EXPERIMENTS IN UNDERSTANDING PASSENGER NEEDS ON THE FIRST AND LAST MILE OF THE PUBLIC TRANSPORT TRIP

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ABSTRACT

Transport planners traditionally pay more attention to the in-vehicle quality of public transport, focusing first on issues of vehicle quality, travel speed, and affordability. The out-of-vehicle components of the trip – walking to the vehicle, waiting, and transferring – often receive less attention and subsequently are of poorer quality. It is likely that the poor quality of the out-of-vehicle experience suppresses public transport demand, especially among choice users who are quality sensitive. Arguing that we do not know enough about what passengers need on the first and last mile of the journey, this paper sets out to report on the findings of two recent experiments aimed at filling this knowledge gap. The experiments include importance/satisfaction surveys and stated preference surveys undertaken amongst Bus Rapid Transit and Gautrain users in Gauteng, and include access and egress across a range of modes such as walking, feeder bus, and ridehailing. The data modelling shows that passengers often have different priorities on the access and the egress trips, and that passenger needs vary according to mode and socio-economic factors. Nevertheless, the basic needs of security from crime, short travel times and low fares stand out as key priorities for improving first/last mile experience. Specific strategies are suggested that could be applied to improve access/egress quality of public transport in South African cities.

1. INTRODUCTION

Transport planners are traditionally more focused on the in-vehicle quality of public transport, addressing issues of vehicle quality, travel speed, and affordability. The out-of-vehicle components of the trip – walking to the vehicle, waiting, and transferring – often receive less attention and subsequently are of poorer quality. That the out-of-vehicle part is often perceived as the worst part of the trip is borne out by satisfaction surveys: in 2013 facilities at taxi ranks was the single factor taxi-users nationwide were least satisfied with (Statistics South Africa, 2014). Long walking distances and waiting times have been identified as key weaknesses of Bus Rapid Transit systems in South Africa (Venter, 2016). It is likely that the poor quality of the out-of-vehicle experience suppresses public transport (PT) demand, especially among choice users who are quality sensitive. Understanding it, measuring it, and improving it is important to protecting and growing sustainable transport options in the future. This is true locally and internationally, driving increased interest in the first/last mile aspects of public transport (Zellner et al., 2016; Boarnet et al., 2017; Venter 2021).

Part of what makes the first/last mile (1LM) experience difficult to manage, is the lack of control over it – most of this part of the trip takes place in the street away from stations and stops over which an operator or authority can exercise direct control. The first/last mile

environment is also very diverse, encompassing a variety of modes, roleplayers, and conditions. It is argued here that an insufficient understanding exists of what passengers want from the out-of-vehicle experience, preventing practitioners from prioritising actions to improve it.

This paper helps to fill the knowledge gap about passenger needs for the 1LM part of the trip. It reports on two studies in Gauteng that were undertaken to identify passenger needs at a variety of locations and modes. An underlying question is to what extent do 1LM needs vary across locations and across user groups: i.e. how much of our out-of-vehicle strategies can be generic, and how much should be informed by local user characteristics and priorities. The first/last mile is defined as any access/egress segment between the trip origin/destination and a main public transport mode, including the transfer to/from the mode, but excluding transfers between main mode segments. A mixed methods approach is followed, including focus groups and quantitative surveys. The intention is to help authorities move towards effective whole-trip strategies for improving public transport in their jurisdictions.

The paper briefly highlights major literature approaches, then describes the two studies, and finally draws conclusions and recommendations.

2. PREVIOUS RESEARCH

International research has generated some knowledge about what public transport passengers want on the 1LM part of the trip. Since the vast majority of 1LM trips have historically been made by walking (Jiang et al., 2012), many studies have examined preferred conditions for walking. This has been partly driven by interest in the health benefits of active modes in general, and walking to PT in particular. Most interest has been on walking distances (Van Soest et al., 2020) and general walkability (e.g. Frank et al., 2010). One key finding is that preferences for walking vary by attributes of the people and places served (Jiang et al., 2012; El-Geneidy et al., 2014). There is some evidence that commuters in developing countries such as China (Jiang et al., 2012) and South Africa (Behrens 2004) are willing to tolerate longer walking distances to public transport, perhaps because of different expectations and generally lower values of time. Universally, passengers value out-of-vehicle travel time (including walking, waiting, and transferring) 2-3 times higher than in-vehicle segments (Litman, 2004; Venter, 2016), reflecting the more onerous nature of the former.

Certain insights into passenger preferences are to be gleaned from satisfaction surveys that have been undertaken in South Africa. Verster (2004, 2010) studied passenger satisfaction at selected public transport interchanges in Cape Town, and found passengers to be most concerned with safety and security and informal traders blocking movements. Behrens et al. (2018) found that the top three most important service attributes to transferring minibus-taxi users in Mitchells Plain were related to in-vehicle components of the trip (personal security in the vehicle; trip time; and driver compliance), ahead of out-of-vehicle attributes such as rank security, infrastructure, and walking distances between vehicles. An obvious question that emerges is whether these findings related to transferring also apply to the trip to/from the interchange.

3. FIRST/LAST MILE PRIORITIES AMONGST BRT AND GAUTRAIN USERS

The first study examined priorities related to the access/egress trip among Bus Rapid Transit and Gautrain passengers in December 2017 and January 2018. The results were

later used to develop an index to measure the quality of the first/last mile environment for these modes (see Venter, 2020). The intercept face-to-face survey recruited respondents at stations and bus stops, across a variety of Central Business District (CBD) and suburban locations in Tshwane and Johannesburg.

The response rate was approximately 60%, and the total sample of 250 was split evenly between Gautrain and BRT[1] users. The 1LM modes used by these passengers include walking, Gautrain feeder buses, and other public transport such as minibus-taxis as a feeder mode. Car-based feeder modes such as metered taxi, e-hailing, and kiss-and-ride were excluded, as was bicycling which has minimal use in this population.

Due to the fact that Gautrain and BRT are priced higher than other public transport systems, the sample is representative of the upper end of the transit-using population in Gauteng. The majority of respondents were employed (47%) or studying (44%), but only a quarter had a car available. Students are probably over-represented in the sample (24%) compared to the general public transport market, as the Gautrain and BRT service areas include many universities and colleges. Work (48%) and school/education (28%) were the most popular reasons for taking public transport in this sample; the majority of respondents are thus regular public transport users (44% use Gautrain or BRT daily).

From the literature, 19 quality attributes of first/last mile environments were identified, and grouped into seven broad categories (Table 1). The categories go beyond those typically reflected in walkability or NMT-only indices (see Frank et al., 2010; Park et al., 2014), but also include aspects related to feeder buses as 1LM mode, such as feeder trip distance, travel time, fare, and the quality of the waiting area (such as bus stops) where passengers wait for feeder vehicles.

Table 1: Categories and attributes included in first/last mile quality assessment

Broad Category of First/Last Mile Attributes	**Specific Attributes**
Personal security from crime while waiting for and walking to public transport	○ CCTV monitoring ○ Visible security and police ○ Emergency call box ○ Lighting of sidewalks and bus stops
Comfort of waiting areas	○ Overhead shelter (rain and sun) ○ Resting facilities ○ Wi-Fi provision at waiting areas
Ease of finding information	○ Info on bus delays and arrivals ○ Alternative route information
Safety from traffic accidents while waiting and walking	○ Safe road crossings ○ Sidewalks and waiting areas protected from vehicle traffic
Sidewalk comfort and quality	○ Walkways wide and obstruction-free ○ Clean and pleasant street environment ○ Walkways flat, even and neat
Time and distance of access trip	○ Short walking distance to/from final origin/destination ○ Short waiting time for feeder bus ○ Overall trip to Gautrain station fast
Cost of access trip	○ Cost associated with feeder trip ○ Pay point machines at bus stations and pickup/ drop off points

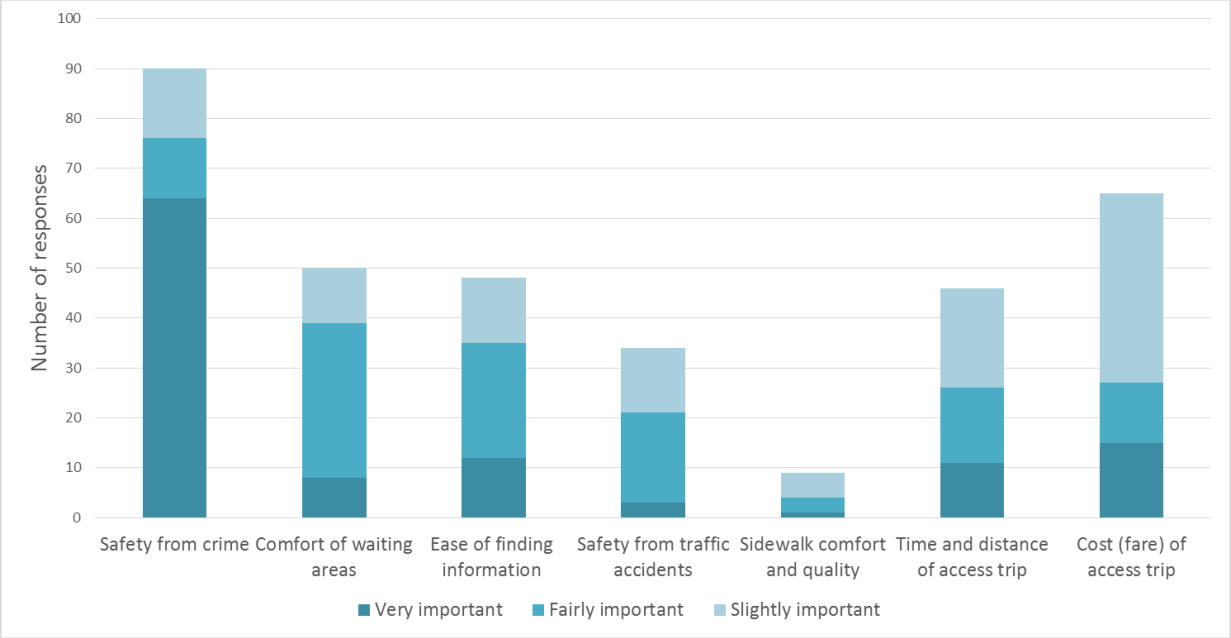
[1] Both Rea Vaya (Johannesburg) and A re Yeng (Tshwane) passengers were included.

The survey asked respondents to select (from the list in Table 1) and rank the three most important categories of attributes relating to the 1LM part their trip. They were then asked to rate the importance of individual attributes on a Likert scale between 1 (very unimportant) and 5 (very important).

3.1 Results

Figure 1 shows the results from the first ranking of broad categories of first/last mile criteria. The height of the bar shows the total number of mentions of each category within the top three, and the shading shows the breakdown by rank of each element. Further data are shown in Table 2.

A clear ranking emerges. Security from crime is considered the most important by far, with both the highest number of mentions, and the highest number of people selecting it as their most important criterion. About 73 percent of respondents selected security from crime to be among the top three concerns for them. The cost of the access trip is among the top three concerns of 55% of people and ranks second on the priority list. This is followed by three criteria with similar importance ratings, namely the ease of finding information, travel time/distance, and the comfort and convenience of waiting for the bus. Then follows traffic safety, which was included in the top three priorities by only a third of respondents. Finally, sidewalk quality and comfort is the least important issue to this group of users.



Source: Venter, 2020

Figure 1: Results of user survey: Importance of broad categories of first-last mile attributes (n = 750 responses)

One-way Analysis of Variance (ANOVA) was performed to test the clustering of categories in terms of their importance ratings. It confirmed that the lowest and highest categories differ significantly (at a 95% significance level), but that the categories of comfort, information, time, and cost have similar importance levels. As a result, four clusters of importance levels ranging from low to high were identified, as shown in Table 2.

Table 2: Results of user survey: importance and inferred ranking of broad categories of first/last mile attributes

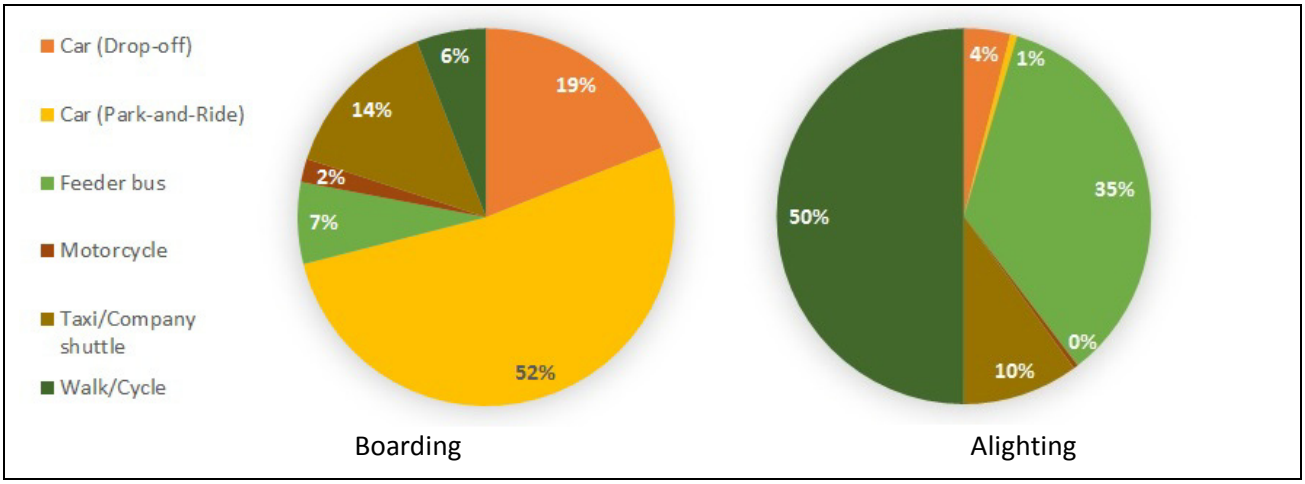
Broad Category of Attributes	Percentage of Times Selected Within Top Three (%)	Percentage of Mentions With Most Important (%)	Inferred Ranking
Personal security from crime while waiting and walking	73%	67%	HIGH
Cost of access trip	55%	26%	MED-HIGH
Comfort of waiting areas	47%	21%	MED-HIGH
Time and distance of access trip	44%	27%	MED-HIGH
Ease of finding information	43%	22%	MED-HIGH
Safety from traffic accidents while waiting and walking	32%	15%	MED-LOW
Sidewalk comfort and quality	6%	13%	LOW

One reason for potential bias in the results is differing sample sizes – for instance, underrepresentation of passengers with experience walking to stops and stations could explain the low rating of the sidewalk attribute. To test for this the average ratings were compared between subsamples for the two access modes (walk and feeder bus). One-tailed t-tests revealed no significant differences in the average ratings for any of the attribute categories (95% significance) between the subsamples. The same test was also applied to test for differences between the main mode subsamples (Gautrain versus BRT passengers). It showed no significant differences except for the security attribute which is judged more important by Gautrain passengers. It is concluded that, overall, perceptions do not vary substantially across the sample, suggesting that access/egress preferences are relatively similar across users of different 1LM modes *and* different main modes.

4. ACCESS/EGRESS MODE CHOICE BEHAVIOUR AMONGST GAUTRAIN USERS

The second experiment studied 1LM preferences in the context of the choice between different modes that a commuter faces on the first or last mile part of the trip. The sample was limited to Gautrain users, and the main question was what are the factors that systematically affect 1LM mode choice in this population. The survey was a stated preference (SP) survey, which could improve the realism of the data (compared to an importance survey described above) by forcing the respondent to consider trade-offs in the context of an actual choice situation. However the number of attributes that can be studied is typically more limited in order to reduce respondent burden.

The survey was collected amongst passengers of all nine commuter stations, excluding Oliver Tambo International Airport (ORTIA). By way of illustration, Figure 2 shows the distribution of access and egress modes at Hatfield station. Overall, the car is the most important access mode: about three quarters of access trips are by car (either drop-off or park-and-ride), drawn from the terminal station's large commuter catchment area.



(Source: Royal HaskoningDHV 2017). Note: Rideshare is included in 'Taxi'

Figure 2: Access and egress modes of Gautrain passengers, Hatfield station

Only 7% of passengers use Gautrain's feeder buses and 6% walk to the station. The mode use of alighting passengers looks different. Walking (50%) and feeder buses (35%) dominate.

To understand the factors driving such mode choice behaviour, an online SP survey was conducted in 2019 in which respondents had to select first access and then egress modes for their most recent Gautrain trip. Each experiment was pivoted around the current access/egress mode, with the respondent given a choice between the current access/egress trip and a hypothetical alternative with varying attribute levels. Experimental levels were selected using a fractional factorial design. The modes chosen for the experiments were as follows:

- Park and Ride (first mile only).
- Drop off / Pick up (first and last mile).
- E-Hail (first and last mile).
- Walk (first and last mile).
- Gautrain Bus (first and last mile).

E-hail (like Uber and Bolt) was included as this is a fast-growing alternative that system planners need to understand in order to leverage it better. The attributes were selected following a focus group with current Gautrain users, in which salient factors affecting access and egress behaviour were explored. The attributes consisted of the standard travel time and cost variables, as well as walk and wait time for the Gautrain Bus. The focus group also confirmed that safety from crime is a major concern during first/last mile travel on public transport; this was subsequently added as a qualitative variable to each modal alternative with a component that required walking to the station or bus stop.

Survey respondents were recruited using Gautrain's social media platforms (e.g. Twitter and Facebook), and directed to online survey platform (Survey Monkey™). The sample size of usable surveys was 240 responses. Examination of the sample indicated it to be slightly skewed towards younger (25-44 years) passengers, scholars and part-time workers, and lower-income people; possibly as a result of the use of the online tools for recruitment and survey administration. However the bias was not large enough to introduce serious bias concerns in the results.

The data were analysed by fitting a large number of nested logit models in order to search for correlations in the underlying preference structure. The efforts and detailed results are described in Watts (2022). This paper just briefly highlights the main findings.

Table 3 shows the indicative findings in terms of significant coefficients in the choice model utility functions, for the best fitting access and egress models. The models are highly significant, and all the coefficient signs are rational.

The results confirm that service variables like fare, in-vehicle time, and walk time significantly affect the choice of 1LM mode. Safety from crime is a very significant factor, especially for the bus and walk access trip where exposure to crime is presumably higher. Waiting time proved to be insignificant – an interesting finding given that buses currently operate at fairly long headways (20 to 30 minutes). Anecdotal evidence suggests that passengers manage to reduce their waiting times in practice by arriving just before the bus, through use of an app with real-time bus tracking. This practice may lead passengers to "discount" the waiting time attribute given in the SP experiment, thus reducing the ability to detect its effect (if there is one). Sensitivity to waiting needs further research as not all passengers use the app or have the ability to change arrival times, especially on the return journey.

Table 3: Indicative findings of access and egress mode choice models, Gautrain passengers (n = 240 respondents)

Variable	**Access Mode**					**Egress Mode**			
	Drop-off	**Car**	**Bus**	**e-Hail**	**Walk**	**Pick-up**	**Bus**	**e-Hail**	**Walk**
Mode constant	(base)	+	O	+	O	(base)	O	– –	O
In-vehicle time	–	–	–	–		– –	– –	– –	
Fare/Parking cost	– –	– –	– –	– –		– –	– –	– –	
Walk time			– –		– –		– –		– –
Wait time			O				O		
Safety			++		++		+		+
Age					O			–	
Income		+		+			–		
Female	–				–	O			O
Model significance	**High (p-value of Chi-square test = 0.00)**					**High (p-value of Chi-square test = 0.00)**			

Key: ++, + : increase in variable is strongly (95%), weakly (90%) associated with higher choice probability
O : variable not significant
– – , – : increase in variable strongly (95%), weakly (90%) associated with lower choice probability

Socio-demographic factors that were tested included age, income, and gender. The results show that passenger preferences do vary somewhat based on personal factors. Younger people are more likely to select e-hail for the egress trip than older people, consistent with other research that showed e-hailing is very popular amongst students in Johannesburg (Fenton et al., 2019). Women are less inclined to consider drop-off and walk modes on the access trips, everything else being equal. And lower incomes are associated with higher bus use and lower use of car-based modes, as can be expected.

Table 4: Estimated Value of Travel Time savings, Gautrain passengers (n=240 respondents)

Variable	Access Model	Egress Model
In-vehicle time	R44.35	R87.27
Walk time	R78.26	R106.36
Wait time	-*	-*

Note: * Could not be estimated – insignificant coefficients

Comparing the results for the access and egress models some interesting results emerge. The largest difference can be seen in Table 4, which shows the estimated Value of Travel Time Savings (VTTS) (time coefficient divided by cost coefficient) for the two models. The values for in-vehicle travel time are quite high when compared to other public transport modes in South Africa of about R15/hr or less (Hayes & Venter, 2017). This difference is likely due to the high income of Gautrain users relative to the rest of the population, but could also indicate that passengers value the in-vehicle time spent on the access and egress part of their trip (if motorised) more highly than the time on rail (the main mode). Walking time to the feeder bus stop or rail station is valued at between 1.2 and 1.7 times higher than the in-vehicle part, which is a common finding in the literature (Litman, 2004). Both in-vehicle and walking time is valued significantly higher for the egress trip than for the access trip. This could indicate that people become more anxious about on-time arrival at their destination as they near it on the last-mile part of their trip. The implication is that strategies to reduce travel times on last mile modes will be more effective at attracting passengers, than those aimed at first-mile modes. In the context of the morning peak hour commute, this means more attention is needed on the work-end than the home-end of trips – perhaps through congestion relief measures or priority lanes for distributor bus services and personalised modes like e-hailing that connect from the egress station to the destination. Table 3 also shows that safety from crime, while still significant, is less of a concern on the egress than on the access trip, suggesting that timeliness becomes such an important factor on the egress trip that it may overshadow other concerns. In effect commuters are willing to accept slightly reduced security levels on the egress trip in exchange for faster service.

5. DISCUSSION

The work reported here provides insight into what users value when considering the first/last mile (1LM) part of their public transport trip, which could be of value when deciding on improvement actions. Unsurprisingly, travel time and walking time on the access/egress trip are clearly important factors across users of all modes. Strategies that speed up feeder buses (such as localised bus priority) or that reduce walk times (such as adding feeder bus routes) would be effective at attracting passengers. E-hail services are popular (especially amongst younger travellers), but could be improved by speeding up pick up/drop off movements at stations. The cost of the 1LM trip remains important, even for this population of higher-income BRT and Gautrain passengers, so integrated fare policies (especially around integrated fare payments to reduce the transfer penalty) could help to promote the use of public transport as 1LM mode.

A new finding is that travel time is much more important to passengers on the last mile than the first mile segment of their (morning) trip. This suggests that the access/egress trip is not simply symmetrical, and that the above time-saving strategies should firstly be aimed at the non-home end of the morning commute (e.g. in work and educational precincts) to gain larger benefits.

Both studies reported here found that users place high importance on security from crime, echoing previous studies that have found that security on the walk to public transport and at stops is a major cause for dissatisfaction amongst bus and train users (Statistics South Africa, 2014). This is not unique to South Africa, as public transport users the world over rank security very highly as a concern (Tilahun et al., 2016; Agrawal et al., 2008). Crime prevention and the design of safe environments are clearly crucial not only on public transport itself, but also on the part of the trip to/from public transport.

Lower down the importance ranking are service quality issues like accessibility, sidewalk infrastructure, the comfort of waiting areas like bus stops, and waiting times. Even traffic safety on the 1LM trip appears to be of medium to low priority to Gautrain and BRT users. This is somewhat surprising, given the seriousness of the traffic safety problem in South Africa in general, and among pedestrians in particular. However it accords with the perceptions of Gauteng bus users in general: a recent perception survey shows traffic safety to be relatively low as a cause of dissatisfaction, behind issues such as security, punctuality, and fares (Statistics South Africa, 2014).

6. CONCLUSIONS

In conclusion, the paper shows that there is a hierarchy of needs related to the first/last mile of the public transport journey, with travel time, walking time, and the cost of access/egress modes most important. Service quality issues like accessibility, sidewalk infrastructure, the comfort of waiting areas like bus stops, and waiting times are ranked lower down the list. These findings are largely similar across user groups of different modes, and despite different data collection and analysis techniques, suggesting that similar strategies to improve the first and last mile environment might be successful in different places.

How dissatisfaction or subjective experience correlates with importance ratings is a topic for further research. Some work has been done to assess the actual quality of 1LM environments (Royal HaskoningDHV, 2017; Venter, 2020), and this could be helpful in prioritising areas for action taking both customer expectations and current conditions into account. However the findings from this paper are clear: we need to pay attention to the basics of crime-free environments, and fast and cheap connectivity to/from public transport.

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