determining domains, attributes and attribute levels. The results confirmed the NHTS data, and in some places provided mode-specific and demographic-specific nuances.

This study provided a unique **simultaneous study** of all four public transport modes and where homogeneous exploring the same attributes and attribute levels. Even where there are differing attributes and or attribute levels in the domain were concerned the outcome could be compared by virtue of them occurring under the similar conditions (period, season and location).

Safety **domain composition** provided an opportunity to compare attributes and attribute levels without cost dominating the choice sets (Soekhai et.al, 2021). As a result, a subtle difference

between preferences for personal safety and safety from crashes were observed. The less important attributes and attribute levels were almost always ignored in domains where safety or security or cost were the dominant attributes.

In the National Household survey, **information** is one of the commuter frustrations. In some modes it is a case of wait and see. However, there are call centres where timetable information, delays and changes can be accessed. There are sometimes also social media posts about delays on some routes and modes. One of the most reliable means of accessing information on changes to the timetable is commuter WhatsApp groups where those who are upstream inform the downstream commuters of the state of public transport vehicles. This attribute did not emerge in the survey results, most probably because of the dominant nature of cost in any choice sets.

Soekhai et.al (2021) warned against **dominated choice** sets that result when positive and negative attribute levels are in a choice set. This was not entirely avoidable, however the overall models that were generated produced instinctively correct results that is confirmed by existing literature. Therefore, well-crafted domains may have a dominated choice set however the overall results will provide comparison for the other attribute levels.

The challenge of conducting a multi-domain study was the **questionnaire length** in this investigation most of the respondents were engaged on one domain, depending on their waiting time. In modes where waiting time was predictable onboard surveying was conducted for short trip lengths.

Most of the domains had three attributes with three attribute levels. Only the Bus and MyCiTi safety domain had four **attributes per domain.** In this study the models generated for the four attributes per domain generated more coefficients that were not statistically significant, this could be because of the attributes combinations or that it presented a layer of complexity for the respondents. However, personal safety was understood and responded to. A further investigation is needed.

Attribute level pivoting for cost and travel time was an interesting approach. The percentage pivoting used was low and the changes almost negligible, however the importance of cost and travel time was evident in the coefficient magnitude and significance and the attribute levels chosen.

Upon consideration of the resultant coefficient magnitude and significance, it is evident that to some degree this study had some **mixed attributes domains.** The intention of the composition of the comfort domain was to explore the willingness to pay for some of the unique features of the different modes such as *timetable information (for bus, MyCiTi and train)* and *flexibility(for MBT)*. The result was cost dominating the choice sets, by implication diminishing the importance of the other attributes and attribute levels. Case 3 Best-Worst scaling which mirrors the Stated Preference studies, the cost and combination of attribute levels. The comparison is to determine optimum improvements linked to the maximum cost the respondent is willing to pay. That may be a better study option for cost and attributes that may be considered choice or premium elements linked to public transport operations. However, all modes' comparison highlighted that eliminating overcrowding in the minimum required service level.

Limitations to this study were analysis capabilities of existing software for Case 2 Best Worst scaling.

6. Conclusion

The first objective of the research and research question was to explore the applicability of case 2 best-worst scaling for passenger preference. A multi-mode Case 2 Best-Worst Scaling study was a timely contribution to the passenger transport studies for South Africa and beyond. This study sought to investigate user attribute level preference using the Case 2 Best-Worst Scaling. The findings of the study corroborated findings in literature on attribute importance and whether the various mode users considered them an utility or disutility. As such we can conclude that this method is applicable for future preference studies in South Africa and beyond.

The second objective linked to the second research question was to compare the attribute level preference across all modes for the travel domain. In the Travel domain, all respondent considered paying more a disutility. The majority of the intercepted bus commuters the bus service would have to exceed 36% of its current reliability for the commuter to accept a 10% increase in fare. Alternatively, the bus must exceed 30% of its current reliability for the commuter to accept a *10% slower travel time.* MBT users esteemed *cost* more than *travel time*, MBT cost coefficient had a greater magnitude than that of other modes. For the majority of the intercepted MBT commuters the MBT service quality would have to exceed 100% of its current reliability for the commuter to accept a 10% increase in fare. Alternatively, the MBT must drop its current reliability by 62% for the commuter to experience a *10% slower travel time.* MyCiTi users seem to be more satisfied of the intercepted commuters, *cost* and *travel time* are estimated as a utility yet the magnitudes are lower than all the overall modes. For the majority of the intercepted MyCiTi commuters the MyCiTi bus service would have to exceed 100% of its current reliability for the commuter to accept a 10% increase in fare. Alternatively, the MyCiTi bus service must exceed 30% of its current reliability for the commuter to experience a *10% faster travel time.* MyCiTi users seem to be enjoying service reliability more than the other mode users. Train users are the least satisfied of all. For the majority of the intercepted train commuters the train would have to far exceed more than 100% (3 times more) of its current reliability for the commuter to accept the current fare. Alternatively, far exceed 100% (almost 3 times more) of its current reliability for the commuter to attain a desired faster travel time.

The last objective was to determine the preferred attribute levels per mode and domain. The Safety and Comfort domains outputs provide both insights and areas of improvement in research design. For the Safety domain, different modes esteemed different aspects of *safety from crashes*, *personal security* and *access*. Safety and security can continually be presented together in choice sets to solicit nuanced importance. In this study the B&M commuters preferred *swerve* by a lesser magnitude than they detest *sudden braking* when compared to *fender benders (minor crashes)*. Secondly, they prefer *5minutes decrease in access time* by a greater magnitude than they detest *5minures increase in access time* when compared to *access time unchanged*. From the results MBT and Train commuters are dissatisfied with all safety attribute levels, and all access attribute levels. If there are no other available desirable public transport modes, they are likely to move to private car use. The decision to decouple cost from safety and security attributes was a brilliant. However, because some of the findings would need qualitative data to explain the results. A mixed method should be considered for a deeper safety study. It could include: case 2 BWS survey, case 3 BWS survey, and open-ended questions.

The last research question was on the expected comfort levels of passengers across modes. It was a resounding finding that overcrowding is the worst attribute level. In the comfort domain there were nuances from different modal operating conditions. Cost dominated the choice sets yet the minimum or expected service quality for the all modes was a statistically significant disutility for *overcrowding*. *Information (bus, MyCiTi and Train)* and *flexibility (MBT)* were nuanced. A similar study with a proxy for cost or a case 3 BWS survey would yield better results.

The study further provides transport operators another tool to measure areas of potential improvements per mode addressing attributes that are in their scope of influence. In agreement with Mokonyama and Venter (2018), it is worthwhile finding out which PT attributes improvement are key. Exploring case 2 Best-Worst Scaling method provided insights to improved solicitation of commuter preferences.

The method presented a unique opportunity to compare attribute levels across domains and shows promise for similar studies.

7. Recommendations

After all the analysis these are recommendations for the future Case 2 Best-Worst Scaling studies:

- Transport domain study pivoting *cost* upwards only, the probable outcome would be the majority of the respondent selecting the lowest pivot.
- A separate or joint study that pivots travel time solely for improvements in order determine the willingness to pay for improvements.
- A safety and security study that considers a baseline for safety and security in order to elucidate any demographic preferences.
- A study with comfort related attributes excluding cost (or using a proxy for cost) should be considered.
- Where applicable, domains with attribute levels greater than three (3) levels should be explored.
- Other combinations of attributes per domain.

8. Reference

Abenoza RF, Cats O, Susilo YO. (2017). *Travel satisfaction with public transport: Determinants, user classes, regional disparities and their evolution.* Transportation Research Part A 95, pp 64–84

Anciaes PR, Jones P, Metcalfe PJ. (2018). *A stated preference model to value reduction in community severance caused by roads.* Transport Policy 64 (2018) pp 10-19

Aizaki H, Fogatry J. (2019). *An R package and tutorial case for case 2 best-worst scaling.* Journal of Choice Modelling. 32. 100171.

Bansal P, Kessels R, Krueger R, Graham DJ. (2022). *Preferences for using the London Underground during the COVID-19 pandemic.* Transportation Research Part A. 160 (2022) pp 45-60

Beck MJ, Rose JM. (2016). *The best of times and the worst of times: A new best-worst measure of attitudes towards public transport experiences.* Transportation Research Part A 86, pp 108-123.

Beck MJ, Rose JM, Greaves SP. (2017). *I can't believe your attitude: A joint estimation of best worst attitudes and electric vehicle choice.* Transportation 44 (4) pp 752-772.

Behrens R, Dodgen S, Fusire T, and Mukhuba T. (2018). *Passenger satisfaction with minibus-taxi feeder services at the Mitchells Plain public transport interchange in Cape Town.* 37th Annual South African Transport Conference. Pretoria, South Africa.

Chitate N. (2016). *Transport: a catalyst for socio-economic growth and development opportunities to improve quality of life.* 35th Annual Southern African Transport Conference. Pretoria, South Africa.

Chrzan K, Peitz M. (2019). *Best-worst scaling with many items.* Journal of Choice Modelling 30 (2019), pp 61–72.

Curl A, Clark J, Kearns A. (2018). *Household car adoption and financial distress in deprived urban communities: A case of forced car ownership?* Transport Policy 65 (2018) pp 61-71.

Delle Site P, Kilani K, Gatta V, Marcucci E, de Palma A. (2019). *Transportation Research Part B: Methodological.* Volume 128, pp 87 - 106

De Oña J. (2022). *Service quality, satisfaction and behavioral intentions towards public transport from the point of view of private vehicle users*. Transportation 49 (2022), pp 237-269.

Department of Transport South Africa (2017). *National Transport Master Plan (NATMAP) 2050 Synopsis Report.* Pretoria, South Africa.

Echaniz F, Ho CQ, Rodriguez A, dell'Olio L. (2020). *Modelling user satisfaction in public transport systems considering missing information.* Transportation 47 (2020) pp 2903-2921.

Echaniz F, Ho CQ, Rodriguez A, dell'Olio L. (2019). *Comparing best-worst and ordered logit approaches for user satisfaction in transit services*. Transportation Research Part A: Policy and Practice 130, pp 752-769

Efthymiou D, Antoniou C. (2017). *Understanding the effects of economic crisis on public transport users' satisfaction and demand*. Transport Policy 53 (2017), pp 89–97

Farrar TJ, Abiodun GJ, and Farmer J. (2019). *A 2018 customer satisfaction survey with users of a subsidised private bus service in Cape Town, South Africa*. 38th Annual South African Transport Conference. Pretoria, South Africa.

Gao K, Sun L. (2018). *Incorporating Inertia in mode choice and influential factors of car stickiness: implications for shifts to public transit.* Promet Traffic and Transportation. Vol 30 No 3, 2018, pp 293-303.

Goosen ES. (2016). *Transport - a catalyst for socio-economic growth and development opportunities to improve quality of life*. 35th Annual Southern African Transport Conference. Pretoria, South Africa.

Gössling S. (2016). *Urban transport justice.* Journal of Transport Geography. 54 (2016), pp 1–9

Gupta H. (2018). *Evaluating service quality of airline industry using hybrid best worst method and VIKOR.* Journal of Air Transport Management. 68 (2018) pp 35-47

Hayes G, Venter C (2016). *Trip Utility and the Value of Travel Time Savings (VTTS) for Commuter Trips: Critique and Recent Advances.* ISBN Number: 978-1-920017-64-4. 35th Annual South African Transport Conference. Pretoria, South Africa, pp 314 - 326

Luke R, Heyns GJ. (2020). *An analysis of the quality of public transport in Johannesburg, South Africa using an adapted SERVQUAL model.* Transport Research Procedia 48 (2020), pp 3562 – 3576

Mokonyama C, Venter C. (2018). *How worthwhile is it to maximise customer satisfaction in public transport service contracts with a large captive user base? The case of South Africa.* Research in Transportation Economics 69 (2018), pp 180–186

National Treasury (2022). *Budget 2022: Estimates of National Expenditure.* ISBN: 978-0-621-49976-6. Pretoria, South Africa.

Soekhai V, Donkers B, Levitan B, de Bekker-Grob EW. (2021). *Case 2 best-worst scaling: for good or bad but not both.* Journal of Choice Modelling 41(2021) 100325.

Song F, Hess S, Dekker T. (2020). *A joint model for stated choice and best-worst scaling data using latent attribute importance: application to rail-air intermodality.* Transportmetrica A: Transport Scienc. ISSN 2324-9935

Statistics South Africa (2021). *Statistical Release P0320: National Household Travel Survey NHTS 2020*. Pretoria, South Africa.

Statistics South Africa (2022). *Report no. 03-20-02: National Household Travel Survey – Western Cape Transport Profile, 2022*. Pretoria, South Africa.

Su S, Li Z, Xu M, Cai Z, Weng M. (2017). *A geo-big data approach to intra-urban food deserts: Transit-varying accessibility, social inequalities, and implications for urban planning.* Habitat International 64 (2017) 22-40

Tatar O, Haward B, Zhu P, Griffin-Mathieu G, Perez S, Zimet G, Rosberger Z. (2022). *Using Best-Worst Scaling to investigate younger adult Canadians' preferences for COVID-19 vaccination and public health measures: An observational study.* Preventative Medicine Reports 26 (2022) 101755.

Teffo M, Earl A, Zuidgeest MHP. (2019). *Understanding public transport needs in Cape Town's informal settlements: a Best-Worst-Scaling approach.* Journal of the South African Institution of Civil Engineering, ISSN 1021-2019. Vol 61 No 2, June 2019, pp 39–50, Paper 0083.

Vanderschuren MJWA, Payane SR, Gwynne-Evans AJ. (2019). *Perceptions of Gender, Mobility, and Personal Safety: South Africa Moving Forward.* Transportation Research Record, 2673(11) (2019), pp. 616-627.

Veeneman W, Mulley C. (2018). *Multi-level governance in public transport: Governmental layering and its influence on public transport service solutions.* Research in Transportation Economics. 69 (2018), pp 430-437.

Venter C. (2016). *Are we giving BRT passengers what they want? User preference and market segmentation in Johannesburg*. 35th Annual South African Transport Conference. Pretoria, South Africa.

Wankmuller C, Kunovjanek M, Sposato RG, Reiner G. (2020). *Selecting E-Mobility Transport Solutions for Mountain Rescue Operations.* Energies (Basel), 2020-12-02, Vol.13 (24), pp 661

Annexure A: EBE Ethics Committee Report

Ethics approval obtained **- EBE/02062/2023**

Annexure B: Questionnaires

BUS – Questionnaire

Surveyor Name	
Date	YYYY/MM/DD
Location	
Mode	
Reference No.	

DEMOGRAPHIC INFORMATION

[would you please answer the following questions?]

1. Age Range?

a.	18-20	
b.	21-35	
c.	36-45	
d.	46-55	
e.	56-70	
f.	70+	
g.	Rather not say	

2. Gender:

a.	Male	
b.	Female	
c.	Non-binary	
d.	Rather not say	

3. Occupation:

a.	Employed	
b.	Self-employed	
c.	Casual employment	
d.	Full-time study	
e.	Part-time study	
f.	Not employed looking for a job	
g.	Not employed not looking for a job	
h.	Other – specify	

4. Home:

a.	Suburb name	
b.	Postal code	

5. Place of school or work you travel to:

a.	Suburb name	
b.	Postal code	

6. Other destination (if applicable)

a.	Trip reason	
b.	Suburb name	
c.	Postal code	

7. Current trip

a.	Bus fare from home (Bus stop) to work or school?	
b.	How long is your trip from getting onto the Bus to getting off?	

Item	***10% less***	***10% more***
Fare		
Trip length		

TRAVEL SECTION

[For the Bus, would you please answer the following travel questions by rating the scenarios as either <u>one best</u> or <u>one worst</u>? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Example question
For your current trip which scenario would be best and which one is worst? Pick <u>one</u> of each.

	Best	*Worst*
Free WIFI inside the bus	*[X]*	*[ ]*
Travelling in a crowded bus	*[ ]*	*[X]*
Walking to town	*[ ]*	*[ ]*

Question 8

For your current trip choose one best and one worst statement.

	Best	**Worst**
Travel same length of time as usual	**[ ]**	**[ ]**
Travel with maximum 10 minutes delay	**[ ]**	**[ ]**
Pay same fare	**[ ]**	**[ ]**

Question 9
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]

Questions 10
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% slower than usual	[ ]	[ ]
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]

Question 11
For your current trip choose one best and one worst statement.

	Best	Worst
Pay same fare	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]

Question 12
For your current trip choose one best and one worst statement.

	Best	Worst
Travel with maximum 10 minutes delay	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]

Question 13
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]
Travel with maximum 10 minutes delay	[ ]	[ ]

Question 14
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% faster than usual	[ ]	[ ]
Pay same fare	[ ]	[ ]
Departs every 60 minutes off-peak	[ ]	[ ]

Question 15
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 16
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]

SAFETY AND SECURITY SECTION
[For the Bus, would you please answer the following safety and security questions by rating the following statements as one best or one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 17
For the current bus operations choose one best and one worst statement.

	Best	Worst
Have community safety patrols along walkways	[ ]	[ ]
Know where to complain about the bus services	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Walk to bus stop increases by 5 minutes	[ ]	[ ]

Question 18
For the current bus operations choose one best and one worst statement.

	Best	Worst
Experience a fender bender	[ ]	[ ]
Walk to the bus stop increases by 5 minutes	[ ]	[ ]
Experience a rude driver	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]

Question 19
For the current bus operations choose one best and one worst statement.

	Best	Worst
Have security personnel at the bus stop	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]
Walk to bus stop increases by 5 minutes	[ ]	[ ]
Experience a rude passenger	[ ]	[ ]

Question 20
For the current bus operations choose one best and one worst statement.

	Best	Worst
Know where to complain about the Bus services	[ ]	[ ]
Have security personnel at bus stop	[ ]	[ ]
Experience a fender bender	[ ]	[ ]
Walk duration unchanged	[ ]	[ ]

Question 21
For the current bus operations choose one best and one worst statement.

	Best	Worst
Walk duration unchanged	[ ]	[ ]
Experience a rude driver	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]

Question 22
For the current bus operations choose one best and one worst statement.

	Best	Worst
Have security personnel on the trip	[ ]	[ ]
Walk duration unchanged	[ ]	[ ]
Experience a rude passenger	[ ]	[ ]
Experience sudden braking	[ ]	[ ]

Question 23
For the current bus operations choose one best and one worst statement.

	Best	Worst
Walk to the bus stop decreases by 5 minutes	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]
Know where to complain about the bus services	[ ]	[ ]

Question 24
For the current bus operations choose one best and one worst statement.

	Best	Worst
Experience a rude driver	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Walk to the bus stop decreases by 5 minutes	[ ]	[ ]
Have security personnel at bus stop	[ ]	[ ]

Question 25
For the current bus operations choose one best and one worst statement.

	Best	Worst
Experience a rude passenger	[ ]	[ ]
Experience a fender bender	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Walk to the bus stop decreases by 5 minutes	[ ]	[ ]

BUS – Questionnaire

COMFORT SECTION

[For the Bus, would you please answer the following questions relation to information, overcrowding, and cost by rating the following statements as one best and one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 26

For the current bus operations choose one best and one worst statement.

	Best	Worst
Get timetable from social media and call centres	[ ]	[ ]
Facilities at bus stop	[ ]	[ ]
Pay the same bus fare	[ ]	[ ]

Question 27

For the current bus operations choose one best and one worst statement.

	Best	Worst
Bus ventilation or open windows	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]

Question 28

For the current bus operations choose one best and one worst statement.

	Best	Worst
Get timetable at the bus stop.	[ ]	[ ]
Bus ventilation or open windows	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 29

For the current bus operations choose one best and one worst statement.

	Best	Worst
Pay the same bus fare	[ ]	[ ]
Bus overcrowded	[ ]	[ ]
Get timetable at the bus stop	[ ]	[ ]

Question 30

For the current bus operations choose one best and one worst statement.

	Best	Worst
Facilities at the bus stop	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]

Question 31

For the current bus operations choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable at the bus stop	[ ]	[ ]
Facilities at the bus stop	[ ]	[ ]

Question 32

For the current bus operations choose one best and one worst statement.

	Best	Worst
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay the same bus fare	[ ]	[ ]
Bus ventilation or open windows	[ ]	[ ]

Question 33

For the current bus operations choose one best and one worst statement.

	Best	Worst
Bus overcrowded	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 34

For the current bus operations choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]
Bus overcrowded	[ ]	[ ]

INCOME

Question 35
[Would you please indicate your household monthly income?]

	Income tranches	
a.	Less than R1,250	
b.	Between R1,251 and R3,500	
c.	Between R3,501 and R7,500	
d.	Between R7,501 and R12,000	
e.	More than R12,001	
f.	I'm not sure	
g	I would rather not say	

TRANSPORT OPTIONS

Question 36 – which of the following options are available within walking distance?

a.	**Train**	
b.	**Minibus Taxi**	
c.	**MyCiTi**	
d.	**None**	

Question 37 – please rank the reasons you would consider the other transport modes?
(1 = most important; and 7 = least important)

No	Item	Rank (1 to 7)
a.	**Fare**	
b.	**Comfort**	
c.	**Travel time**	
d.	**Reliability**	
e.	**Safety from accident**	
f.	**Safety from crime**	
g.	**More information**	

Question 38 – What is you other preferred mode?

- **The end –**

Finishing time	

Minibus Taxi – Questionnaire

Surveyor Name	
Date	YYYY/MM/DD
Location	
Mode	
Reference No.	

DEMOGRAPHIC INFORMATION

[would you please answer the following questions?]

1. Age Range?

a.	18-20	
b.	21-35	
c.	36-45	
d.	46-55	
e.	56-70	
f.	70+	
g.	Rather not say	

2. Gender:

a.	Male	
b.	Female	
c.	Non-binary	
d.	Rather not say	

3. Occupation:

a.	Employed	
b.	Self-employed	
c.	Casual employment	
d.	Full-time study	
e.	Part-time study	
f.	Not employed looking for a job	
g.	Not employed not looking for a job	
h.	Other – specify	

4. Home:

a.	Suburb name	
b.	Postal code	

5. Place of school or work you travel to:

a.	Suburb name	
b.	Postal code	

6. Other destination (if applicable)

a.	Trip reason	
b.	Suburb name	
c.	Postal code	

7. Current trip

a.	Minibus Taxi fare from home (taxi rank/stop) to work or school?	
b.	How long is your trip from getting onto the taxi to getting off?	

Item	***10% less***	***10% more***
Fare		
Trip length		

TRAVEL SECTION

[For a minibus taxi, would you please answer the following travel questions by rating the scenarios as <u>one best</u> and <u>one worst</u>? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Example question
For your current trip which scenario would be best and which one is worst? Pick <u>one</u> of each.

	Best	*Worst*
Free WIFI inside the taxi.	*[X]*	*[ ]*
Travelling in a crowded taxi	*[ ]*	*[X]*
Walking to town	*[ ]*	*[ ]*

Question 8

For your current trip choose one best and one worst statement.

	Best	**Worst**
Travel same length of time as usual	**[ ]**	**[ ]**
Travel with maximum 10 minutes delay	**[ ]**	**[ ]**
Pay same fare	**[ ]**	**[ ]**

Question 9
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]

Questions 10
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% slower than usual	[ ]	[ ]
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]

Question 11
For your current trip choose one best and one worst statement.

	Best	Worst
Pay same fare	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]

Question 12
For your current trip choose one best and one worst statement.

	Best	Worst
Travel with maximum 10 minutes delay	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]

Question 13
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]
Travel with maximum 10 minutes delay	[ ]	[ ]

Question 14
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% faster than usual	[ ]	[ ]
Pay same fare	[ ]	[ ]
Departs every 60 minutes off-peak	[ ]	[ ]

Question 15
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 16
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]

SAFETY AND SECURITY SECTION
[For the minibus taxi would you please answer the following safety and security questions by rating the following statements as one best and one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 17
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Experience sudden braking	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Walk to the taxi rank unchanged	[ ]	[ ]

Question 18
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Have security personnel at the taxi rank	[ ]	[ ]
Walk to the taxi rank increases by 5 minutes	[ ]	[ ]
Experience sudden braking	[ ]	[ ]

Question 19
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Experience a fender bender	[ ]	[ ]
Have security personnel at the taxi rank	[ ]	[ ]
Walk to the taxi rank decreases by 5 minutes	[ ]	[ ]

Question 20
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Walk to the taxi rank unchanged	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]
Experience a fender bender	[ ]	[ ]

Question 21
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Have community safety patrols along walkways	[ ]	[ ]
Walk to the taxi rank decreases By 5 minutes	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]

Question 22
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Walk to the taxi rank increases by 5 minutes	[ ]	[ ]
Experience a fender bender	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]

Question 23
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Experience swerving to avoid crashes	[ ]	[ ]
Walk to the taxi rank unchanged	[ ]	[ ]
Have security personnel at the taxi rank	[ ]	[ ]

Question 24
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Have security personnel on the trip	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]
Walk to the taxi rank increases by 5 minutes	[ ]	[ ]

Question 25
For the current taxi operations choose one best and one worst statement.

	Best	Worst
Walk to the taxi rank decreases by 5 minutes	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]

COMFORT SECTION

[For the minibus taxi, would you please answer the following questions relation to information, overcrowding, and cost by rating the following statements for one best or one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 26

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Taxi changes route to avoid congestion	[ ]	[ ]
Facilities at the taxi rank	[ ]	[ ]
Pay the same taxi fare	[ ]	[ ]

Question 27

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Taxi ventilation or open windows	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Taxi changes route to avoid congestion	[ ]	[ ]

Question 28

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Taxi has no route changes	[ ]	[ ]
Taxi ventilation or open windows	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 29

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Pay the same taxi fare	[ ]	[ ]
Taxi overcrowding	[ ]	[ ]
Taxi has no route changes	[ ]	[ ]

Question 30

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Facilities at the taxi rank	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Taxi collects passengers away from main road	[ ]	[ ]

Question 31

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Taxi has no route changes	[ ]	[ ]
Facilities at the taxi rank	[ ]	[ ]

Question 32

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Taxi collects passengers away from main road	[ ]	[ ]
Pay the same taxi fare	[ ]	[ ]
Taxi ventilation or open windows	[ ]	[ ]

Question 33

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Taxi overcrowding	[ ]	[ ]
Taxi collects passengers away from main road	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 34

For the current taxi operations choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Taxi changes route to avoid congestion	[ ]	[ ]
Taxi overcrowding	[ ]	[ ]

INCOME

Question 35
[Would you please indicate your household monthly income?]

	Income tranches	
a.	Less than R1,250	
b.	Between R1,251 and R3,500	
c.	Between R3,501 and R7,500	
d.	Between R7,501 and R12,000	
e.	More than R12,001	
f.	I'm not sure	
g	I would rather not say	

TRANSPORT OPTIONS

Question 36 – which of the following options are available within walking distance?

a.	**MyCiti**	
b.	**Train**	
c.	**Bus**	
d.	**None**	

Question 37 – please rank the reasons you would consider the other transport modes?
(1 = most important; and 7 = least important)

No	Item	Rank (1 to 7)
a.	**Fare**	
b.	**Comfort**	
c.	**Travel time**	
d.	**Reliability**	
e.	**Safety from accident**	
f.	**Safety from crime**	
g.	**More information**	

Question 38 – What is you other preferred mode?

- **The end –**

Finishing time	

MyCiTi - Travel

Surveyor Name	
Date	YYYY/MM/DD
Location	
Mode	
Reference No.	

DEMOGRAPHIC INFORMATION

[would you please answer the following questions?]

1. Age Range?

a.	18-20	
b.	21-35	
c.	36-45	
d.	46-55	
e.	56-70	
f.	70+	
g.	Rather not say	

2. Gender:

a.	Male	
b.	Female	
c.	Non-binary	
d.	Rather not say	

3. Occupation:

a.	Employed	
b.	Self-employed	
c.	Casual employment	
d.	Full-time study	
e.	Part-time study	
f.	Not employed looking for a job	
g.	Not employed not looking for a job	
h.	Other – specify	

4. Home:

a.	Suburb name	
b.	Postal code	

5. Place of school or work you travel to:

a.	Suburb name	
b.	Postal code	

6. Other destination (if applicable)

a.	Trip reason	
b.	Suburb name	
c.	Postal code	

7. Current trip

a.	MyCiTi fare from home (MyCiTi stop) to work or school?	
b.	How long is your trip from getting onto the MyCiTi to getting off?	

Item	***10% less***	***10% more***
Fare		
Trip length		

TRAVEL SECTION

[For the MyCiTi, would you please answer the following travel questions by rating the scenarios as either one best or one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Example question
For your current trip which scenario would be best and which one is worst? Pick one of each.

	Best	*Worst*
Free WIFI inside the MyCiTi bus	*[X]*	*[ ]*
Travelling in a crowded MyCiTi	*[ ]*	*[X]*
Walking to town	*[ ]*	*[ ]*

Question 8

For your current trip choose one best and one worst statement.

	Best	**Worst**
Travel same length of time as usual	**[ ]**	**[ ]**
Travel with maximum 10 minutes delay	**[ ]**	**[ ]**
Pay same fare	**[ ]**	**[ ]**

MyCiTi

Question 9
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]

Questions 10
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% slower than usual	[ ]	[ ]
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]

Question 11
For your current trip choose one best and one worst statement.

	Best	Worst
Pay same fare	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]

Question 12
For your current trip choose one best and one worst statement.

	Best	Worst
Travel with maximum 10 minutes delay	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]

Question 13
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]
Travel with maximum 10 minutes delay	[ ]	[ ]

Question 14
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% faster than usual	[ ]	[ ]
Pay same fare	[ ]	[ ]
Departs every 60 minutes off-peak	[ ]	[ ]

Question 15
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 16
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]

SAFETY AND SECURITY SECTION
[For the MyCiTi, would you please answer the following safety and security questions by rating the following statements as one best and one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 17
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Have community safety patrols along walkways	[ ]	[ ]
Know where to complain about the MyCiTi services	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Walk to MyCiTi increases by 5 minutes	[ ]	[ ]

MyCiTi

Question 18
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Experience a fender bender	[ ]	[ ]
Walk to MyCiTi increases by 5 minutes	[ ]	[ ]
Experience a rude driver	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]

Question 19
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Have security personnel at the MyCiTi stop	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]
Walk to MyCiTi increases by 5 minutes	[ ]	[ ]
Experience a rude passenger	[ ]	[ ]

Question 20
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Know where to complain about the MyCiTi services	[ ]	[ ]
Have security personnel at MyCiTi stop	[ ]	[ ]
Experience a fender bender	[ ]	[ ]
Walk duration unchanged	[ ]	[ ]

Question 21
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Walk duration unchanged	[ ]	[ ]
Experience a rude driver	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]

Question 22
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Have security personnel on the trip	[ ]	[ ]
Walk duration unchanged	[ ]	[ ]
Experience a rude passenger	[ ]	[ ]
Experience sudden braking	[ ]	[ ]

Question 23
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Walk to MyCiTi decreases by 5 minutes	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]
Experience swerving to avoid crashes	[ ]	[ ]
Know where to complain about the MyCiTi services	[ ]	[ ]

Question 24
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Experience a rude driver	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Walk to MyCiTi decreases by 5 minutes	[ ]	[ ]
Have security personnel at MyCiTi stop	[ ]	[ ]

Question 25
For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Experience a rude passenger	[ ]	[ ]
Experience a fender bender	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Walk to MyCiTi decreases by 5 minutes	[ ]	[ ]

MyCiTi

COMFORT SECTION

[For the MyCiTi, would you please answer the following questions relation to information, overcrowding, and cost by rating the following statements as one best and one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 26

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Get timetable from social media and call centres	[ ]	[ ]
Facilities at MyCiTi stop	[ ]	[ ]
Pay the same MyCiTi fare	[ ]	[ ]

Question 27

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
MyCiTi ventilation	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]

Question 28

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Get timetable at the MyCiTi stop	[ ]	[ ]
MyCiTi ventilation	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 29

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Pay the same MyCiTi fare	[ ]	[ ]
MyCiTi overcrowded	[ ]	[ ]
Get timetable at the MyCiTi stop	[ ]	[ ]

Question 30

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Facilities at the MyCiTi stop	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]

Question 31

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable at the MyCiTi stop	[ ]	[ ]
Facilities at the MyCiTi stop	[ ]	[ ]

Question 32

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay the same MyCiTi fare	[ ]	[ ]
MyCiTi ventilation	[ ]	[ ]

Question 33

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
MyCiTi overcrowded	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 34

For the current MyCiTi operations choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]
MyCiTi overcrowded	[ ]	[ ]

MyCiTi

INCOME

Question 35
[Would you please indicate your household monthly income?]

	Income tranches	
a.	Less than R1,250	
b.	Between R1,251 and R3,500	
c.	Between R3,501 and R7,500	
d.	Between R7,501 and R12,000	
e.	More than R12,001	
f.	I'm not sure	
g	I would rather not say	

TRANSPORT OPTIONS

Question 36 – which of the following options are available within walking distance?

a.	**Train**	
b.	**Minibus Taxi**	
c.	**Bus**	
d.	**None**	

Question 37 – please rank the reasons you would consider the other transport modes?
(1 = most important; and 7 = least important)

No	Item	Rank (1 to 7)
a.	**Fare**	
b.	**Comfort**	
c.	**Travel time**	
d.	**Reliability**	
e.	**Safety from accident**	
f.	**Safety from crime**	
g.	**More information**	

Question 38 – What is you other preferred mode?

- **The end –**

Finishing time	

Train – Questionnaire

Surveyor Name	
Date	YYYY/MM/DD
Location	
Mode	
Reference No.	

DEMOGRAPHIC INFORMATION

[would you please answer the following questions?]

1. Age Range?

a.	18-20	
b.	21-35	
c.	36-45	
d.	46-55	
e.	56-70	
f.	70+	
g.	Rather not say	

2. Gender:

a.	Male	
b.	Female	
c.	Non-binary	
d.	Rather not say	

3. Occupation:

a.	Employed	
b.	Self-employed	
c.	Casual employment	
d.	Full-time study	
e.	Part-time study	
f.	Not employed looking for a job	
g.	Not employed not looking for a job	
h.	Other – specify	

4. Home:

a.	Suburb name	
b.	Postal code	

5. Place of school or work you travel to:

a.	Suburb name	
b.	Postal code	

6. Other destination (if applicable)

a.	Trip reason	
b.	Suburb name	
c.	Postal code	

7. Current trip

a.	Train fare from home (train station) to work or school?	
b.	How long is your trip from getting onto the train to getting off?	

Item	***10% less***	***10% more***
Fare		
Trip length		

TRAVEL SECTION

[For the train, would you please answer the following travel questions by rating the scenarios as <u>one best</u> and <u>one worst</u>? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Example question
For your current trip which scenario would be best and which one is worst? Pick <u>one</u> of each.

	Best	*Worst*
Free WIFI inside the train.	*[X]*	*[ ]*
Travelling in a crowded train.	*[ ]*	*[X]*
Walking to town	*[ ]*	*[ ]*

Question 8

For your current trip choose one best and one worst statement.

	Best	**Worst**
Travel same length of time as usual	**[ ]**	**[ ]**
Travel with maximum 10 minutes delay	**[ ]**	**[ ]**
Pay same fare	**[ ]**	**[ ]**

Question 9
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]

Questions 10
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% slower than usual	[ ]	[ ]
Depart every 60 minutes off-peak	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]

Question 11
For your current trip choose one best and one worst statement.

	Best	Worst
Pay same fare	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]

Question 12
For your current trip choose one best and one worst statement.

	Best	Worst
Travel with maximum 10 minutes delay	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]

Question 13
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Travel 10% slower than usual	[ ]	[ ]
Travel with maximum 10 minutes delay	[ ]	[ ]

Question 14
For your current trip choose one best and one worst statement.

	Best	Worst
Travel 10% faster than usual	[ ]	[ ]
Pay same fare	[ ]	[ ]
Departs every 60 minutes off-peak	[ ]	[ ]

Question 15
For your current trip choose one best and one worst statement.

	Best	Worst
Depart every 20 minutes during peak period	[ ]	[ ]
Travel 10% faster than usual	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 16
For your current trip choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Travel same length of time as usual	[ ]	[ ]
Depart every 20 minutes during peak period	[ ]	[ ]

SAFETY AND SECURITY SECTION
[For the train would you please answer the following safety and security questions by rating the following statements as one best and one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 17
For the current train operations choose one best and one worst statement.

	Best	Worst
Experience sudden braking	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]
Walk to the station unchanged	[ ]	[ ]

Question 18
For the current train operations choose one best and one worst statement.

	Best	Worst
Have security personnel at the station	[ ]	[ ]
Walk to the station increases by 5 minutes	[ ]	[ ]
Experience sudden braking	[ ]	[ ]

Question 19
For the current train operations choose one best and one worst statement.

	Best	Worst
Experience longer platform stops to avoid train accidents	[ ]	[ ]
Have security personnel at the station	[ ]	[ ]
Walk to the station decreases by 5 minutes	[ ]	[ ]

Question 20
For the current train operations choose one best and one worst statement.

	Best	Worst
Walk to the station unchanged	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]
Experience longer platform stops to avoid train accidents	[ ]	[ ]

Question 21
For the current train operations choose one best and one worst statement.

	Best	Worst
Have community safety patrols along walkways	[ ]	[ ]
Walk to the station decreases by 5 minutes	[ ]	[ ]
Stopping between stations to prevent train accidents	[ ]	[ ]

Question 22
For the current train operations choose one best and one worst statement.

	Best	Worst
Walk to the station increases by 5 minutes	[ ]	[ ]
Experience longer platform stops to avoid train accidents	[ ]	[ ]
Have community safety patrols along walkways	[ ]	[ ]

Question 23
For the current train operations choose one best and one worst statement.

	Best	Worst
Stopping between stations to prevent train accidents	[ ]	[ ]
Walk to the station unchanged	[ ]	[ ]
Have security personnel at the station	[ ]	[ ]

Question 24
For the current train operations choose one best and one worst statement.

	Best	Worst
Have security personnel on the trip	[ ]	[ ]
Stopping between stations to prevent train accidents	[ ]	[ ]
Walk to the station increases by 5 minutes	[ ]	[ ]

Question 25
For the current train operations choose one best and one worst statement.

	Best	Worst
Walk to the station decreases by 5 minutes	[ ]	[ ]
Experience sudden braking	[ ]	[ ]
Have security personnel on the trip	[ ]	[ ]

COMFORT SECTION

[For the train, would you please answer the following questions relation to information, overcrowding, and cost by rating the following statements for one best or one worst? Please note that some of the sentences will be in more than one question to allow for comparison in this study]

Question 26

For the current train operations choose one best and one worst statement.

	Best	Worst
Get timetable from social media and call centres	[ ]	[ ]
Facilities at train station	[ ]	[ ]
Pay the same train fare	[ ]	[ ]

Question 27

For the current train operations choose one best and one worst statement.

	Best	Worst
Train ventilation or open windows	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]

Question 28

For the current train operations choose one best and one worst statement.

	Best	Worst
Get timetable at the train station	[ ]	[ ]
Train ventilation or open windows	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]

Question 29

For the current train operations choose one best and one worst statement.

	Best	Worst
Pay the same train fare	[ ]	[ ]
Train overcrowding	[ ]	[ ]
Get timetable at the train station	[ ]	[ ]

Question 30

For the current train operations choose one best and one worst statement.

	Best	Worst
Facilities at the train station	[ ]	[ ]
Pay 10% more than current fare	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]

Question 31

For the current train operations choose one best and one worst statement.

	Best	Worst
Pay 10% cheaper than current fare	[ ]	[ ]
Get timetable at the train station	[ ]	[ ]
Facilities at the train station	[ ]	[ ]

Question 32

For the current train operations choose one best and one worst statement.

	Best	Worst
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay the same train fare	[ ]	[ ]
Train ventilation or open windows	[ ]	[ ]

Question 33

For the current Train operations choose one best and one worst statement.

	Best	Worst
Train overcrowding	[ ]	[ ]
Get timetable from other commuters/ friends and family	[ ]	[ ]
Pay 10% cheaper than current fare	[ ]	[ ]

Question 34

For the current Train operations choose one best and one worst statement.

	Best	Worst
Pay 10% more than current fare	[ ]	[ ]
Get timetable from social media and call centres	[ ]	[ ]
Train overcrowding	[ ]	[ ]

INCOME

Question 35
[Would you please indicate your household monthly income?]

	Income tranches	
a.	Less than R1,250	
b.	Between R1,251 and R3,500	
c.	Between R3,501 and R7,500	
d.	Between R7,501 and R12,000	
e.	More than R12,001	
f.	I'm not sure	
g	I would rather not say	

TRANSPORT OPTIONS

Question 36 – which of the following options are available within walking distance?

a.	**MyCiti**	
b.	**Minibus Taxi**	
c.	**Bus**	
d.	**None**	

Question 37 – please rank the reasons you would consider the other transport modes?
(1 = most important; and 7 = least important)

No	Item	Rank (1 to 7)
a.	**Fare**	
b.	**Comfort**	
c.	**Travel time**	
d.	**Reliability**	
e.	**Safety from accident**	
f.	**Safety from crime**	
g.	**More information**	

Question 38 – What is you other preferred mode?

- **The end –**

Finishing time	