DEVELOPMENT OF A BUS SHELTER WARRANT AND PRIORITISATION – TOWARDS ENHANCED RESOURCE UTILISATION AND PASSENGER EXPERIENCE: GO GEORGE BUS SERVICE

A VAN STRATEN[*], C HEYNS[**] and Y VENTER[***]

Zutari (Pty) Ltd; 1 Century City Drive, Waterford Precinct, Century City Cape Town
Tel: 021 526 9400; Email: *Armandt.vanStraten@zutari.com; **Carine.Heyns@zutari.com, ***Yolandi.Venter@zutari.com

ABSTRACT

Public Transport (PT) plays a critical role in fostering urban development and social equity. PT systems are also vital for reducing traffic congestion, minimising environmental impact, and providing accessible mobility options for diverse populations. Effective PT planning is essential for maximising these benefits, requiring a comprehensive understanding of urban dynamics, demographic trends, and much more. One aspect of PT planning is the effective use and placement of PT infrastructure such as shelters at bus stops.

In South Africa, there is a need to develop guidelines guiding the implementation of shelters at bus stops. This paper sets out guidelines developed for the GO GEORGE bus service currently operating in George, by introducing a model to use for the warranting and prioritisation of shelters at bus stops. The two main objectives of the warrant and prioritisation model are: enrichment of passenger experience and the optimal use of available funds. The model was developed by considering studies and guidelines used around the world. As well as, considering characteristics unique to George, a common example of a South African city.

This paper aims to guide policymakers and stakeholders to develop an approach, using both qualitative and quantitative data. The proposed approach is aimed to guide the effective implementation of bus stop infrastructure (such as shelters) to enhance mobility, promote inclusivity, and foster sustainable development in South African cities. While noting the various challenges applicable to South Africa such as, limited resources and a diverse population.

Keywords: Public Transport (PT), Bus stop, Shelter, Warrant, Prioritise.

1. INTRODUCTION

Public Transport (PT) plays an indispensable role in promoting urban development and advancing social equity by providing a reliable and accessible means of mobility for diverse populations. PT systems are essential in addressing urban challenges such as, lack of personal transport, traffic congestion, environmental degradation, and the growing need for inclusive mobility solutions. They serve as a catalyst for sustainable urban growth, enabling equitable access to economic opportunities, education, healthcare, and social services. However, for PT systems to fully realise their potential, careful and effective planning is required.

Effective PT planning involves more than just route identification and scheduling; it encompasses a comprehensive understanding of urban dynamics, population demographics, and the unique socio-economic challenges of the area. One critical aspect of PT planning is the development and placement of kerbside infrastructure aimed at improving passenger experience. The provision of shelters at bus stops plays a crucial role in enhancing the pedestrian experience. Shelters not only offer physical comfort and safety for passengers but also contribute to the overall appeal and functionality of PT systems.

1.1 Problem Statement

Despite the importance of PT, planners often face significant challenges, especially in countries with limited resources and diverse populations, such as South Africa. In particular, South Africa lacks clear guidance on the implementation of infrastructure elements like bus stop shelters. Previous work has been conducted but with limited impact and it was identified to be somewhat lacking in the shelter warranting and prioritisation planning aspects (Zutari, 2021). International guidelines and standards are often unsuitable to use in the South African context due to lack of funding and many other challenges (ADSHEL Street Furniture Pty Ltd, 2009; Department of State Growth, n.d.; Mid Ulster District Council, n.d.; NZ Transport Agency, 2014; The City of Edinburgh Council, 2019; Washington Metropolitan Area Transit Authority, 2009). International guidelines offer a good foundation from which evaluation criteria can be identified such as, passengers demand, stops serving special facilities, lack of passenger amenities, site footprint, to name a few.

1.2 Aim of Paper

This paper seeks to address the identified gap by presenting a Bus Shelter Warrant and Prioritisation Model (hereafter referred to as the Model) which can be used to warrant and prioritise the provision of shelters at bus stops. The Model was developed for the GO GEORGE bus service in George, South Africa, and integrates global best practices with local characteristics unique to the region. The primary objective of the Model is to enhance passenger experience and ensure optimal utilisation of available funds. By offering practical insights and guidelines, this paper aims to improve on existing work, and support policymakers and stakeholders in fostering sustainable development and improved mobility across South African cities.

1.3 Research Question

This paper is guided by the following primary research question: To what extent can qualitative and quantitative data be used to develop a Model to inform and optimise resource allocation and the implementation of bus stop shelters, while simultaneously enhancing passenger experience?

1.4 Scope of Paper

The paper discusses the development, structure and application of the Model. This paper employs the various components and examines how the Model operates. In addition, the paper explains the output and usability of the Model.

2. MODEL COMPONENTS

The Model itself was developed as a semi-automated model with three key components namely, Data Component, Warrant Component, and Prioritisation Component. Each of these components will be discussed in some detail in the sections that follow.

2.1 Data Component

The placement of bus stops is informed by a Public Transport Demand Model and the urban structure (road network and land use). This gives rise to a database of stop locations, supported by information such as Google Earth and other geospatial information. The database of stop locations forms the basis of the Data Component. Thereafter information from different sources is imported and added. Data sources included but are not limited to the following:

- Surveyed data: Onboard survey data, infrastructure surveys, and kerbside data;
- Database data: AFC tap-on data and Stop information data;
- GIS data: Stop location data and zonal data; and
- Desktop study data: Google Earth surveys.

2.2 Warrant Component

The Warrant Component of the Model consisted of defining definitive Yes or No questions to determine whether a bus stop "warrants" a shelter. Table 1 shows a summary of the warrants defined in the Model. For a bus stop to warrant a shelter, the bus stop should comply with either the first or the second warrant criteria. If the first or second warrant is met, the third warrant is applied. A special condition warrant was included to allow stops that are identified as special stops, to warrant a shelter even if it does not comply with the first warrant criteria.

Table 1: Model warrants

Warrant	Description
1. Passenger Volume (Number of Passengers Boarding Daily)	Define the minimum number of passengers boarding daily that warrants a stop. After consulting the expert GO GEORGE operating team, a minimum daily boarding threshold of the 50 daily boarding passengers was deemed a realistic threshold in the South African context.
2. Special Condition	Determine if a stop is considered as a special stop. For example, a stop is outside a hospital, clinic, or retirement home. If a stop complies with this warrant, it warrants a shelter even if it does not meet the passenger volume warrant.
3.Technical Feasible	This criterion considers the width of the verge, urban grain (size house on adjacent erf) and sizing/height of buildings. For example, at locations with a narrow verge, placing a shelter will obstruct the walkway and have a negative impact on pedestrian flow. A shelter cannot be allocated to a stop if it is not technically possible, even if it warrants a shelter.

It is noted that passengers waiting time at a stop is an important consideration for the provision of a shelter. However, the GO GEORGE service is a scheduled service (i.e., maintains a specific timetable) therefore passengers can arrive at a particular stop at the expected arrival time of the bus. Thus, the number of boarding passengers was considered as a warranting criterion rather than the waiting time.

Furthermore, it is noted that there are instances where stops are located where a shelter is technically not feasible. This is generally evident in residential areas, especially areas of lower income, where properties are innately small, and houses are densely packed. Also, in some areas there aren't always adequate sidewalks or verges available to accommodate a shelter, meaning if a shelter is provided it will be on the adjacent erf, which is generally not supported by the respective homeowner.

2.3 Prioritisation Component

Stops that warrant a shelter are taken to the next component of the Model, the Prioritisation Component. In order to make the provision of bus shelters more efficient, stops are prioritised and ranked. This approach ensures that as funds are available, shelters are provided where it is needed most. Multi-Criteria Analysis (MCA) is a systematic and structured approach used to evaluate and compare options based on multiple criteria. This method was used to evaluate and prioritise bus stops based on characteristics of the stop.

The prioritisation criteria are defined based on achieving the two main goals of the Model: 1) the enrichment of passenger experience and; 2) the optimum financial performance. More detail regarding how the prioritisation process is conducted is discussed later in the paper. The criteria chosen were based on international practices and then adapted for GO GEORGE in consultation with the GO GEORGE operations team. The MCA criteria were broken down further into sub-criteria. The chosen evaluation criteria and sub-criteria are summarised in Table 2.

Table 2: Model prioritisation criteria

Goal	Criteria	Sub-Criteria	Reasoning
Enrichment of the passenger experience	Location and Land Use	Land Use	Land uses that are major trip attractors or production areas are prioritised higher.
		Transfer Location Stop	Stops where transfers occur will be prioritised higher, making the transfer between routes more comfortable for users.
	Exposure to Elements	Existing protection against elements	Higher prioritisation will be given to stops that have no protection against the elements, like wind and rain.
		Existing amenities and comfort options	A stop with existing comfort amenities, without a shelter, will be of lower priority than those stops that have no existing amenities and comfort options.
	Passenger Profile	Age	Stops accommodating vulnerable users will be prioritised over those less likely to serve vulnerable users.
		Choice or Captive User	Depending on the mobility options available to users, stops that accommodate those that are captive to the service should be prioritised over stops that only accommodate choice users.
	Daily number of passengers		Shelters will be prioritised based on the number of passengers using the stops on a daily basis. Since, it is more cost effective to build a shelter for a large number of passengers than for a small number.
Goal	**Criteria**	**Sub-Criteria**	**Reasoning**
Optimisation of financial performance	Increase in Revenue	Advertising Opportunity	Stops that are located in areas of higher opportunity for revenue generation through advertisement will be prioritised.
		Potential to Increase Ridership	Providing a shelter may have the potential to increase ridership, those stops that have higher potential will be prioritised.
	Likelihood of Vandalism		Shelters subject to lower risk of vandalism will be prioritised over stop subject to higher risk of vandalism.

3. MODEL METHODOLOGY

The Model methodology can be summarised as shown in Figure 1. Each of the procedures is discussed in the sections that follow.

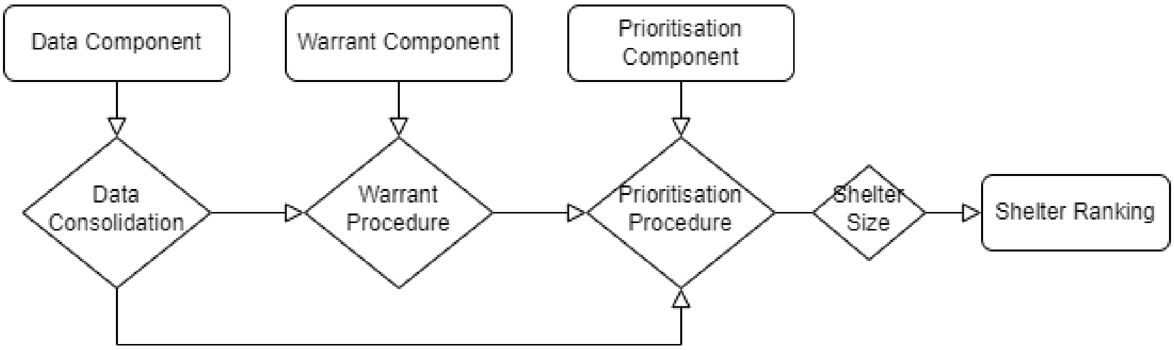

Figure 1: Model methodology

3.1 Data Consolidation

The first process in the methodology is Data Consolidation. In this process data is gathered and consolidated into a single database. The data gathered was consolidated per unique bus stop, extracted from databases consisting of all the collected data for all bus stops throughout the GO GEORGE operations. The data used in the Data Consolidation phase is discussed in short in the sections that follow.

3.1.1 Stop Information

This is mostly the basic system data containing the information related to active stops, and includes:

- Stop ID: a unique ID that can be used to identify a stop;
- Stop Name: the name of the stop also used for identification purposes; and
- Transfer Location Stop: specifies whether a stop has been identified as a location where passengers can transfer between different routes is expected to be a common occurrence.

3.1.2 Boarding Data

Noting that passengers do not generally wait at a stop when disembarking a bus, only boarding data is considered to be relevant for shelter planning. The boarding data per stop is consolidated on two levels:

- Daily Boardings: The daily boarding data was consolidated based on the maximum number of daily boardings ever recorded for a stop. This will be used for the warranting and prioritisation of shelters.
- Time Stamp Boardings: Boardings were recorded with time stamps. This is used to provide an estimate of the number of passengers that may be at a stop at any given time. The time stamp boarding is consolidated and the 85th percentile of all the time stamp boardings ever recorded for a stop calculated, this number is then used to estimate the size of the shelter.

3.1.3 Technical Feasibility and Special Condition

Individual stops are evaluated utilising available survey data, extracted from the GO GEORGE database, as well as zonal data, and supplementary Google Earth information. Individual stops are evaluated to determine if a shelter could in fact be built at a stop given the available space and other factors (i.e., urban grain). As mentioned previously, it must be technically feasible/possible for a shelter to be placed at a stop for a shelter to be warranted. Consideration is also given to whether a stop should be labelled as a special stop. A stop is deemed to be a special stop if it serves a particular land use type, facility or passenger, as mentioned in Table 1. A special stop is prioritised over non-special stops.

3.1.4 Location and Land Use

Using zonal data and supplementary Google Earth information, a stop was assigned a land use indicator based on the surrounding zones and land uses. The zonal and land use indicators considered are as follows: agricultural, business, community, residential, industrial, and mixed. In the prioritisation process of the Model, stops that are in zones that are potentially high trip attractors or generators are prioritised. Stops located in residential areas offer some complexity since there is not always sufficient space available to place a shelter, however priority should be given to stops located in residential areas if there is in fact space available.

3.1.5 Exposure to Elements

From available stop surveys and supporting Google Earth information, stops are evaluated before a shelter is provided based on:

- The existing protection offered against the elements; and
- The existing amenities and comfort options available for passengers such as seating, grass, adequate lighting and sidewalk.

Stops were evaluated based on the form of protection or amenities that are available at the stop. For example, a stop was assigned indicators S and R, if protection against the Sun and Rain is present at the stop. The result of this evaluation is used in the prioritisation of bus shelters, an example of how the prioritisation was done is discussed in Section 3.3.2.

3.1.6 Passenger Profile

Using zonal data and supplementary Google Earth information, the profile of passengers using a stop was assumed. This included aspects such as age (young, middle, old or sickly) and user type (choice, captive or both). These passenger profile characteristics are used in the prioritisation process.

3.1.7 Increase in Revenue

The increase in revenue was based on two aspects, a stop's advertising opportunities and the potential to increase ridership if a shelter is provided at a stop. A stop's advertising opportunities are based on the location and land use surrounding the stop. Stops are given a rating, Low, Medium or High, based on the potential to increase ridership if a shelter is provided. Stops with a High rating is prioritised over a stop where ridership is unlikely to increase based on the availability of a shelter. A stop's ranking was determined based on survey data gathered, as well as the collective opinion of the operations team. This data was used in the prioritisation of the bus shelters.

3.1.8 Likelihood of Vandalism

To ensure that funds are used optimally and to reduce the potential for wasteful expenditure, stops are ranked, Low, Medium or High, based on the risk of the shelter being vandalised. The rankings of the stop were determined based on a vandalism risk survey that was conducted for operating areas of the GO GEORGE system (Zutari, 2022). The risk of vandalism ranking was used in the prioritisation of shelters.

3.2 Warrant Procedure

The shelter Warrant Procedure is shown in Figure 2. The first check is whether a stop complies with the minimum threshold of daily boarding passengers (assumed to be 50 daily boarding passengers in the case of GO GEORGE). If it complies, the stop environment is evaluated to determine whether it is technically feasible to provide a shelter. If it is technically feasible, a shelter is warranted. If a stop does not comply with the minimum daily boarding threshold, consideration is given to whether this stop is a special stop. Special stops immediately warrant a shelter, provided that it is technically feasible. Once it has been determined that a shelter is warranted, the stop proceeds to the next process, the Prioritisation Procedure.

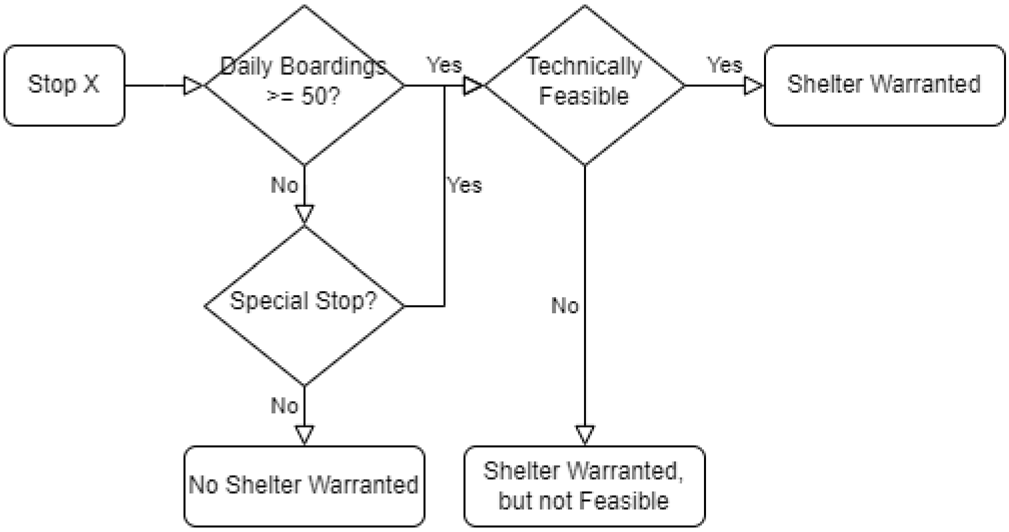

Figure 2: Shelter warranting process

3.3 Prioritisation Procedure

Figure 3 shows the Prioritisation Procedure which follows the warranting process. As shown, the Prioritisation Procedure consists of the following steps: Criteria Weighting, MCA, Determine Shelter Size, Stop Ranking and finally a list of Ranked Stops.

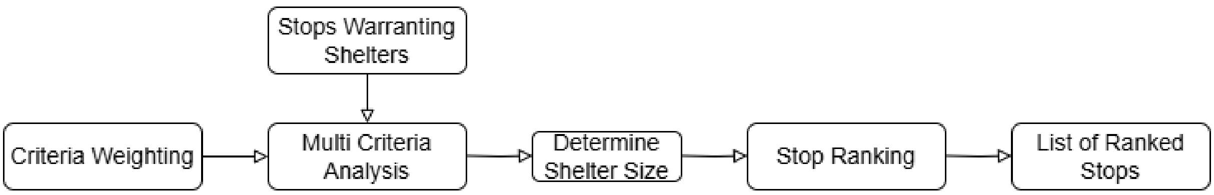

Figure 3: Stop prioritisation process

Each step of the Prioritisation Procedure is discussed in the sections that follow.

3.3.1 Criteria Weighting

The first step in the Prioritisation Procedure was determining the weighting of each respective prioritisation criteria. This was done using the Delphi Technique with the members of the GO GEORGE team. Table 3 shows the resulted weight of each of the criteria after the voting session. As shown in Table 3, after the voting session the Enrichment of Passenger Experience was deemed to be the most important goal for providing a shelter at a bus stop. With the most important criteria being the Daily Number of Boarding Passengers. This is justified, since providing a shelter at a stop that is highly used means that the number of passengers benefitting from shelters is maximized. For the

Optimisation of Financial Performance, the Increase in Revenue criteria was deemed to be the most important. This is also justified since increasing revenue means that costs are recovered quicker.

Table 3: Citeria weighting

Goal	Goal Weighting	Criteria	Criteria Weighting	Overall Weight
Enrichment of Passenger Experience	0.56	Location and Land Use	0.24	0.13
		Exposure to Elements	0.25	0.14
		Passenger Profile	0.21	0.12
		Daily Number of Boarding Passengers	0.30	0.17
Optimisation of financial performance	0.44	Increase in Revenue	0.60	0.26
		Likelihood of Vandalism	0.40	0.18

3.3.2 Multi Criteria Analysis (MCA)

Each stop was evaluated and scored based on the criteria and sub-criteria. Figure 4 shows an example of the scoring of bus stops for the Exposure to Elements criteria. As shown in Figure 4, the sub-criteria were scored based on the existing protection or amenities found at the stop. For example, if a shelter has existing protection from elements like a building overhang and wall providing protection against the rain, wind and sun, the shelter was given a lower score value reducing its priority. Note these are arbitrary stops.

Bus Stop	Protection Against Elements Combination	Value	Comfort and Amenities Combination	Value	Combined Rating	Score
800Z	N	50	S, L, G, St	0	50	5
93Z	W	40	S	40	80	8
122Z	W, S	30	S, L	30	60	6
320Z	S	40	S, G	30	70	7
260Z	N	50	S, St	20	70	7
336Z	N	50	N	50	100	10
532Z	S	40	S, L, G, St	0	40	4
400Z	N	50	S, L	30	80	8

Existing Protection againts Elements	Indicator	Value
N = None	N	50
W, R, S = Wind, Rain, Sun	W, R, S	10
W, R = Wind, Rain	W, R	20
R, S = Rain, Sun	R, S	20
W, S = Wind, Sun	W, S	30
S = Sun	S	40
W = Wind	W	40
R = Rain	R	20

Existing Amenities and Comfort Options	Indicator	Value
N = None	N	50
S, L, G, St = Sidewalk, Lighting, Grass, Seating	S, L, G, St	0
S, L, St = Sidewalk, Lighting, Seating	S, L, St	10
L, G, St = Lighting, Grass, Seating	L, G, St	10
S, L, G = Sidewalk, Lighting, Grass	S, L, G	20
S, G, St = Sidewalk, Grass, Seating	S, G, St	20
G, St = Grass, Seating	G, St	20
L, St = Lighting, Seating	L, St	20
L, G = Lighting, Grass	L, G	30
S, St = Sidewalk, Seating	S, St	20
S, G = Sidewalk, Grass	S, G	30
S, L = Sidewalk, Lighting	S, L	30
St = Seating	St	30
G = Grass	G	40
L = Lighting	L	40
S = Sidewalk	S	40

Figure 4: Example of exposure to elements MCA

The score was then combined with that of the other criteria and a final score out of 10 was given to a stop. With 10 being the highest score, meaning highest priority. Once the stop has been scored for each of the criteria an overall weighted score is calculated for the stop, based on the criterion weighting defined in Table 3.

Figure 5 shows an example of the final scores per criterion of bus stops, note these are arbitrary stops. These scores are used in the ranking of the bus stops, from highest priority to lowest priority. The ranking of the bus stops is discussed later in Section 3.3.4.

Bus Stop	Location and Land Use	Exposure to Elements	Passenger Profile	Daily Passenger Volumes	Increase in Revenue	Likelihood of Vandalism
	Overall Weight					
	0.13	0.14	0.12	0.17	0.26	0.18
800Z	8	5	3	62	6	10
93Z	2	8	4	91	4	0
122Z	2	6	4	311	4	5
320Z	5	7	8	34	7	10
260Z	4	7	4	51	5	10
336Z	2	10	4	90	4	0
532Z	3	4	3	62	6	1
400Z	10	8	3	790	8	10

Figure 5: Final MCA score

3.3.3 Shelter Size

A secondary objective of the Model was to determine the shelter size for the stops that warrant a shelter. This was done based on the number of passengers that could be boarding a bus at the stop at any point in time. A shelter is to be sized based on the 85th percentile of all the timestamp passenger boardings recorded, while ensuring the passengers are accommodated for at a Fruin Level of Service (LOS) D (Transportation Research Board, 2000).

Table 4: Shelter passenger capacity

Shelter Design	Max Passenger Capacity
Design A	±9
Design B	±23
Design C	±37

Based on Fruin LOS D the capacity of each shelter design is calculated, as shown in Table 4. Finally, an adequate shelter size for a stop is proposed based on the 85th Percentile timestamp boardings recorded for the stop and the shelter capacity.

3.3.4 Stop Ranking

The final step in the Prioritisation Procedure is the ranking of the stops based on the MCA results. This was done using the EVAluation of MIXed data (EVAMIX) method, first introduced by Voogd (1982) and generally used in MCA for handling decisions which include quantitative and qualitative criteria. The scores achieved by each stop are first normalised across all the different criteria, this ensures comparability since the scale of each criteria differs. A distance-based approach is used to evaluate and score each stop against the "ideal stop", i.e., a stop that achieved the highest score for the criteria. All the scores determined across all the different criteria are combined into a single score, using the weight determined for each criterion (See Table 3). The stops are finally ranked according to their combined score.

4. MODEL OUTPUT

Table 5 shows an example of the Model output showing a list of ranked stops with proposed shelter sizes.

Table 5: Example of ranked stop list

Bus Stop*	Description	Score	Adjusted	Rank	Proposed Shelter
400Z	Stop Located in CBD	91.39	1	**1**	Design C
320Z	Stop near Hospital**	57.63	0.78	**2**	Design A
800Z	Stop Located in CBD	35.84	0.64	**3**	Design C
260Z	Stop Located in Industrial Area	18.01	0.52	**4**	Design A
336Z	Stop near School	-20.46	0.27	**5**	Design B
112Z	Stop Located in Residential Area	-23.66	0.25	**6**	Design A
532Z	Stop near Sport Stadium	-26.10	0.24	**7**	Design B
93Z	Stop Located in Residential Area	-39.26	0.15	**8**	Design A

*Arbitrary bus stops
**Special Condition stop that serves a hospital

This Model can be used to:

- Determine which bus stops warrant a shelter;
- Prioritise the provision of shelters where budget constraints limit the provision of shelters; and
- Provide insight into the size of the shelter required at a specific bus stop, provided that boarding data is available.

4.1 GO GEORGE Use Case

In the GO GEORGE case, the Model proved to be very effective in streamlining the implementation of shelters at bus stops, accurately identifying bus stops already equipped with shelters and validating the need for a shelter at stops where a shelter is not currently provided. Although the Model was quite accurate in identifying stops which require shelters, the Model was not meant to be followed blindly. This was evident in the GO GEORGE case, where stops (some of which already had shelters) had to be re-evaluated to determine whether a shelter is in fact warranted after the shelter was already installed (some shelters were placed before the development of the Model). Another useful application of the model is to use it as part of the public participation process when engaging with property owners. The model helps with justification in cases where the owner of a property adjacent to a stop questions the need for a shelter and requests it to be removed.

Recently, GO GEORGE was given a sizable budget for the upgrading of the system's infrastructure. The Model was very effective in generating a list of bus stops, warranting a shelter, ranked in terms of its priority. Making it possible to stay within the allocated budget with justification for the expenditure. The Model is used on a continual basis for evaluating the need for shelters as new data, such as passenger boarding numbers, become available.

5. LIMITATIONS AND FUTURE WORK

This Model was developed for a system which is already operational and where actual data is available, the process may need to be adjusted in cases where boarding data is not available. With some further development it can be used to evaluate bus stops where boarding data may not be available and give an indication as to where shelters may be required. The Model can be further development to not only test whether a stop warrants a shelters and what size shelter is required but also guide the provision of other amenities such as Closed-Circuit Television (CCTV), benches, tourist specific way finding elements, and other features that can enhance the users experience. The semi-automated nature of the model is a minor limitation, and future work should focus on making the model fully automated.

6. CONCLUSION

In conclusion, public transport systems are essential for fostering sustainable urban development, enhancing social equity, and addressing the multifaceted challenges of urban mobility. Effective planning and implementation of PT infrastructure, such as bus stop shelters, play a pivotal role in achieving these goals. This paper has introduced a model tailored to determine the warrant for and then to prioritise the provision of bus stop shelters, focusing on the dual objectives of improving passenger experience and optimising resource utilisation.

By integrating global best practices with the unique socio-economic and spatial characteristics of South African cities, particularly George, the Model provides actionable insights for policymakers and stakeholders. It offers a pathway to enhance public transport infrastructure in a way that promotes inclusivity, sustainability, and efficient resource management. The insights presented in this paper are not only applicable to George but also provide a foundation for addressing similar challenges in other urban contexts across South Africa and beyond. This work underscores the critical need for data-driven, locally adapted strategies to transform public transport systems into catalysts for broader urban development.

7. REFERENCES

ADSHEL Street Furniture Pty Ltd. 2009. Planning and Development (Bus Shelter Master Plan) Approval 2009 (No 1). Available at: https://www.bing.com/ck/a?!&&p=4fea42a6567dd0efb2826974fa2673108111b22e36bfdde0c394a54a27e47e68JmltdHM9MTc0NTE5MzYwMA&ptn=3&ver=2&hsh=4&fclid=22d7af38-fe9f-6515-18c1-bb41ff016461&psq=ADSHEL+Street+Furniture+Pty+Ltd%2c+2009.+Planning+and+Development&u=a1aHR0cHM6Ly93d3cubGVnaXNsYXRpb24uYWN0Lmdvdi5hdS9Eb3dubG9hZEZpbGUvbmkvMjAwOS00MTIvMjAwOTA5MDQtNDA2MzAvUERGLzIwMDktNDEyLlBERg&ntb=1. Accessed 6 June 2023.

Department of State Growth, n.d. Bus Shelter Guidelines. Available at: https://www.transport.tas.gov.au/data/assets/pdf_file/0006/521358/BusStopShelter_Guidelines.PDF. Accessed 6 June 2023.

Mid Ulster District Council, n.d. Procedural Guide on the Provision of Bus Shelters. Available at: https://mid-ulster.cmis-ni.org/MidUlster/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=Gx%2Bq5RuEPsbmCWhhtB1YV2zA19rH%2FUr5s0M5aqZbjm7Qnqpkm8ss2A%3D%3D&rUzwRPf%2BZ3zd4E7Ikn8Lyw%3D%3D=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2FLUQzgA2uL5jNRG4jdQ%3D%3D&mCTIbCubSFfXsDGW9IXnlg%3D%3D=hFflUdN3100%3D&kCx1AnS9%2FpWZQ40DXFvdEw%3D%3D=hFflUdN3100%3D&uJovDxwdjMPoYv%2BAJvYtyA%3D%3D=ctNJFf55vVA%3D&FgPlIEJYlotS%2BYGoBi5olA%3D%3D=NHdURQburHA%3D&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJFf55vVA%3D&WGewmoAfeNR9xqBux0r1Q8Za60lavYmz=ctNJFf55vVA%3D&WGewmoAfeNQ16B2MHuCpMRKZMwaG1PaO=ctNJFf55vVA%3D. Accessed 6 June 2023.

NZ Transport Agency, 2014. Guidelines for public transport infrastructure and facilities. Available at: https://www.nzta.govt.nz/assets/consultation/guidelines-for-public-transport-infrastructure/docs/guidelines-pt-infrastructure-draft.pdf. Accessed 7 June 2025.

The City of Edinburgh Council. 2019. Edinburgh Street Design Guidance: Part C - Detailed Design Manual. Available at: Edinburgh street design guidance – The City of Edinburgh Council. Accessed 7 June 2023.

Transportation Research Board. 2000. Highway Capacity Manual. Transportation Research Board, National Research Council, United States of America.

Voogd, H. 1982. Multicriteria Evaluation with Mixed Qualitative and Quantitative Data. *Environment and Planning B: Planning and Design*, 9(2):221-236. Available at: https://doi.org/10.1068/b090221. Accessed 6 June 2023.

Washington Metropolitan Area Transit Authority. 2009. Guidelines for the Design and Placement of Transit Stops. Available at: https://www.wmata.com/initiatives/plans/upload/Bus_Stop_Guidelines_Brochure.pdf Accessed 7 June 2023.

Zutari. 2021. Public Transport (Street Transit) Infrastructure Design Guideline, Cape Town.

Zutari. 2022. George Integrated Public Transport Network: GO GEORGE Bus Shelter Security Risk Assessment, Cape Town.