

Transport and Urban Development:

Two Studies from Johannesburg



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Acknowledgements

The authors are thankful to the Department of Science and Technology, and the National Research Foundation, South Africa for funding this work, which does not necessarily represent their views.

Copy Editing: Karin Pampallis

Report Design and Layout: HotHouse South Africa

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Results from the Gauteng City Region Quality of Life Survey, 2011
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Foreword

There is a growing international literature on the relationship between transport and urban form, with accumulating evidence pointing to the positive correlation between residential densities, the use and viability of public transport, and the economic and social sustainability of the city. There are encouraging indications that urban policy makers and planners in South Africa understand these relationships, with an initiative such as the Corridors of Freedom in Johannesburg actively supporting densification along major transit routes as a contribution to building a more resource efficient and socially equitable city. However, while the relationships may be strong they are not always straightforward and ongoing empirical investigation is needed to inform policy development.

This booklet contains two research pieces which offer evidence-based perspectives on transport and its relationship to urban form. The first, by Dylan Weakley, explores the relationship between population density and modes of transport in Johannesburg using data from both the Gauteng City Regional Observatory (GCRO) Quality of Life Survey conducted in 2011 and the National Population Census of the same year. The research confirms a clear relationship between density and use of public transport but, importantly, reveals that this relationship holds across all income groups.

The second piece, written by Geoffrey Bickford, helps us understand better the relationship between new transport infrastructure and other urban development processes. It explores the impact that the Diepkloof Bus Rapid Transit (BRT) station in Soweto is having on development in adjoining areas. The research confirms that the BRT is having a positive impact on the access of local residents to the wider city but does indicate that the impact of the BRT on the built form of neighbourhoods may be evolving only gradually, and will have to be analysed over a longer period.

The research in this booklet was carried out as part of a three year research programme entitled “Urban Resilience Assessment for Sustainable Urban Development” at the University of the Witwatersrand (Wits) which was carried out as a partnership between Wits and the GCRO. The programme was funded as part of the Department of Science and Technology’s (DST) Grand Challenge on Global Change.

The work on “resilient densities”, conducted as part of this broader initiative, included an investigation into four case areas which are illustrative of different typologies of densification in the city. We intend to publish the findings of this case-based research shortly as a complement to this book and to the existing publication,

Urban Resilience Thinking for Municipalities published in 2014. We also intend to extend and deepen our work on resilient densities in a partnership with the City of Johannesburg and the Agence Française de Développement (French Development Agency - AFD), and in the hope that it will both contribute usefully to policy development and planning locally, and to the accumulating insights from research across a range of contexts internationally.

Philip Harrison

South African Research Chair in Spatial Analysis and City Planning

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Population Density and Transport in the City of Johannesburg: Results from the Gauteng City Region Quality of Life Survey, 2011

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Abstract

This work seeks to quantitatively investigate the relationship between population density and transport in the City of Johannesburg Metropolitan Municipality (CoJ), South Africa. It does so by comparing data from the Gauteng City Region Observatory's (GCRO) 2011 Quality of Life Survey (QoL) (Gauteng City Region Observatory, 2011a) to population density data from the South African Census 2011. The work finds a correlation between urban population density and the use of different modes of transport in the City of Johannesburg, with private cars used more in lower-density areas, and higher rates of public transport and non-motorised transport use in higher-density areas. The study also compares density and household income to the use of public transport in the city. Across all of the household income categories in the QoL 2011, those living in higher-density areas are more likely to use public transport than those living in lower-density areas. Lastly the paper examines why those living in higher-density areas are more likely to use public transport than those living in low-density areas. The data suggests that cost and walking time to public transport are major factors. On average, walking times to public transport increase as density decreases. Household incomes in higher-density areas are generally lower than those in lower-density areas, and public and non-motorised transport is generally cheaper (in real values) than private motorised transport

Introduction

Over the past twenty years, urban planners and theorists have placed much emphasis on urban infill, densification and compaction (Gordon & Richardson, 1997). This has been in response to car-induced urban sprawl, high carbon emissions and spatially based social and economic inequality (Turok, 2011). In South Africa, this also relates to apartheid and post-apartheid planning and city growth/development. During the apartheid era, state planning *actively* sprawled cities by placing Black, Indian and Coloured people in segregated dormitory towns on the outskirts of cities and towns (Pieterse, 2009). Since the end of apartheid, various forces, including the Reconstruction and Development Programme's housing policy, have reportedly continued the tendency of South African cities and towns to sprawl and become less dense (Charlton & Kihato, 2006).

Compact cities are argued to increase access to the variety of services and functions that cities accommodate, optimise the efficiency and cost of service delivery, promote the use of public transport, and create more 'walkable' and 'liveable' urban forms (Schwarz, 2010). The promotion of densification is also influenced by the concepts of sustainability and sustainable development, where it is argued that the process reduces carbon emissions generated by combustion engines in transporting people, services and goods into, around and out of the city (Jabareen, 2006). This is basically explained, in that it is more efficient to deliver services and goods to many people in a small area than it is to fewer people spread out over a large area.

Specifically regarding transport (or mobility, the term used by the authors cited below), densification is reported to have a number of possible positive effects on society and on urban form. From a review of the literature, Boyko & Cooper (2011, p. 10) summarise the mobility advantages of higher urban densities as:

- Reducing fossil fuel emissions/carbon footprint
- Enhancing accessibility, as people live closer to where they work, shop and play
- Making transit more viable and efficient
- Decreasing pressure on land further from hubs by building developments near public transportation
- Enabling public health benefits from more walkable and bike-friendly neighbourhoods
- Offering more opportunities to walk or cycle
- Decreasing pollution from vehicle exhausts due to decreased use of vehicles, a better mix of land uses and more walking and accessible public transportation, as well as decreasing traffic congestion

- Decreasing the total number of vehicle trips as well as the number of kilometres per trip
- Creating efficiencies in mixed-used developments through shared parking.

Although compaction and densification have received much attention, the concepts are not universally supported, with various writers voicing their critiques. These critiques can be categorised into two general threads: the negative effects of over-densification (often referred to as overcrowding) (e.g. Dovey & Symons, 2013); and densification that occurs in a limited or one-dimensional manner (e.g. Boyko & Cooper, 2011). Overcrowding can lead to a number of negative effects, especially when it occurs without the necessary upgrades to social and 'hard' infrastructure. Densification without change to infrastructure can lead to infrastructure overload, because more people use it than it was initially designed for. This can include sewage networks, water and electricity reticulation, road provision, and social infrastructure such as libraries, hospitals, schools, open space and recreation facilities (Boyko & Cooper, 2011). Other reported negative social and psychological impacts of overcrowding can include loss of individual privacy, increased crime, an eroded sense of community, and even increased levels of stress and anxiety (Boyko & Cooper, 2011, pp. 14-15). Many of the negative effects of overcrowding relate to the second general critique of densification - that is, where it occurs in a limited manner. A basic example of this is where only one type of densification takes place. For instance, population density increases that occur without an increase in the densification of other land uses such as shops, schools or access to recreation facilities. Densification of people per area needs to be accompanied by concurrent densification of other functions per area; it should take place with the required diversification and intensification of land uses and amenities in order for it to work.

This is also the case with mobility and transport; in some cases, densification may have undesirable effects. Again, Boyko & Cooper (2011, p. 10) summarise these as:

- Exacerbating traffic congestion, parking problems and increased traffic accidents
- Losing a status symbol because it may be difficult to maintain an automobile (e.g., finding parking spaces)
- Creating pedestrian congestion and congestion in public transportation facilities
- Causing congestion and disruption at the street level where the construction of high-density buildings is taking place

QoL 2011 data in Johannesburg show that the majority of commuters in the city use public transport with 68.9% of the 4502 respondents who answered question (4.9 in the questionnaire) indicating that they do, and only the remaining 31.1% indicating that they do not (Gauteng City Region Observatory, 2011b).¹ Figure 1 indicates the most frequently reported main modes of public transport in the city.² The two most reported modes of public transport are 'Taxi'³ (50.85%) and 'Train' (5.88%), with 'Other Bus' (3.09%) the next most frequently reported mode of public transport used. Interesting here is that the most commonly used form of public transport is the minibus taxi service which is a privately owned and run form of 'public transport' (Barrett, 2003). This is significant in that it shows that state-provided public transport still only moves a small percentage of commuters in the city. Very interesting, too, is that the third most frequently reported main mode of transport is walking, at 8.39% of respondents. When added together, all modes of public and non-motorised transport make up 69.63% of frequent transport types utilised by QoL respondents in the CoJ (see Figure 2).

Lastly is the use of private cars. In total, private cars (including their use as a passenger or in a lift club) make up almost one-third of regular trips in the city (30.15%). In addition, almost three-quarters of car trips make up the category 'car as driver', making up the second most frequent regular mode of transport in the city, at 22.06% (almost one in four trips). As a frequent mode of transport, 8.91% of QoL respondents' use non-motorised transport,⁴ 30.36% use private motorised transport, and the majority used public transport (60.72%) (see Figure 2).

Figure 1 and Figure 2 paint a good overall picture of transport in the city of Johannesburg. What this work seeks to do, however, is to look at the relationship between transport and population density, motivated by the close relationship between the two claimed in densification literatures. While the findings from this study do not prove or disprove all of the possible positive and negative effects that density may have on transport

or mobility, it does provide some empirical evidence on the positive relationship between density and non-motorised and public transport in Johannesburg. The work focuses on how *people* move through the city, and not on how goods and services are delivered. The research is done quantitatively by comparing data from the Gauteng City Region Observatory's (GCRO) 2011 Quality of life Survey (QoL) to population density data from the South African Census 2011. The method used is discussed immediately below, followed by the study's findings and a concluding discussion.

FIGURE 1: Frequent Transport Types in the City of Johannesburg⁵ (Gauteng City Region Observatory, 2011a)

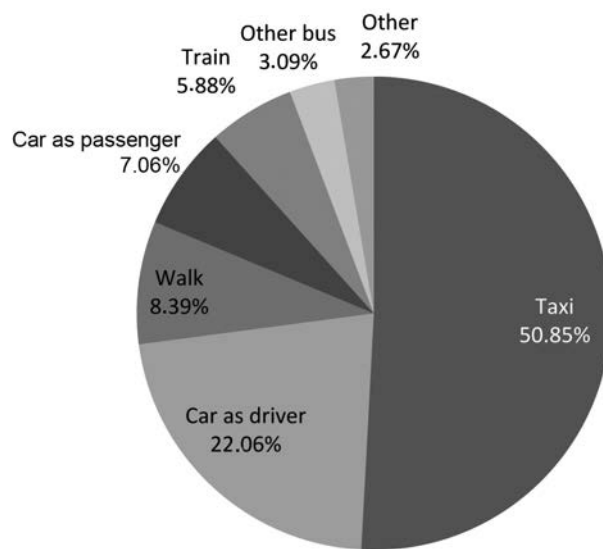
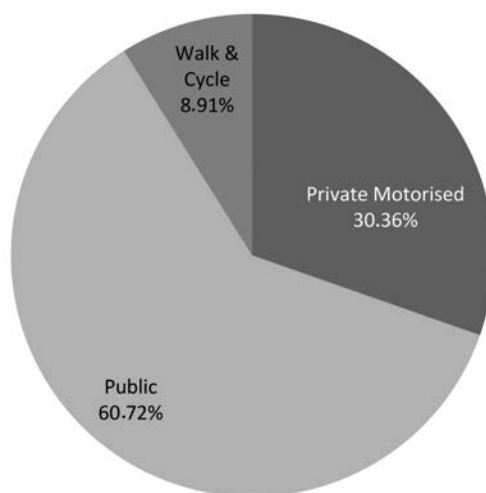


FIGURE 2: Main Transport Types in the CoJ Divided into Public, Private Motorised and Non-motorised⁶ (Gauteng City Region Observatory, 2011a)



Method

Although many measures of density exist, in this study the author chose to define population density as people per area (gross neighbourhood density). This was done for a number of reasons, but primarily due to data availability. The South African Census 2011 divides the land mass of the country into various enumeration areas. These include political boundaries (provinces, municipalities and wards) and smaller enumeration areas such as sub-places and the small area layer. Population data is coded with this enumeration area data, allowing it to be mapped with corresponding shape files that Statistics South Africa⁷ (Stats SA) provides with the data. As the larger project of which this study forms a part looks at different suburbs⁸ in the City of Johannesburg (Hillbrow, Bram Fischerville, Houghton Estate and Northriding), the sub-place layer (which includes these suburbs) was chosen as the layer of investigation. This layer gives sufficient detail to the work, making comparisons at the scale of investigation of the wider project possible. The layer was also useful in that it allows for a consistent approach to measuring density (Boyko & Cooper, 2011) and in that it covers the entire area of the CoJ.

Although each response in the QoL data is recorded with the location of the respondent's residence, this detail is not made publically available to protect the anonymity of respondents. The standard data set also does not contain the sub-places where respondents live. For this reason, the author first had to contact the GCRO, to have sub-places added to the data. This was done by mapping each response in the ArcMap GIS programme, and performing a spatial join with the sub-place layer provided by Stats SA with the 2011 census data. Once this was done, respondents' individual co-ordinates were deleted from the dataset, which was then supplied to the author.

In order to calculate density for each sub-place (again in ArcMap) the population of each sub-place was simply divided by its area, giving population density in people per square kilometre (ppl/km²).

The author then sought to categorise densities across all sub-places for analysis. Two methods were proposed for this. The first was to divide the dataset into categories with intervals of ten thousand people per square kilometre. This was problematic in that the vast majority of respondents (and people in Johannesburg) live in the two lowest density categories, being 0-10,000 and 10,000-20,000 ppl/km². Only 10 percent of respondents live in the five higher categories, ranging from 20,000 to 70,000 ppl/km². This is illustrated in Figure 3. While this method does effectively represent the different levels of density in the city, responses in each category would not be representative because such small percentages of respondents live in the highest density parts of the city.

The second method was to divide the data into density categories, each of which have the same number of responses. Ten categories were created, using class intervals based on response frequencies; the results

are shown in Table 1. While this method does provide very nearly the same number of responses per density category, it is limited in that lower density categories have much smaller ranges in density than higher density ones, as illustrated in Figure 4. While the second method was the one used during data analysis, its use was limited due to the skewed ranges of density. The highest density category ranges from 19,670.27 to 68,459.85 ppl/km², which does not sufficiently differentiate between those living in very high-density areas and those living in medium-density areas. For this reason, most of the findings in the study use mean density to compare responses to different questions in the QoL. However, results are clearly marked as being 'by mean density' or 'by density category' in the work.

FIGURE 3: Number of Respondents and Density per Sub-place in the City of Johannesburg

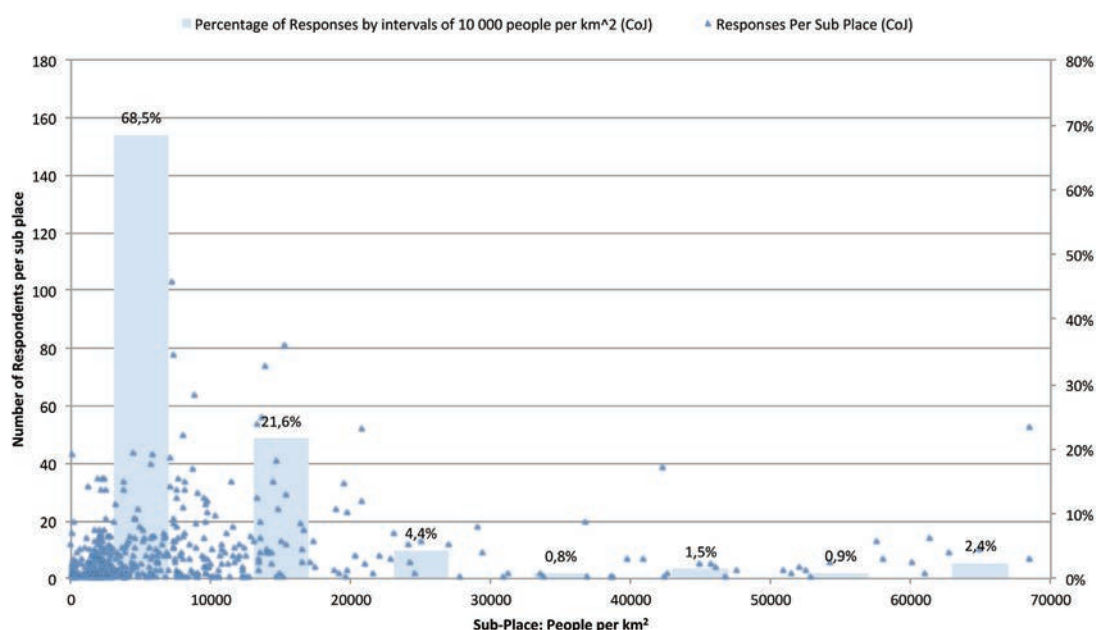
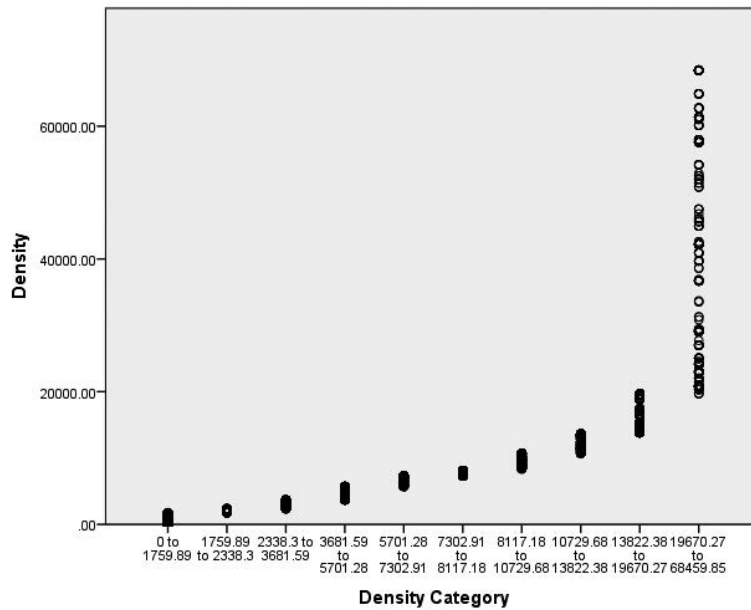


TABLE 1: Density Categories Divided to have Equal Responses⁹ per Category, City of Johannesburg

Density category (range: people per km ²)	Responses per category	Percent
Density unknown	9	.2
0 to 1,759.89	448	9.9
1,759.89 to 2,338.3	474	10.4
2,338.3 to 3,681.59	441	9.7
3,681.59 to 5,701.28	447	9.8
5,701.28 to 7,302.91	441	9.7
7,302.91 to 8,117.18	473	10.4
8,117.18 to 10,729.68	440	9.7
10,729.68 to 13,822.38	407	9.0
13,822.38 to 19,670.27	515	11.3
19,670.27 to 68,459.85	444	9.8
Total	4539	100.0

FIGURE 4: Density Categories with an Approximately Equal Number of Respondents per Category, Showing Density Ranges per Category



Density categories and individual densities for each sub-place, along with sub-place names and codes for each respondent, were then imported into the QoL dataset using the programme IBM SPSS 21, where all of the calculations and correlations were done.

It is acknowledged that the results may be somewhat skewed by non-residential land use (parks, business, roads, etc.) and by large, sparsely populated sub-places on the outskirts of the city. It is also acknowledged that the work does not investigate densification as such, but rather density. This represents a snapshot, using data sources from the same year, rather than looking at changes over time. These are unavoidable limitations of the data available. Positively, the data does cover the whole area of the City of Johannesburg, diluting these limitations, and is thus believed to paint a consistent and reliable picture.

Findings

Findings from the work are presented through graphs and tables depicting data, accompanied by discussion on each. The section starts by comparing modes of transport to density, looking at both QoL respondents' frequent transport types and the main forms of transport to school. It then presents findings on factors that correlate to whether or not people use public transport, with a specific focus on population density. Next, the section compares population density and income to whether or not people use public transport. The section ends by presenting two sets of data that give some indication of why people living in higher-density areas may use public transport more than those living in lower-density areas, including access to public transport, income and transport cost.

Modes of Transport and Density

Figures 5 and 6 below show main modes of transport and main modes of transport to school compared to the mean residential population density of respondents for each transport type. Broadly, the findings from these two datasets and the resulting graphs show that QoL respondents living in higher density areas use public, non-motorised transport and motorbikes more than those living in lower-density ones; the latter are more likely to use private cars.

The first notable finding and similarity between the two sets of data is the low average population density of adults and learners who travel using private cars. In each, 'car as driver' has either the lowest or second-lowest mean density (4,835.04 ppl/km² for general respondents and 2,975.20 ppl/km² for school-goers). The much lower figure for schoolchildren could be due to the fact that higher-income families generally live in lower-density areas in the city (see Figure 8). Here, the small proportion of children who drive themselves to school¹⁰ likely come from high-income families that can afford to buy them cars. Both figures are similar in the category 'car as passenger', and again very low in comparison to other modes of transport (5,450.87 ppl/km² and 4,677.37 ppl/km² respectively). In both instances, the category 'Car as passenger through a lift club' corresponds to higher population densities than other private car use (9,879.86 ppl/km² for general commuters and 7,118.06 ppl/km² for school trips). However, both of these are lower than the average population density of QoL respondents in the CoJ 10,213.3 ppl/km². Although these average densities are low compared to those of users of other forms of transport, they are still significantly higher than the categories 'car as passenger' and 'car as driver'. This may be attributed to economic factors – lower-income car owners may use this method to subsidise their transport costs – or to the fact that lift clubs in higher-density areas are more efficient and practical.

The second main finding depicted in Figures 5 and 6 is the higher use of public transport, non-motorised transport and motorbikes in higher-density residential areas. This is most evident in Figure 5, where the six

FIGURE 5: Main Transport Type by Mean Density¹²

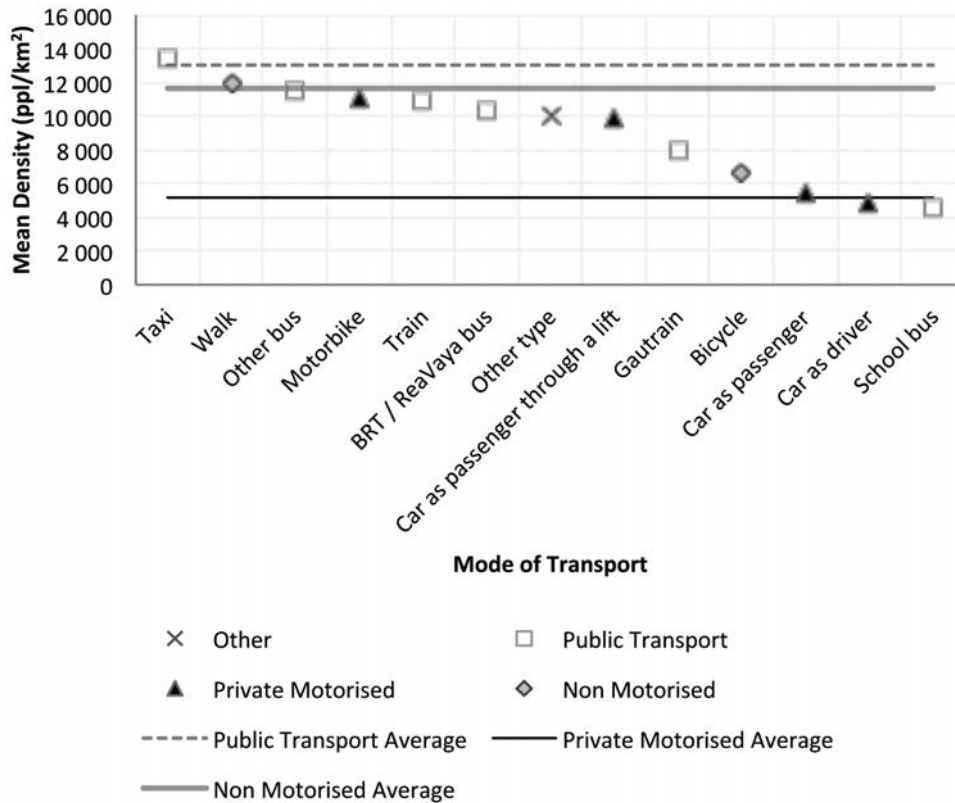
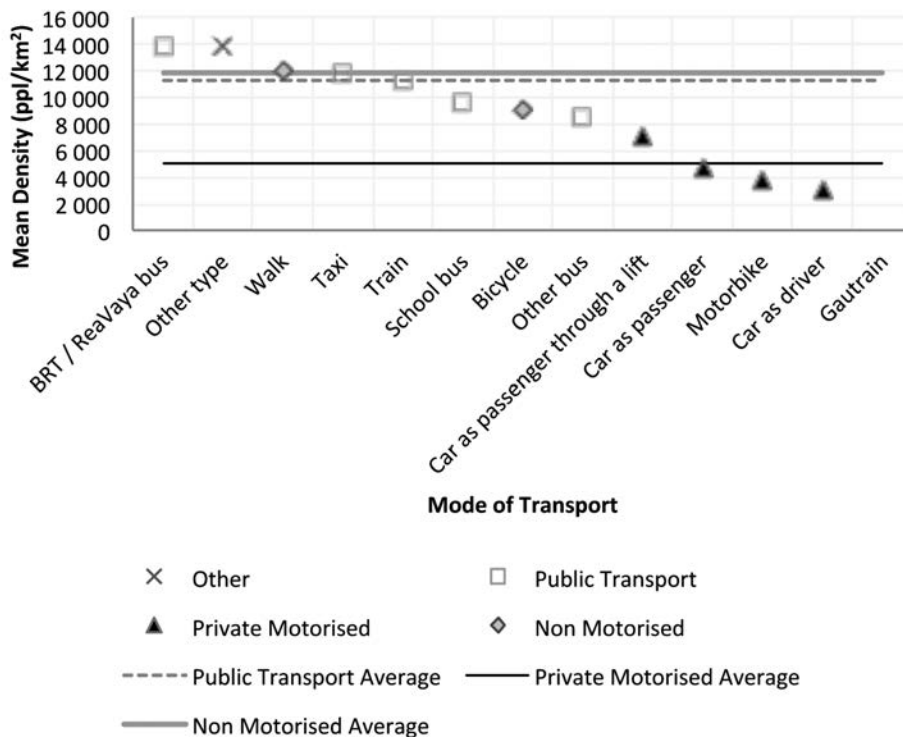


FIGURE 6: Main Mode of Transport to School by Mean Density¹³



highest mean densities for transport types are 'taxi' (13,433.87 ppl/km²), 'walk' (11,900.23 ppl/km²), 'other bus' (11,528.27 ppl/km²), 'motorbike' (11,090.86 ppl/km²), 'train' (10,955.94 ppl/km²) and 'BRT/ReyaVaya bus'¹¹ (10,285.72 ppl/km²). This is also shown in both graphs by the inclusion of average densities for the groups 'public transport', 'private motorised transport' and 'non-motorised transport'. In both graphs, the average population density of those who use public transport is much higher than those who use private motorised transport. For general travel, the average density for public transport users is 11,197.36 ppl/km², more than double the average for private motorised travel (4,950.40 ppl/km²). This is important in that it starts to back up common statements about the public transit benefits of higher densities touched on in the introduction to this paper.

The first major disparity in the two graphs comes in the density figures of the category 'motorbike'. While motorbike drivers who are general commuters live on average in relatively high-density areas (11,090.86 ppl/km²), school-goers who use motorcycles live, on average, in much lower-density areas (3,691.12 ppl/km²). Here again, it is thought that this relates to the fact that a small proportion of pupils travel to school by motorbike, and that those who do are likely from high-income and low-density families. From Figure 5, the significance of the high average density of motorcycle users is that higher-density urban dwellers, even when using private motorised transport, emit less carbon and contribute less to road congestion. This is only positive, however, in comparison to private cars, since carbon emissions from motorbikes are far from negligible (Vasic & Weilenmann, 2006). The disparity here may also be due to the low number of respondents who use motorcycles as their main mode of transport or as the mode of travel to school (seven in each case). It is assumed that these frequencies (around 0.2% of responses for each question) represent a very small number of motorcycle users, and the representativeness of the figures is not significant enough to permit any meaningful conclusions.

The second disparity is seen in the categories 'bicycle' and 'walk', which have been grouped in this work as 'non-motorised transport'. As is seen in Figures 5 and 6, for general transport the average density of public transport users is higher than for non-motorised transport, while the opposite is true for school-goers. The main reason for this is that, proportionally, fewer children use public transport to go to school (27.54%) than general commuters (60.72%). At the same time, a greater proportion of school-goers walk or cycle to school (51.1%) than those who do so for general commuting (8.88%). While the average density of walkers is similar in both graphs, the density of children who cycle to school is higher than people who cycle for their general commute.

Density, Income and Public Transport Use

A useful question in the QoL data for this study was, 'Do you ever use public transport such as buses, minibus taxis, trains, etc.?' with a yes or no answer given. While it has already been shown that over two-thirds of respondents indicated that they do use public transport, and over 60% use it as their frequent mode of transport, this section looks at density and income as correlating factors. The results show that both income and density correlate to public transport use and, interestingly, across all income brackets people living in higher-density areas are more likely to use public transport.

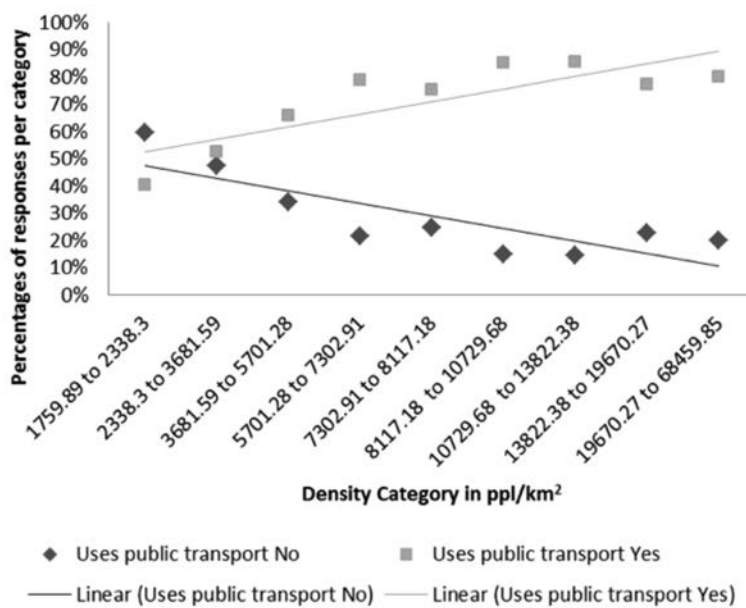
TABLE 2: Mean Density of QoL Respondents who do and do not use Public Transport in the CoJ

		Mean Density (ppl/km ²)
Uses public transport	No	7,607.27
	Yes	11,388.67
	All QoL Respondents	10,213.3

The first indication of the relationship between density and public transport use is seen in Table 2, which compares the mean densities of users and non-users of public transport. The average density of those that do not use public transport is below the average density of respondents in the QoL, while the mean density of public transport users is above the overall average. The difference between the two mean densities is also significant, with the mean density of those who use public transport almost 50% higher than those who do not.

Figure 7 gives the second clear indication of the relationship between density and the use of public transport. For each density category, the light data points indicate the percentage of respondents who use public transport and the dark, those who do not. There is a clear pattern here. There is a direct relationship between density and the use of public transport, and an inverse relationship between density and the non-use of public transport. In other words, the higher the density where people live, the higher the percentage of them report using public transport, and vice versa. Interesting, however, and relating to the fact that more people in the QoL survey report using public transport than those who do not, is that only in the lowest density category (1,759.89 to 2,338.3 ppl/km²) are there more people who do not use public transport than those who do. In the other nine categories, more people use public transport than not. As categories increase in density, the gap between users and non-users generally gets bigger, as indicated by the linear trend lines in Figure 7. This is *generally* the case because in the two highest density categories, the gap between public transport users and non-public transport users does narrow. The reason for this is unclear, but may be due to the much wider density scales in the highest-density categories, as explained earlier in the method section.

FIGURE 7: Percentage of Responses per Density Category that use and no not use Public Transport



As is shown in Figure 8, there is a direct relationship between density and income, where lower-income households are located in higher average density areas and vice versa. From this, the question arises whether the use of public transport is mainly related to household income, which happens to relate to density. This necessitates a comparison of public transport use, mean density and income. Results from this comparison are shown in Figure 9. First, the downward angling trend lines reiterate the inverse relationship between density and income. What is significant, however, is to note the gap between the two trend lines and the two series of data they represent. The graph shows the average densities of those who use public transport and those who do not in each income category. The data shows that in all income categories, users of public transport live in higher-density areas than non-users. This is significant in that it shows that while income has a substantial influence on whether or not people use public transport, density is an important influencing factor, too. The higher the density of the area in which they live, both high and low income households are more likely to use public transport.

FIGURE 8: Mean Density Per Household Income Bracket

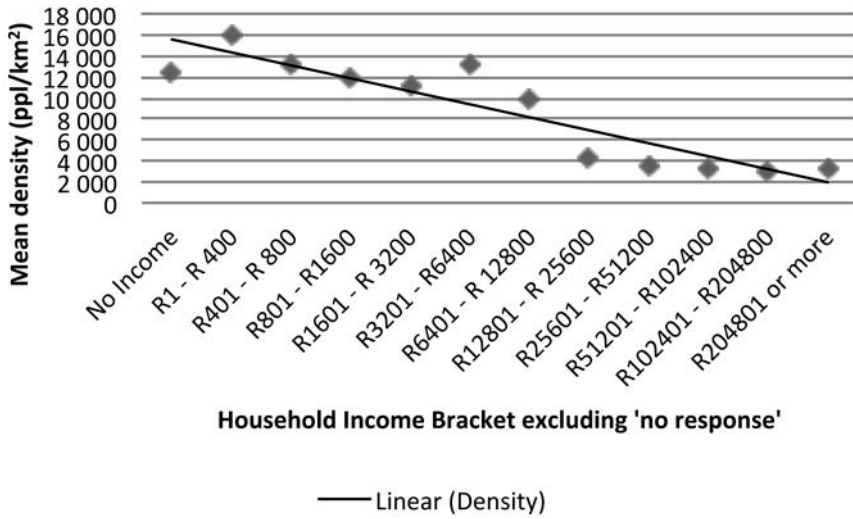
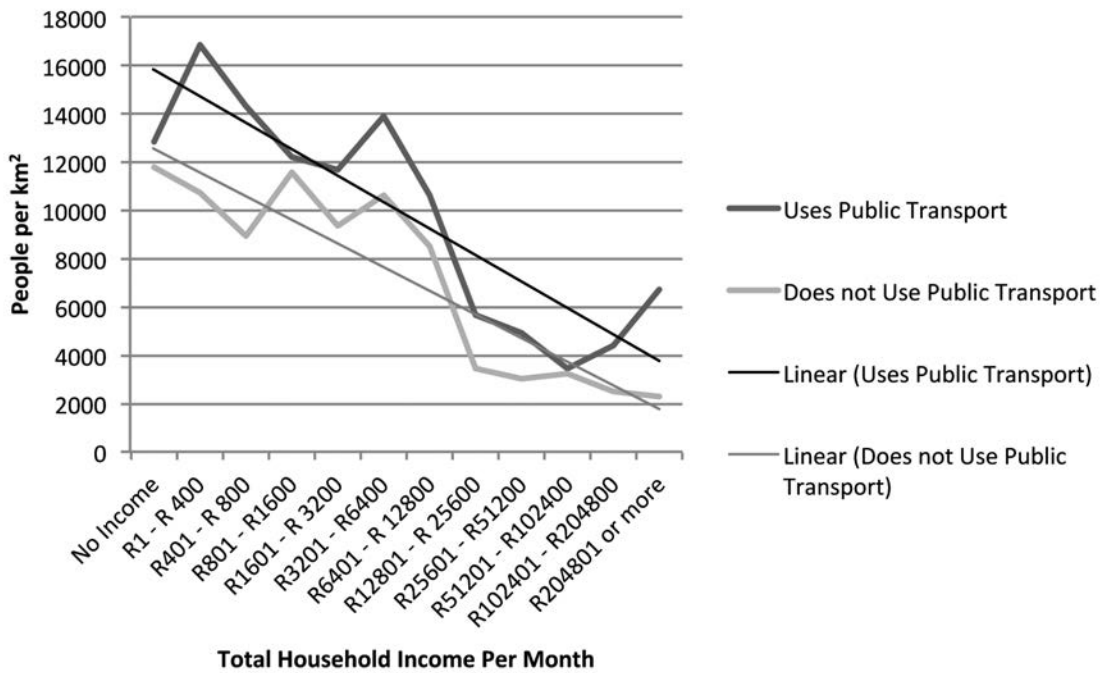


FIGURE 9: Public Transport Use by Mean Density and Income Category¹⁴



Influencing Factors on Density and Public Transport Use

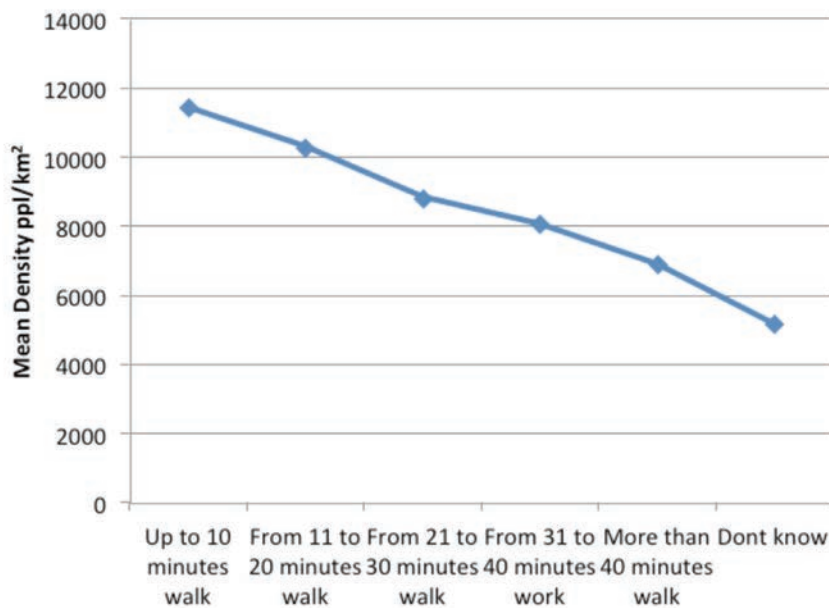
Based on the findings presented so far as to the links between density and transport, this final section briefly presents findings from the data that suggest why people in higher-density areas use public transport more and vice versa. While the answer to this question is clearly a complex one including many, often unquantifiable factors, this section does not seek to be comprehensive and only presents empirical findings from the data. These relate to access to public transport and cost.

Figure 10 simply compares walking time to public transport categories to mean density. This is a clear indication of the link between density and public transport use. Clearly, there is an inverse relationship between the two factors. Walking times to public transport increase as density decreases. This is likely not a universal relationship, and relates to the specific urban form and pattern of public transport provision in Johannesburg. What it does confirm, though, is that in Johannesburg, public transport networks (whether designed and implemented by the state or the market) tend to cater to higher-density areas. This is likely due

to the higher demand for public transport in more densely populated areas, based simply on the fact that there is a larger market in a small area, as well as the need for more affordable transport in higher density and generally poorer parts of the city, as shown below. It also highlights the fact that public transport networks do not adequately service lower-density parts of the city, as stated by the Council for Scientific and Industrial Research (CSIR):

In most medium- to high-income areas, only rudimentary services exist which can barely be considered an alternative to the motor car. Accordingly, public transport services in South Africa have been designed to serve the perceived need to assemble labour from distant suburbs and satellite low-income dormitories, at centralised workplaces (CSIR, 2000, p. 1).

FIGURE 10: Walking Time to Nearest Public Transport by Mean Density



As was shown in Figure 8, poorer people generally live in higher-density areas in the CoJ, while richer people live in lower-density areas. Table 3 shows that the average monthly household travel cost for non-users of public transport (R 1,024) is about a third higher than for those who use public transport (R 679). Figure 11 compares the monthly household cost of different main modes of transport in the city. The graph reiterates the cost difference of main modes of transport, showing private motorised transport to be the most expensive, public transport to be the second-most expensive and non-motorised transport to be the cheapest. Figure 12, the final figure for this section, then relates density to household travel cost. Again, a clear relationship is seen. Generally, households living in higher-density areas spend more each month on transport than those in lower-density areas. These three sets of data show that there is a clear link between income and the use of public transport, but that it is also intrinsically linked to population density. While it is important to show that, in absolute values, poorer people spend less on transport each month than wealthier people, it is important to note that they spend much more as a proportion of their monthly income (Statistics South Africa, 2013).

TABLE 3: Mean Monthly Household Transport Cost for Users and Non-users of Public Transport

		Monthly household transport cost	
		Mean	
Uses public transport	No	R 1,042	
	Yes	R 679	

FIGURE 11: Mean Monthly Household Transport Cost by Frequent Mode of Transport¹⁵

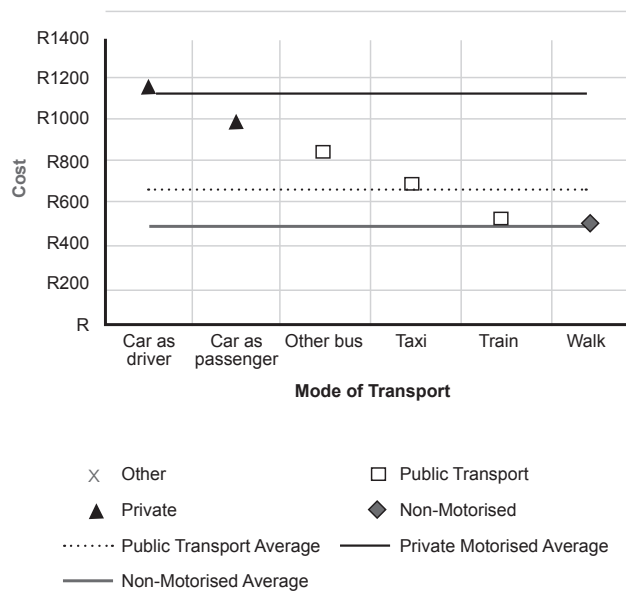
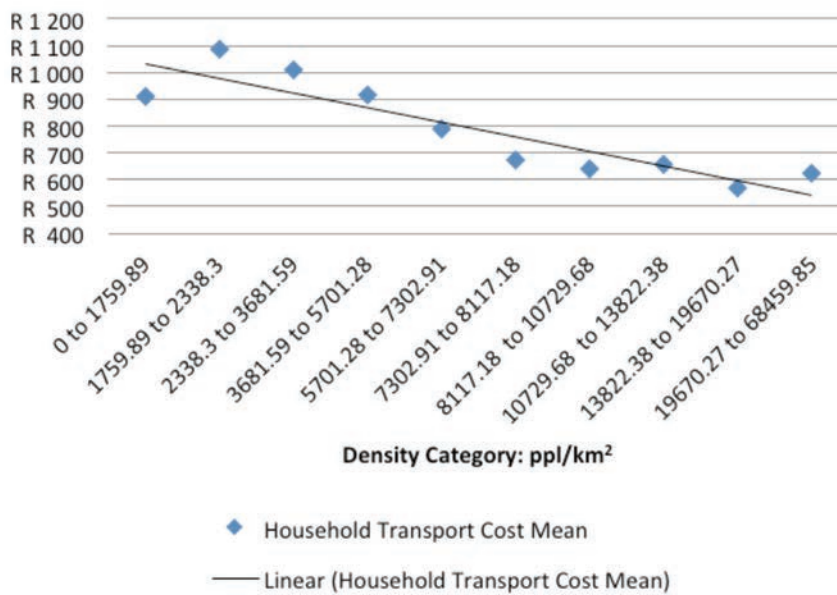


FIGURE 12: Mean Household Transport Cost by Density Category



Conclusion

In the City of Johannesburg, there is a clear link between the modes of transport people use and the population density of the areas where they live. Results from this study broadly show that higher-density urban dwellers are more likely to use public and non-motorised forms of transport, while lower-density inhabitants are more likely to use private motorised transport. While this link is clear, it cannot be looked at in isolation from other factors, including income. The work has shown that there is a clear inverse relationship between household income and gross neighbourhood density, as well as between monthly household transport cost and density. For this reason the question is raised whether household income is in fact the main factor influencing the density people live in and the modes of transport they use. What the work also showed, however, is that within different income categories, density is linked to whether or not people use public transport. Within all income categories, respondents who use public transport live in higher-density areas than those who do not. What can be said from this is that both income and density influence people's choice of transport use in the City of Johannesburg, and that, across income categories, higher-density areas are generally better located in terms of public transport.

The correlation between population density and public transport use that this study has shown cannot prove causality. It cannot be said with any certainty whether higher densities promote the rollout (publically or privately) of public transport services, or if the existence of public transport services promote densification. The likelihood is that it is a bit of both. Investments in public transport routes and stations, whether public or private, must relate to the demands of the market that uses the services, with density around stations seemingly being one of the indicators for this. At the same time, as is suggested in the following paper by Geoffrey Bickford, public transport investments must be accompanied by planning interventions (including strategic densification) to make them more effective and viable. While this is by no means a new idea, this work has added some empirical evidence to back up statements on the positive relationship between high population densities and public transport use, such as:

A high density of development is important for public transport, in that it supports differentiated public-transport provision and enhances operating efficiency (CSIR, 2000, p. 2).

NOTES

- 1 Note, however, that these are respondents who do or don't use public transport at all and not necessarily as their *frequent* mode of transport
- 2 This is part of a series of questions which first asks what the purpose of the respondent's most frequent trip is, followed by how long it took, the different modes of transport used in the trip and (the source of data used here) the mode of transport used for the longest part of the trip. Question number 4.6 (Gauteng City Region Observatory, 2011b).
- 3 This refers to privately run minibus taxis that transport multiple people on set routes as opposed to smaller metered-type taxis that transport people 'door to door'.
- 4 Walking and Cycling
- 5 In this chart, modes of transport that make up less than 1% of the total are grouped into 'Other' including; 'Gautrain' (0.12%), 'Other type' (0.39%), 'BRT/Reya Vaya Bus' (0.27%), 'School Bus' (0.27%), 'Motorbike' (0.29%), 'Car as Passenger' (0.91%) and 'Bicycle' (0.48%). Data from question 4.6 (Gauteng City Region Observatory, 2011b).
- 6 In this chart, the category 'other type' has been excluded. 'Public' includes: 'Train', 'Other bus', 'Gautrain', 'BRT/Rea Vaya bus', 'School bus'. 'Private Motorised' includes: 'Car as driver', 'Car as passenger', 'Car as passenger through a lift club', 'Motorbike'. 'Walk and Cycle' includes: 'Walk', 'Bicycle'. Question 4.6 (Gauteng City Region Observatory, 2011b).
- 7 Statistics South Africa is the national statistical service in South Africa, and is the organisation that conducts and publishes the National Census every 10 years as well as many other surveys and statistical releases (Statistics South Africa, 2010).
- 8 These 'suburbs' are officially known as 'townships' in the City of Johannesburg. The word suburb is used to avoid confusion with the more common use of 'township' in South Africa, which colloquially refers to previously black dormitory towns set up by the apartheid government on the outskirts of cities and towns.
- 9 These are not exactly equal due to irregular numbers of responses between sub-places in the city.
- 10 This is such a small proportion because, generally, pupils only become eligible for a driver's licence in their last year of school, when they turn 18.
- 11 Johannesburg's Bus Rapid Transit system, ReyaVaya, was introduced on 30 August 2009. The system is set to roll out in phases (Gauthier & Weinstock, 2010). Phase 1 is now in operation "with 134 buses and 13 stations... with new routes that connect Parktown and Soweto through Auckland Park, Westbury and New Canada" (Makgoga, 2013, p. 1). Further phases of the system are yet to be laid out, but the aim is to develop a network of 330 km of BRT corridors which would be accessible to 80% of Johannesburg's population.
- 12 Average density lines in this graph are not the average of the points depicted in the graph, but averages of all respondents for the each category. As many more people report using taxis and buses than Gautrain, for example, the average is closer to the first two categories than 'Gautrain'. The category 'other' was excluded in these average calculations.
- 13 Footnote 12 applies to this graph, too.
- 14 The income category "Response Not given" is excluded from the graph.
- 15 This chart includes only respondents who answered both the questions on frequent mode of transport and monthly household transport cost. Because of this, the sample size for this graph is relatively small (1138) when compared to the rest of the work. All modes of transport with less than 30 responses were excluded. This data represents the remaining 1117 responses. Averages were calculated as in Footnote 10, however only using the 1117 valid responses.

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2

BRT Impacts at a Neighbourhood Level: Insights from Diepkloof

Geoffrey Bickford

Abstract

Apartheid-based, inefficient and unequal spatial patterns are intrinsically linked to the state of transport in South African cities. Many people are forced to commute daily over long distances for extraordinarily long periods. This has prompted a drive to invest in the improvement of South African public transport systems. There has been a significant level of investment in public transport across South African cities over the past decade, largely galvanised by the hosting of the 2010 Fifa World Cup, towards improving the public transport services available in South African cities. The fundamental premise of such investments is that they have the potential to improve the access and mobility available to people living in cities, but can simultaneously provide the developmental impetus required to restructure the apartheid city.

This study focuses on the Johannesburg BRT system, Reya Vaya, and seeks to assess the impact the system is having at a neighbourhood level. The Diepkloof Station is used as a case study to understand its impact on the surrounding area. The research used a combination of quantitative and qualitative data, general observation and a range of secondary data sources to arrive at its findings. While the findings are of an indicative nature, they do begin to raise discussion around the BRT's impact in Diepkloof and possibly other areas in Soweto.

Findings around access and mobility benefits contribute to the argument that densification is required around BRT stations throughout Soweto. In this regard, a more nuanced approach to Transit-Oriented Development (TOD) is suggested to ensure that greater opportunities are created that would enable more people to benefit from the improved access and mobility which the system provides. Furthermore, the research findings around the perceived impact of the Diepkloof Square shopping centre highlight that aspirational dynamics are critical when considering the perceptions of the impact of urban developments.

Introduction

The distorted settlement patterns associated with apartheid planning have resulted in a spatial landscape which is extremely inefficient and deeply divided. During apartheid, transport systems were designed to facilitate segregation and discrimination. The predominant investment in infrastructure oriented to private vehicles, mainly in previously white areas, has exacerbated the poor levels of access and mobility in South African cities as the majority of individuals in marginalised communities cannot afford private cars. This legacy has stubbornly persisted in the post-apartheid era despite major transformative intent. Today South African city contexts are characterised by sprawling, relatively low-density, mono-functional development (driven by both private and public-sector investment), and largely facilitated by privately owned motorised transport, be it automobile or mini-bus taxi.⁷ This has resulted in a context where many poor people live extraordinarily far from places of economic opportunity and are forced to travel long distances for long periods every day (Behrens and Wilkinson, 2003).

There has been a sustained effort over the past decade, largely galvanised by the hosting of the 2010 Fifa World Cup, towards improving the public transport services available in South African cities. The mutual dependency of transport systems and land use patterns (Newman and Kenworthy, 1996; Cervero, 2001) were an underpinning factor of the emphasis on public transport in the 1996 white paper on national transport policy. The socio-spatial transformative understanding continues to filter through the thinking behind investing in public transport systems. The fundamental premise is that high-quality² public transport systems have the potential to improve access and mobility for a greater proportion of the urban population, and at the same time provide the developmental impetus required to restructure the apartheid city. This is highlighted in the claim that “BRT ... had significant potential to alleviate poverty and redress historical apartheid town planning...” (Gauthier & Weinstock, 2010, p. 319).

There has been significant investment in public transport across South African cities over the past decade. This investment has given rise to a new regional rail system in Gauteng, the Gautrain, and Bus Rapid Transit (BRT) systems in Johannesburg and Cape Town, with many other cities set for phase 1 BRT completion in coming years. It is thus paramount that reflective research be conducted on these systems to understand whether they are generating the envisioned impacts in terms of access, mobility and transformation of the built environment.

This research paper is located within that context, focusing specifically on the Johannesburg Rea Vaya BRT system. The first phase of the project became operational in late 2009, completed in time for the hosting of

the 2010 FIFA Soccer World Cup. However, the City of Johannesburg had shown commitment to developing a BRT as early as 2006, with the initial thinking explicitly linked to urban transformation. The first phase was intended to be developed along Oxford Road, linking Parktown to Sandton. However, through a series of developments which are not the focus of this paper and the influence of the World Cup, a decision was made to develop phase 1A from the inner city to Soweto, an area south-west of the city which was developed during apartheid as a dormitory black township.

BRT is touted as an affordable rapid transit system which can offer competitive road-based public transport (Gilat and Sussman, 2002; Cervero, 2013a, 2013b). Curitiba in Brazil and Bogota in Colombia are two South American cities which have pioneered BRT development (Gilat and Sussman, 2002). The City of Johannesburg has been particularly influenced by Bogota's Transmilenio BRT system, and CoJ officials attended a working tour to Colombia to learn more about the system prior to implementation. As such the Johannesburg system is modelled on the Bogota system, with stations developed in the median of the roadway.

To date there has been limited research assessing whether public transport investments such as Johannesburg's Rea Vaya BRT are achieving the envisioned policy objectives. However, there is a growing body of evidence. While this study is by no means comprehensive, it is intended to contribute towards understanding BRT impacts. It should also be acknowledged that the research might not be able to fully assess the impacts of a system which has been in operation for little over four years.

It is critical to acknowledge that there are a wide variety of factors which underpin changing dynamics in a specific locality (Suzuki, Cervero and Luchi, 2013). It is thus challenging to ascertain the extent to which the BRT systems are leading to change. However, the premise is that the BRT is a relatively large-scale investment and provides a fundamental change in the manner in which people travel in South African cities. Urban planning and economic theory support the notion that public transport provides the impetus for more intensive land development or redevelopment (Harvey and Jowsey, 2004). Although this paper will not provide an in-depth engagement with these various theories, they are important to reflect on when considering the research findings.

While the findings are indicative, they do begin a discussion around the impact which the BRT is having in Diepkloof and possibly other areas in Soweto. The research for this paper was based on the Diepkloof Station and the surrounding areas within Diepkloof Zones 3 and 4. The major findings are:

- There was a resounding perception that the BRT has had a positive travel and lifestyle impact on the people who use the system.
- There was an observed impact in the manner in which users walk to the station from various parts of the surrounding areas.
- There is a clear indication that there has been an impact on the local taxi operators, who have lost business as a result of the BRT.
- Although there has been relatively significant development activity over the past decade, the impact which the BRT station and system has had on the building intensification is less clear.
- There is no clear indication that the BRT has benefited businesses located in close proximity to the station.
- The privately developed Diepkloof Square shopping complex (which is located on municipally owned land) has limited connection to the BRT investment but has had a number of significant impacts on the area:
 - an overall reduction in population density (the land previously accommodated a densely populated informal settlement);
 - a positive impact on the ability of people to access a range of goods and services which they would have previously had to travel outside of the area to access;
 - a negative impact on small retail business operators (local, informal shops and market stalls to the south of the shopping centre).

While the BRT has improved the levels of accessibility and mobility for people living and working in Diepkloof, the shopping centre development seems to have had a more prominent impact on the minds of Diepkloof residents than the BRT system.

A brief literature review is provided before unpacking how the research was carried out. This will be followed by a contextualisation of Diepkloof. The research outcomes will then be presented and discussed. The report concludes with a discussion of the impacts of the BRT system on the surrounding Diepkloof area, and provides some reflection on the findings.

Literature

Many cities around the world have invested in BRT systems due to the affordability of the mass transit service that they provide (Gilat and Sussman, 2002; Cervero, 2013b). Because of this, there is a growing body of literature and research focusing on BRT. The majority of research has been conducted outside of South Africa. However, some studies specific to South Africa are beginning to emerge around assessing the performance and impact of BRT systems. This section provides a brief overview of the international and local literature which exists.

International literature

With regard to the impact of major public transport projects (largely rail) on land, property and urban space, there is an extensive body of international literature. There is significantly less literature which exists on this topic specifically regarding BRT (Deng and Nelson, 2010). However, a growing body of literature is emerging on the land and property development impacts of BRT systems as there is increasing global investment in these road-based systems. There is growing evidence that BRT systems do lead to increasing land values and create development opportunities similar to rail projects (Deng and Nelson, 2010; Cervero, 2013a; Hook, Lotshaw and Weinstock, 2013).

Hook et al. (2013) go further to argue that the development returns around BRT systems are greater than those around rail. This is mainly because BRT systems are cheaper to build than rail systems but can derive similar development opportunities. However, Cervero (2013b, p. 1) offers a view that to date 'BRT systems have failed to leverage compact, mixed-use development due not only to limited strategic station-area planning but also factors like siting lines and stations in stagnant urban districts and busy roadway medians'. Given the aim of the research, these arguments are particularly pertinent, and will be drawn on later in the paper to reflect on how these understandings situate themselves in a South African context.

According to Cervero (2013b) a relatively extensive literature has emerged in the developing world around the mobility benefits of BRT. This literature argues that BRT systems provide rail-competitive operational characteristics while being generally more affordable (for both operators and users). In South Africa, research on BRT impact and performance is fairly limited, arguably due to the relative infancy of the systems. Of the research which does exist, much of the focus is on the accessibility and mobility aspects of the systems. Cervero (2013b) advocates that in order to extract maximum value from BRT investment, a broader urban development approach and understanding needs to be developed which moves away from a narrow focus on mobility.

South African specific research: an emphasis on poverty reduction

The limited reflective research which has been carried out on the impact of BRT systems in South Africa has focused on poverty alleviation (Maunganidze, 2011; Vaz and Venter, 2012). This is understandable as improving the levels of access and mobility for poorer people in South Africa has been a prominent component of South African transport policy. Maunganidze's (2011) work focuses on Cape Town's My City BRT system; her main finding is that the project has not yet afforded improved mobility and accessibility levels to poorer people living in Cape Town.

Vaz and Venter's (2012) study focuses on the Johannesburg Rea Vaya BRT system. The study attempts to understand the poverty-reduction impacts associated with BRT to date. It uses a station case study approach; a sample survey was conducted on households living in close proximity as well as at a relative distance from the BRT (where access advantages to the system are not experienced). This provided the basis for a comparative assessment of areas which displayed similar characteristics but which had different spatial proximity to the BRT system. The study concluded that although the BRT seems to be contributing to improvements in transport availability in the area, these improvements are skewed towards the middle class rather than the poorest people. It is argued that this is largely due to the price of the service, which is higher than rail prices. This tendency to service the middle class has more than likely increased over time as the price of using a BRT bus in Johannesburg has generally become more than using a minibus taxi. Here the nature of the system's impact on the poor is dependent on the "availability of other modes, pricing policy, and destinations served" (Vaz and Venter, 2012, p. 630). They further caution that BRT is not automatically associated with poverty reduction.

Building on the existing reflective studies conducted to date, this study attempts to understand the impact which the system is having on surrounding neighbourhoods in terms of built urban form but also in terms of people living and operating in the neighbourhood. South African based studies of this nature, assessing the impacts of BRT at the local level seem to be non-existent. This study aims to provide a nuanced perspective on the impact of the BRT on a local neighbourhood serviced by the Rea Vaya BRT system.

Research method

The research aimed to understand the impact which the BRT infrastructure has had on a neighbourhood surrounding a BRT station in Soweto. The research approach necessitated selecting a case study station (see Annexure A). The perspectives of BRT users were captured through a short quantitative survey. The perspectives of residents and business owners, who could be either BRT users or non-users, were captured through qualitative interviews. General observations which were made by the author during fieldwork have been filtered into the findings. A range of secondary data sources have been drawn upon to support the research. These methods are detailed below.

The quantitative component

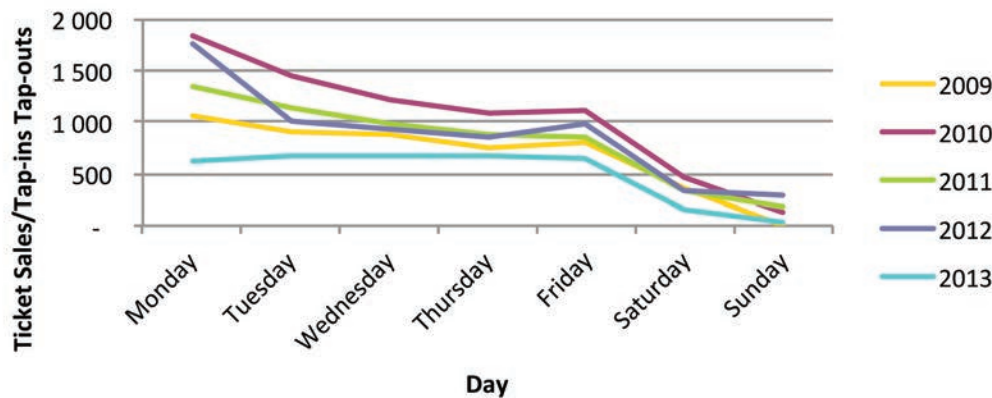
Quantitative interviews were conducted at the selected station to gain a snapshot understanding of the people who access the Rea Vaya system using the Diepkloof Station. This included gaining insight as to how they were getting to the station and how they were interacting with the urban environment around the station (See Annexure B for the survey form). This quantitative component of the research serves as a source of primary data collection, but was not intended to provide an in-depth profiling and analysis of the BRT users at the station. To reiterate, it was rather intended to provide indicative insight into the manner in which the station potentially influences people's interactions with the broader environment.

The quantitative interviews were carried out at the Diepkloof Station on 1 November 2013 from 06:30-08:30. Two researchers (the author and an assistant) conducted the interviews, which took approximately two to four minutes each to complete. Respondents were selected randomly from passengers boarding and alighting at the station; 71 BRT users were interviewed during the survey period.

A secondary dataset of ticket sales and tap-in/tap-outs was obtained from the City of Johannesburg in an attempt to contextualise the primary data collected during the station-based interviews. Important to note is that midway through 2013 the ticketing system for the Rea Vaya system was changed from paper to smartcard-based tickets. This is important to note for two reasons. Firstly, the change to a smartcard-based system had a significant impact on ridership due to price increases and uncertainty around how the new system worked. Secondly, the manner in which ticketing or passenger data is collected by the City changed with the introduction of the new system. This change makes it difficult to accurately compare data collected from the survey period with the City's existing data.

Figure 1 shows the Diepkloof Station ticket sales data from November 1 to November 7, from 2009 to 2012, as well as the tap-in/tap-out data from 2013. Ticket sales did not necessarily take place at stations, and often do not correlate with ridership numbers. What Figure 1 perhaps suggests is that some people bought all their paper tickets for the week on Mondays. Tap-in/tap-out data correlates more directly with ridership numbers as it records entry into the system when a passenger actually makes use of the system. This might begin to explain the relatively large difference between a Monday in 2013 and those in previous years. However, due to the stated impacts of the smartcard on ridership volumes, the assertion that the change in data collection method is responsible for the discrepancy cannot necessarily be made. The tap-in/tap-out data collection method will provide a far more accurate passenger number database across the entire system moving forward.

FIGURE 1: Ticket sales for 1-7 November 2009-2012, and tap-ins/tap-outs for 1-7 November 2013 for Diepkloof Station



Source: City of Johannesburg; author responsible for analysis and graphic.

Diepkloof Station data obtained for Monday 1 November 2013 recorded 623 total tap-ins at the station (see Annexure C). The data is not provided on a time basis so it is uncertain how many of the tap-ins took place in the morning period from 06:30-08:30. However, based on data collected, 96% of respondents *boarded* at the station. This shows that in the morning period the station serves mainly as an origin location for BRT users. General observation largely supported this finding.

Qualitative interviews: understanding change from a resident's perspective

Qualitative data was collected in an attempt to gain insights as to how the BRT system has impacted on people living and/or working in Diepkloof (including users and non-users of the system), as well as how it has impacted on physical spatial change. This type of data collection involved interviewing people living and working in Diepkloof. The approach to the interviews entailed walking through Diepkloof Zones 3 and 4 within 750 metres of the Diepkloof Station and identifying possible respondents. People were randomly collected and had no prior knowledge of the research or the interview. The interview strategy was to ask how long the individual or individuals had been living or working in Diepkloof and why they had located in the area. This was followed by asking them to explain the changes they had noticed in the area during their time spent living and/or working in Diepkloof. The broad and open-ended nature of the questions encouraged a conversation-style interview. If there was little or no mention of the BRT in respondents' answers, then more specific questions around the BRT were directed at respondents near the end of the interview to focus their minds on the potential identified impacts of the system (see Annexure D).

The interviews were carried out over the course of two days (21 November 2013 and 28 November 2013) from approximately 09:00-14:00. Twelve respondents were interviewed over the two days. The respondents

represented residents (home owners and tenants), business owners and employees. Annexure E provides a profile of each of the respondents. Their identities and the location of the interviews will remain anonymous, as it is believed that providing that information will not contribute significantly to the research while it might compromise respondents. All interviews were recorded, translated and transcribed.

Qualitative interviews were central to the research as they provided a series of narratives from various residents' perspectives on how the area has developed and changed over time and how, in their minds, the BRT has affected the area.

General observation

The time spent conducting research in the area provided an opportunity to make general observations from a non-resident or frequent BRT user perspective. Observations of both the physical urban environment as well as the manner in which people interact with the urban space have been used to supplement the data collected.

Secondary data sources

A range of secondary data sources were drawn on to deepen understandings of particular components of the research. The City of Johannesburg's existing station data was drawn on in an attempt to contextualise the data collected, online literature sources were used to develop the contextual understanding of Diepkloof and Google Maps aerial photography and Google Maps street view photography formed the basis for spatial analysis.

It was envisioned that together these combined methods of research would provide useful multiple layers of information around the impacts which the BRT station is having on the urban area surrounding it. Before delving into the analysis of the data and information collected a brief contextualisation of Diepkloof is provided. The aim of this is to provide context for the reader, and a useful base from which to conduct the analysis.

Diepkloof in context

Diepkloof is an area situated in the south-west of the City of Johannesburg. The broader area comprises seven zones – the original township of Diepkloof and six additional zones. This research focuses on areas within Zones 3 and 4 (see Figure 2 (C)).

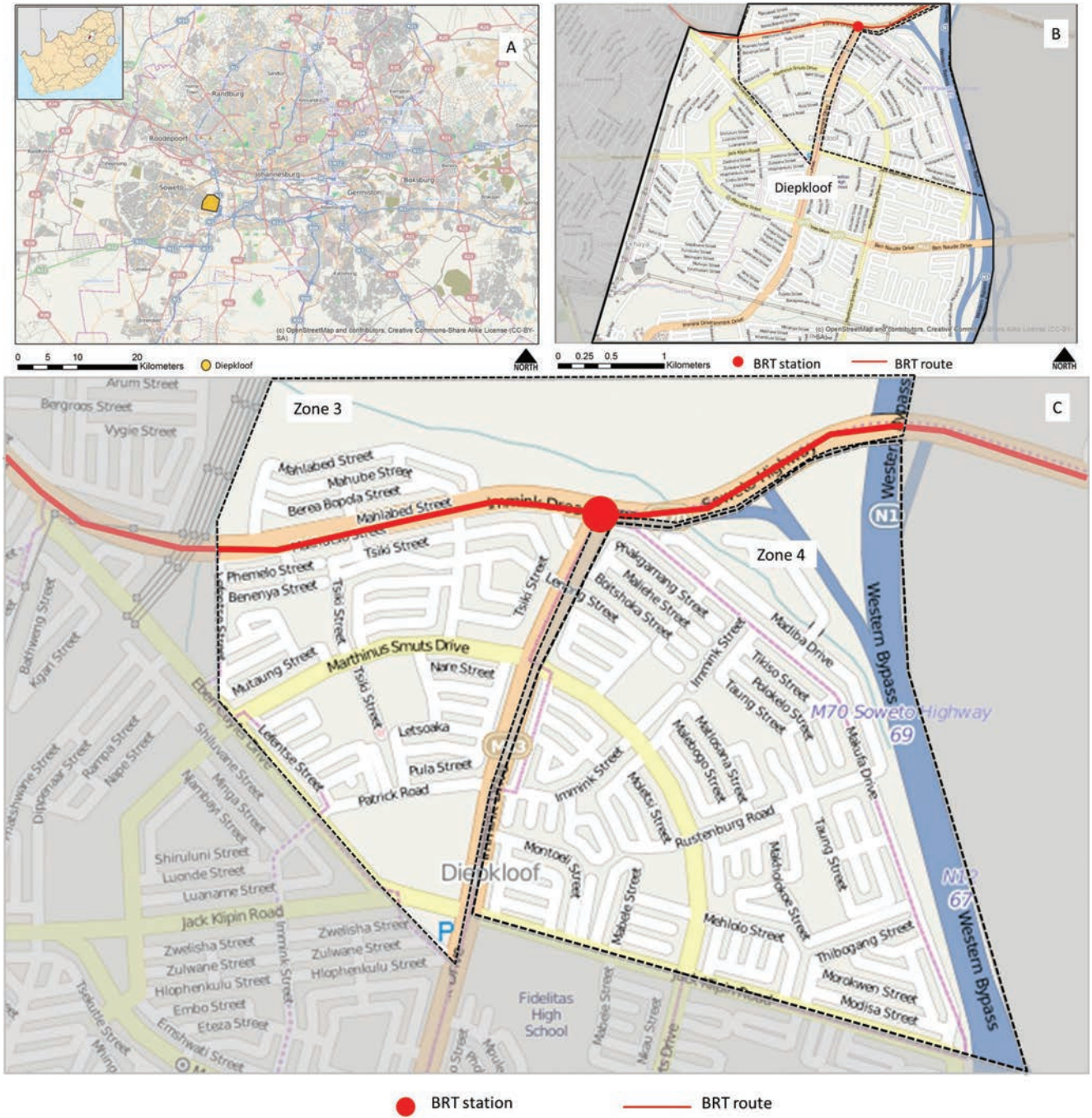
Diepkloof is located in Johannesburg's Region D. It is the closest township in the greater Soweto area to the Johannesburg inner city (see Figure 2 (A-B)). According to Gasennelwe (2011), Diepkloof was established in 1959 to accommodate the forced removal of black people from more centrally located areas in the city, predominantly Alexandra (Marx, Rubin and Progressus, 2008). This resonated strongly through the information obtained from elderly respondents, who had experienced these forced removals. The apartheid government provided small houses of three or four rooms in Diepkloof to black residents who had previously owned one-roomed houses in Alexandra (Marx et al., 2008). It was evident from elderly respondents that the number of rooms which comprised their houses was still considered to be very important, with many mentioning this in interviews.³

A brief historical perspective

It is evident from Marx et al.'s (2008) research that Diepkloof Zones 1 to 6 are not homogeneous. As mentioned previously, this research primarily focuses on Zones 3 and 4.

Marx et al. (2008) further highlight some critical contextual elements which came through strongly in the study area. First, household sizes tend to be large. Second, and linked closely to the first point, is the notion that homes are family homes, and there is a reluctance to sell houses. This is understood to be both a result of culture and of financial position. As such many people living in Diepkloof have been in the township since its establishment. As families have grown over time, household size increased as family members continue to live in the same house or in backyard units. Third, and linked to the first two elements, there exists a history of backyard unit development. This emanates from the fact that the layout plans were approved without conditions of establishment, thus allowing people in Diepkloof to develop as many units on their land as possible and to operate commercial businesses on the land (ibid.). According to Marx et al. (2008, p. 27), 'there were no density or height restrictions and as a result it was quite legal for Diepkloof residents to have as many structures on their stands as they could manage'. Although this was controlled at a later stage, it is evident that the legacy has persisted into the current period where the on-going building of backyard units and commercial activity is taking place on many housing plots.

FIGURE 2: The geographical context of Diepkloof (A-B) and the areas of focus for the study (C).



Source: Maps extracted from OpenStreetMap.org

Other critical elements which have emerged relate to the long-standing favourable status associated with living in Diepkloof. One respondent who was born in Diepkloof referred directly to the status he derives in broader Soweto because he lives in Diepkloof.

It's [referring to the status of Diepkloof] been there for as long as I've been aware of my surrounding. People in Diepkloof have always been proud of their area. I don't know. There's just something about it.... I can't put it into words... it's like a whole pride thing. People take pride in living here. Even if I go to Orlando, which is the next township from Diepkloof, and if I tell someone there that I'm from Diepkloof, they'd be like, "Yeah, I can tell". There's just something about a Diepkloof person. (Respondent 1, interviewed 21 November 2013).

This divide is alluded to by Marx et al. (2008), and was arguably established during the founding of the township.

Study area spatial analysis

FIGURE 3: Diepkloof Station contextual map and study focus area



Map Source: Aerial Photograph © Google Earth, 2014; Digital Globe, 2014. Overlays, Author

Figure 3 provides a spatial context of the study area. The research has largely focused on housing stands in close proximity to the station and southwards along Immink Drive to the shopping centre and previous bus station, now rented by the Johannesburg Property Company (JPC) to traders and also serving as a taxi rank. The predominant land use is residential but many housing stands occupy trading and retail activity, especially along Immink Drive. There is a small cluster of business stands directly opposite the BRT station, currently occupied by a petrol station and a restaurant/bar.

The changing physical context: a spatial analysis

There have been some obvious spatial changes, which are noticeable from Google Earth aerial photography over the period of analysis (2000-2013). These are analysed and discussed below.

Diepkloof Square

In the broader study area, the most profound change in land use has been the removal of the Mandelaville

informal settlement and the development of the Diepkloof Square Shopping Centre where the informal settlement previously existed (see Figure 4). The research has shown that this development has had a significant impact on the area. This will be discussed in more detail later in the paper.

FIGURE 4: Change in the use of the Diepkloof Square land 2000-2012.



Source: Images ©Google Earth, graphic by the author.

Brief insight into the development of Diepkloof Square

According to Charlton and Silverman (2004) and Mohlala (2002), Mandelaville informal settlement was removed by the City of Johannesburg in 2002. The land was owned by the municipality. As part of the research process, the JPC was approached to provide insight into the development of the shopping complex in relation to the removal of Mandelaville and the subsequent development of the BRT. The JPC indicated that the reason for the removal of the township was due to Diepkloof residents placing pressure on the JPC to develop the shopping centre (JPC representative, E-mail communication, 30 May 2014).

Charlton and Silverman's (2004) account of what Mandelaville residents experienced in 2002 indicates that many people were adversely affected by the forced removal to Durban Deep (some 10km North-West of the original site, as the crow flies). Many people lost employment, could not afford transport costs, fell increasingly sick due to poor living conditions, and were unable to draw on their previous social networks (Charlton and Silverman, 2004). Not all residents relocated to Durban Deep, and many attempted to find alternative accommodation in Diepkloof (often in backyard units), as they felt this was more viable than relocating to a peripheral area (Charlton and Silverman, 2004).

According to the Shanduka Investment Holding Company, which has a 52% stake in the Diepkloof Square Development:

In 2004 the City of Johannesburg Property Company invited developers to submit proposals for the development of a site at Diepkloof Ext. 3, Soweto. The site was formally [sic] the Mandelaville Informal settlement, and had subsequently been cleared to facilitate its developments.⁴

When the development process began in 2004, the initial plan was for the site to be developed into a mixed-use complex comprising a shopping centre, a residential component and some commercial space (Property 24, 2006). It was not until December 2011 that actual development activity started on site. The JPC explicitly indicated that the BRT had not informed any of the development decisions. This was confirmed in a discussion with the shopping centre manager, who indicated that he had been with the project since its early stages. An attempt was made to gain insights from the developer, McCormick Property Developers, but to no avail.

To date the mixed-use nature of the site has not materialised. The JPC has indicated that 'the demand for offices in Soweto is not prominent at present. We have not seen any real demand and residential townhouse demand is very price sensitive with a perceived preference for similar developments outside' (JPC representative, E-mail communication, 30 May 2014). It was noted that some demand for residential units was present along

Mooki Street in Orlando (two stops after the Diepkloof station on the BRT line into Soweto), and the JPC was 'packaging sites in response to BRT infrastructure' (JPC representative, E-mail communication, 30 May 2014).

The net result of the removal of Mandellaville was a dramatic decrease in the overall household and population levels in Diepkloof Zone 3. (See later section on census data analysis.) It is argued that the failure of such a large-scale property development investment to consider the BRT is a missed opportunity. This is especially so when the City of Johannesburg's strategic focus on transit-oriented development (TOD) is considered.

Formal housing stand densification

Another relatively clear spatial change is the infill densification which has occurred within formal housing plots in Diepkloof Zones 3 and 4 (see Figure 5). The analysis indicates that fairly high levels of building activity occurred between 2001 and 2009 within the analysis area, with evidence of further additional structures between 2009 and 2013. While this analysis does not differentiate between types of building structures, it does provide indication of building intensification.

The land use context

Using Google Earth Street View photographs which were taken in 2009 and site visit photographs taken in 2013, an analysis was conducted of the changing land use along Immink Drive, the main arterial running through Diepkloof (see Figure 4). The analysis shows that there has been a relatively limited change in land use and trading facilities along Immink Drive between 2009 and 2013; this will be explored in more detail later in the paper. Much of the trading activity is situated within formal housing stands; Figure 6 illustrates that trading facilities take the form of extensions to houses (numbers 1, 2 and 4), a retrofitted shipping container (numbers 3, 5, 6 and 8) and in some cases a table displaying produce (number 7). Of all the images in Figure 6, the series labelled 1 highlights significant levels of investment since 2009. Interestingly, this stand is located within 50 meters of the BRT station.

The comparison of images further highlights that existing businesses have invested in upgrading their facilities, which is evident from changes in signage and paint as well as alterations to existing structures. This analysis clearly shows the mixed land use nature of Immink Drive, with retail facilities fronting the street and easily accessible by pedestrians. The mix of retail facilities is not very diverse, with many liquor outlets (an observed count of five) between the station and the shopping centre, food vendors and spaza shops. In the morning period many of these facilities are closed, and facilities 5 and 6 below were never seen open at any stage during site visits conducted for the research; both are food retailers.

Furthermore, it was expected that there would have been increased demand to trade in close proximity to the station. However, there was no observed spaza or informal trading activity occurring in the immediate areas surrounding the station at any stage during site visits carried out for the research.

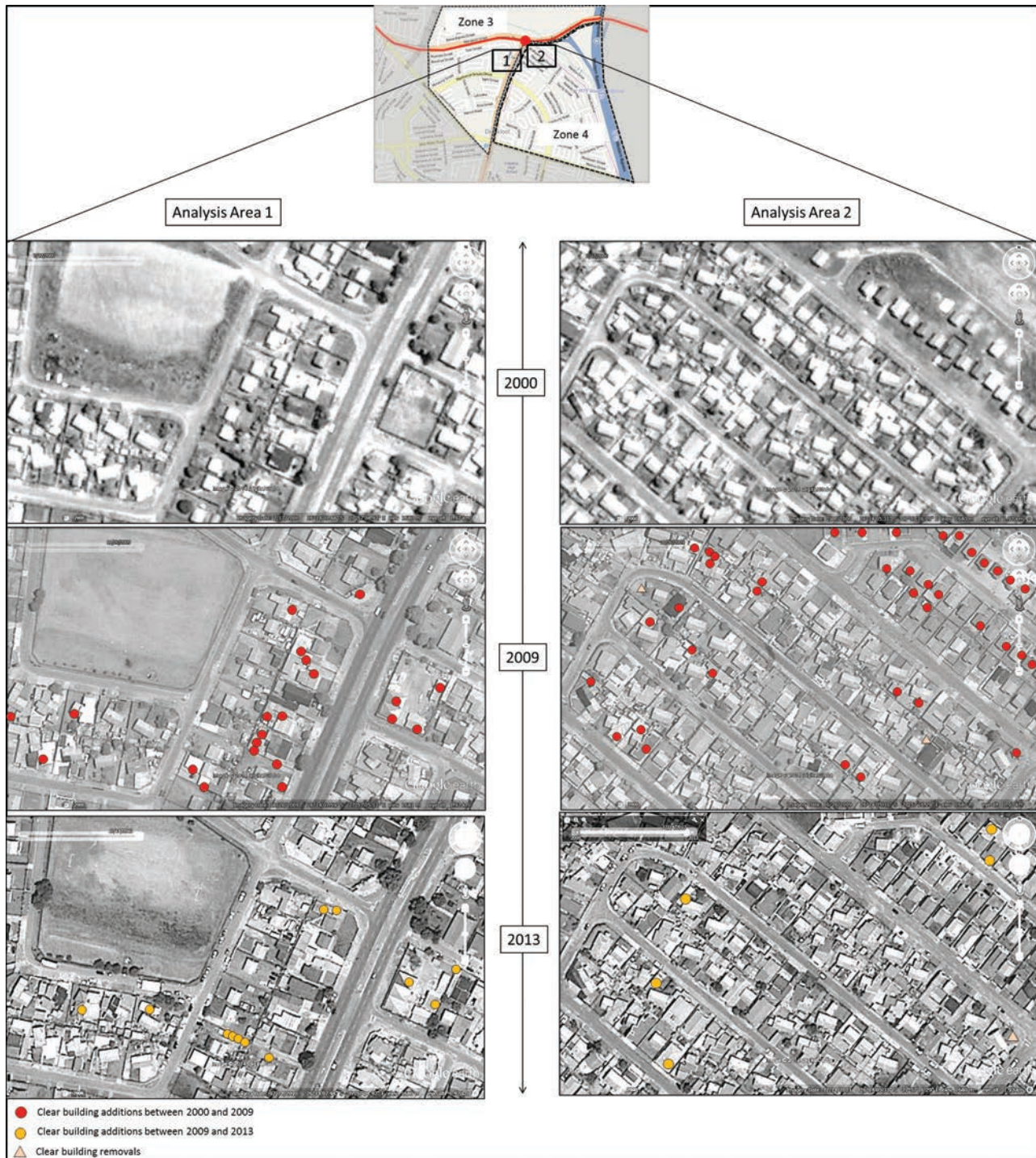
Unpacking the census data

This section provides a brief contextual analysis of Diepkloof population and housing statistics as represented in the 1996, 2001 and 2011 censuses.

The total population of Diepkloof has decreased steadily from 1996 to 2011. It decreased by 2% (from 104 426 to 102 228) between 1996 and 2001, and decreased by 7% (to 95 076) between 2001 and 2011. This is not reflective of the population change for the entire Soweto area, which decreased between 1996 and 2001 by 17% (from 1 041 809 to 858 644 and then increased between 2001 and 2011 by 48% to 1 271 628). The number of households in Diepkloof increased between 1996 and 2001 by 23% (from 22 807 to 28 249) and decreased by 20% between 2001 and 2011 (to 22 493) (see Figure 7).

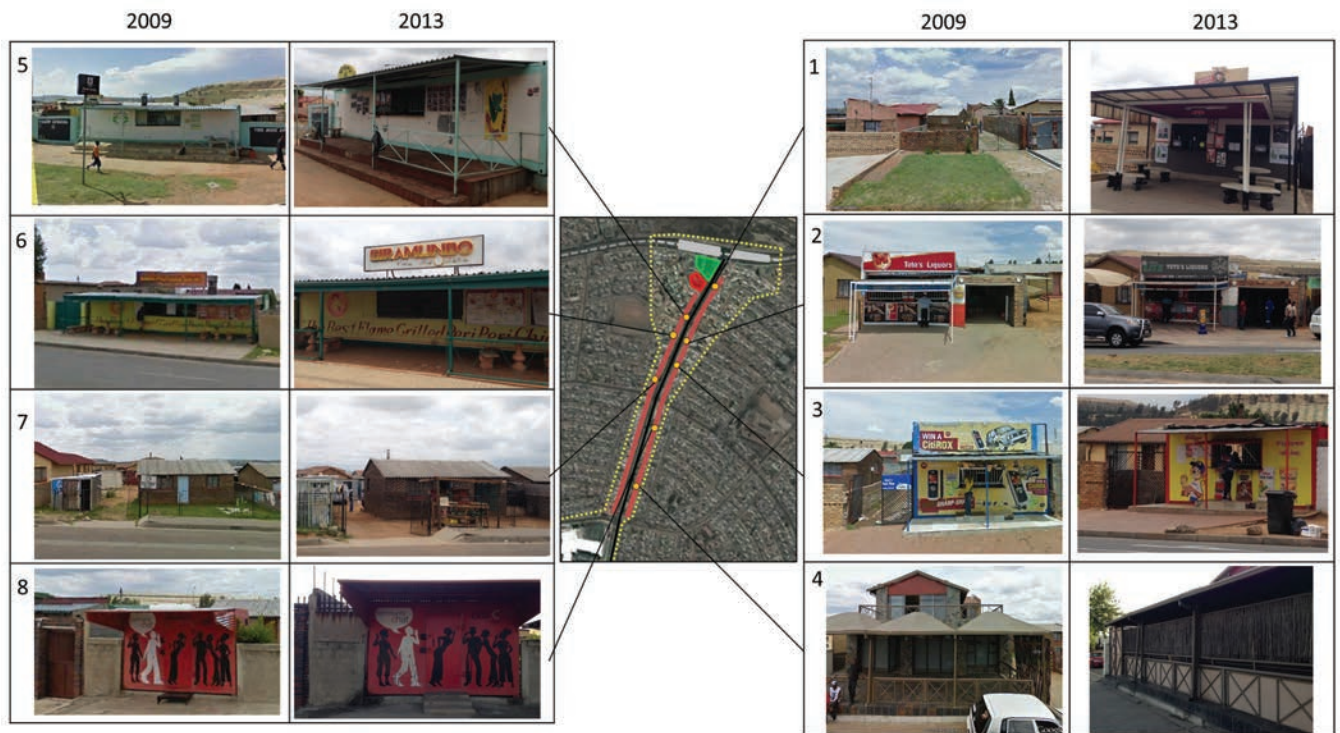
Since the research is focused on Diepkloof Zones 3 and 4, it is useful to gain an understanding as to the change in household numbers over time in these two zones relative to the broader Diepkloof area. Figure 8 illustrates the 44% decrease (the second highest across all Diepkloof zones) in the total number of households between 2001 and 2011. The 14% increase in Zone 4 was the only increase experienced across all zones in Diepkloof.

FIGURE 5: Increase in building density on formal housing stands, 2000-2013



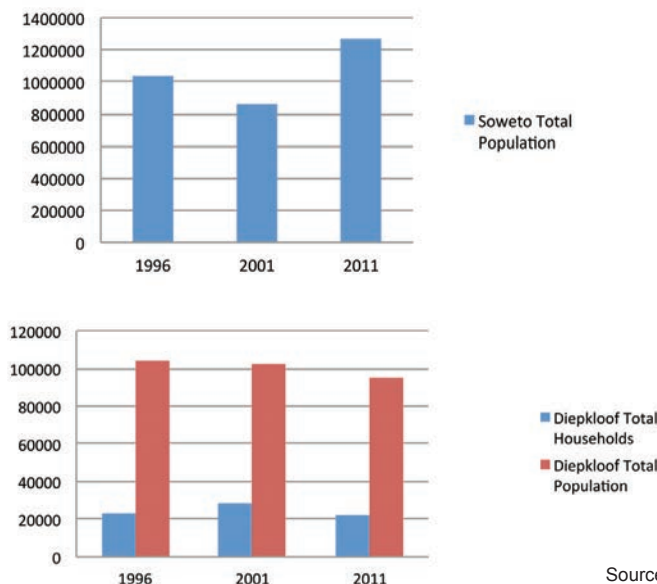
Source: Images extracted from Google Earth, graphic by the author.

FIGURE 6: Photographic comparative analysis 2009 (Google Earth Street View) and 2013 (site photographs)



Source: 2009 images from Google Earth, 2013 images from site visit photographs.

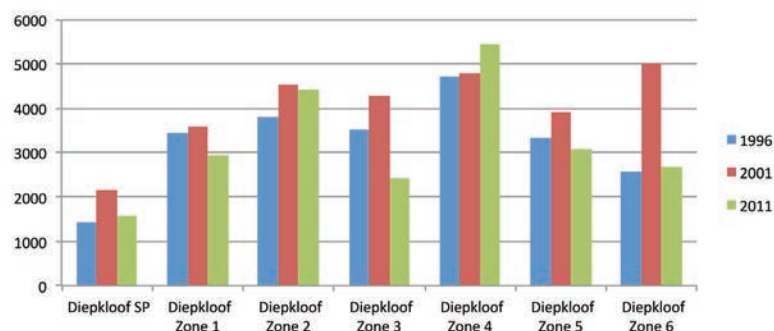
FIGURE 7: Soweto population change, 1996 to 2011, and Diepkloof population and household change, 1996 to 2011



Source: Quantec EasyData

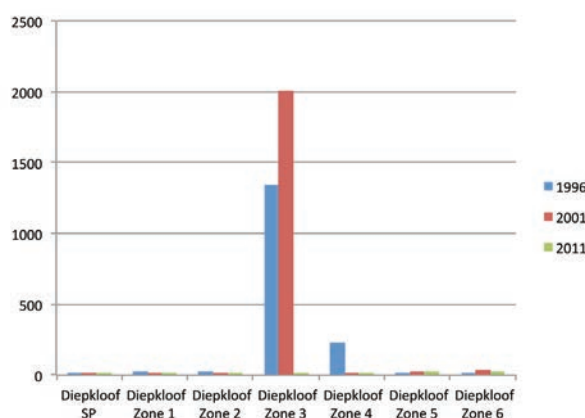
Although it is difficult to draw conclusions around these trends, when they are assessed relative to the aerial photography analysis it is evident that the removal of the Mandelaville informal settlement has had an impact on both the total population and the number of households in Zone 3 between 2001 and 2011 (see Figure 8). Charlton and Silverman's (2004) account of former Mandelaville residents seeking to continue living in Diepkloof suggests that this had an impact on the intensification of formal housing stands (see also Figure 9).

FIGURE 8: Change in the total number of households for all zones in Diepkloof, 1996 to 2011



Source: Quantec EasyData

FIGURE 9: Change in the number of informal dwelling units not in a backyard for all zones, 1996 to 2011



Source: Quantec EasyData

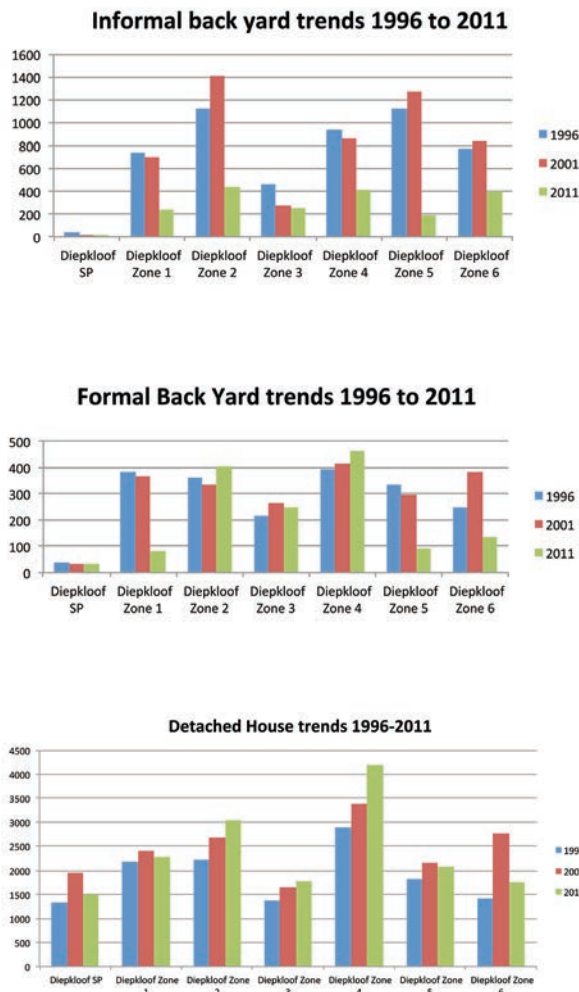
Housing trends

The census data on informal and formal backyard dwellings and detached houses has been drawn upon to present an understanding of housing trends in Diepkloof. The data available on backyard units indicates that Zone 3 has experienced a 40% decrease informal backyard dwellings from 1996 to 2001 (from 464 to 276), and a further 11% decrease between 2001 and 2011 (to 246). The formal backyard units in Zone 3 increased by 24% between 1996 and 2001 (from 214 to 265), and then decreased by 7% in 2011 (to 246). Zone 4 witnessed a consistent decrease in informal backyard units from 1996 to 2011 – a 7% decrease from 1996 to 2001 (930 to 859), and a further 52% decrease to 2011 (to 414). In terms of formal backyard dwellings, Zone 4 displayed a consistent increase from 1996 to 2011 – a 5% increase from 1996 to 2001 (394 to 415), and a further 12% increase in 2011 (to 466) (see Figure 10).

There has been consistent growth of detached housing units in both Zones 3 and 4. Zone 4 has always contained the highest number of detached housing units in Diepkloof, and has shown relatively strong growth, increasing by 17% from 1996 to 2001 (2981 to 3383), with a further increase of 24% in 2011 (to 4202). This strong growth is perhaps reflected in the spatial analysis above which displays new detached housing units being built in Zone 4. Zone 3 displays growth from a relatively low base, increasing by 21% from 1996 to 2001 (1374 to 1662), with a further increase of 8% in 2011 (to 1793) (see Figure 10).

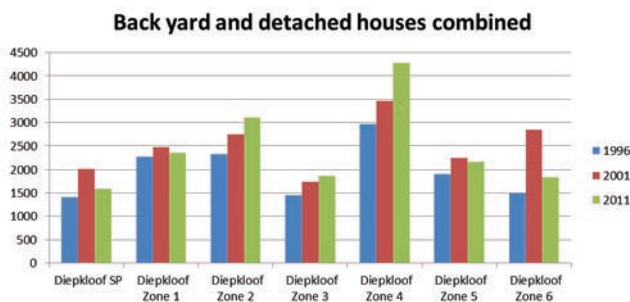
While these three housing typologies represent the vast majority of houses in the area, the detached house numbers far outweigh any other typology. Figure 10 is perhaps misleading, as across all these typologies there has been an overall and consistent increase in the number of units for both Zone 3 and Zone 4 from 1996 to 2011 (Figure 11). Furthermore, the definition of these units is often difficult to differentiate in practice. However, the understanding that there is overall intensification occurring across formal housing stands is supported by the spatial analysis presented earlier.

FIGURE 10: Soweto, Diepkloof and Diepkloof Zones 3 and 4 shelter trends



Source: Quantec EasyData

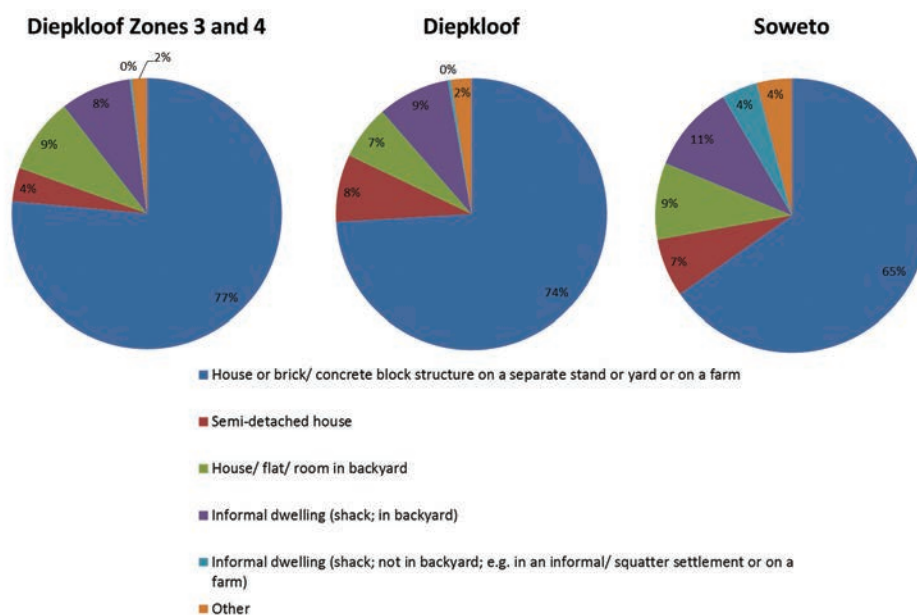
FIGURE 11: The combined change in units from 1996 to 2011



Source: Quantec EasyData

Assessing the current housing makeup of Diepkloof Zones 3 and 4 relative to the broader Diepkloof area indicates that the former is generally representative of the latter. Diepkloof shows a 3% greater proportion of separate brick formal housing stand units, and 4% fewer semi-detached houses. When compared to Soweto, there are 12% more separate brick formal housing stand units in Diepkloof, 3% fewer semi-detached units and, significantly (4%) fewer informal settlement units (see Figure 12).

FIGURE 12: A comparison of 2011 housing makeup in Diepkloof Zones 3 and 4 and Soweto



Source: Quantec EasyData

This contextual analysis suggests that the BRT impact assessment is taking place in a context of fluctuating population, and changing housing and land use characteristics. Diepkloof Zones 3 and 4 display somewhat unique trends relative to the broader Diepkloof area, and are not homogeneous when assessed relative to each other, either. The relatively long-term fluctuation in trends may make it challenging to ascertain, with some level of certainty, the impact of the BRT system on socio-economic and physical change in the area.

Presenting the information collected

Perspectives on change in the neighbourhood: some qualitative insights

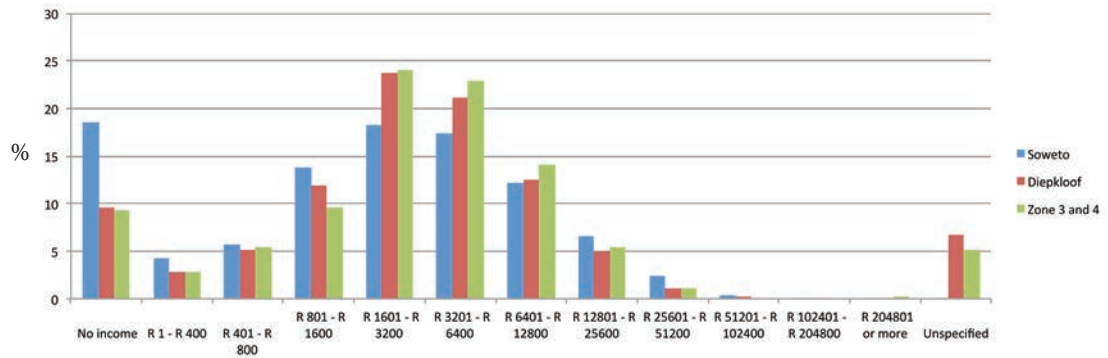
In this section, the information obtained from the research is presented and discussed. First the quantitative BRT station-based interview data is presented and analysed. This is followed by a discussion of the qualitative findings. Finally, general observations by the researcher are used to supplement the discussion on the impacts which the BRT station and system have had and are having on the surrounding neighbourhood.

Understanding BRT users and how they interact with the built environment: a snapshot from the Diepkloof Station

The indicative data collected from the station-based survey provides a snapshot of how people accessing the Diepkloof Station are interacting with the surrounding urban environment. The survey asked some general profiling questions which, although not the core focus of the study, are presented to provide background on the nature of the people accessing the station. Figure 14 indicates that more females were interviewed than males; general observation confirms that there seemed to be a greater number of females accessing the station but not overwhelmingly so. In terms of age, the majority (52%) of users interviewed were older than 25 but younger than 45. Income data collected shows that 50% of the 80% of total respondents who opted to disclose their monthly income bracket earn over R 3500 a month, with 40% of these people earning above R7500. This income level is arguably significant in that it removes people from the subsidised housing bracket, which is targeted at people earning less than R3500 per month. Here, people earning a monthly income of R3500 are not classified as poor but, by most global accounts, would be considered to be middle-income earners (The Economist, 2009).

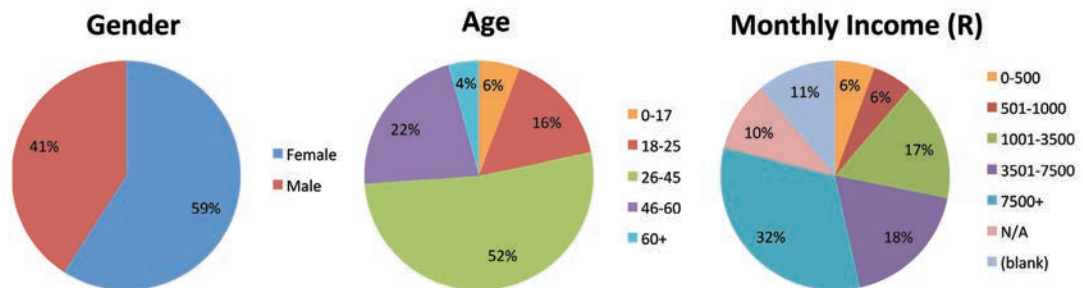
The Census 2011 data indicates that Diepkloof Zone 3 and 4 households have relatively higher income levels when compared with the entire Soweto area. Furthermore, households in Zones 3 and 4 display slightly higher income levels when compared to the entire Diepkloof area (see Figure 13). As such, 44% of households earn above R 3200, with 21% of these households earning above R6400. This data broadly corresponds to the personal income information captured during the research, suggesting that the BRT is being used by a diverse range of income earners.

FIGURE 13: Comparative household income for Soweto, Diepkloof and Diepkloof Zones 3 and 4



For the purposes of this study, the most significant element of this finding is that the majority of BRT users have a relatively high capacity to spend, as do the majority of households in the area (likely an influencing factor in developing a shopping complex in the area). This has significance for the land value surrounding the station as there is evidence that people with a higher spending capacity are congregating close to the station on a daily basis. This phenomenon is often the driver of land development or redevelopment, where developers and businesses attempt to capitalise on the higher concentrations of spending capacity which station areas generate.

FIGURE 14: Demographics of people surveyed at Diepkloof BRT Station

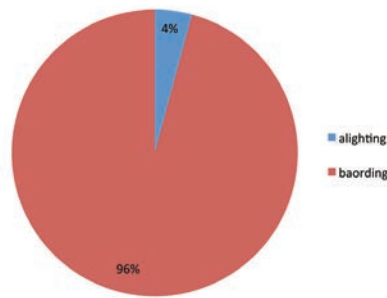


Source: Data extracted from research surveys conducted for this paper on 1 November 2013, graphics by the author

Extracting passengers’ broader urban interactions around the station

The survey provided a series of insights into the manner in which passengers were interacting with the broader urban environment. Figure 15 shows that the vast majority of respondents were entering the station while very few were exiting. This confirms general observations made during the interview process. Due to the location of the station, in the morning very few passengers exited the station. The predominantly residential nature of the Diepkloof area is argued to be the main reason as to why the tidal flow of passengers exists. Another interesting observation was that, of all the boarding respondents, only one was travelling in the direction of Soweto; all the other respondents were travelling toward Johannesburg. This perhaps highlights that the broader Soweto area remains largely residential and that the majority of people living there who are employed or seeking employment travel to the central or northern parts of the city. General observation supported this as both the frequency and occupancy of buses travelling towards the city was far greater than those travelling towards Soweto.

FIGURE 15: Passengers boarding and alighting at Diepkloof BRT Station



Source: Data extracted from research surveys conducted for this paper on 1 November 2013, graphics by the author

During the survey period, all of the respondents who arrived at the station were on foot; there were no observed transfers from another mode of public transport. However, some people were observed to be dropped off by private vehicles near the station. Other than those arriving on foot, there were no observed passengers arriving via non-motorised transport. To better understand where people were coming from when accessing the station, respondents were asked to provide the street name of the location from which they had just come. The locations of the streets were then searched using Google Maps. It seems as though the spelling or capturing of certain street names was incorrect and as a result could not be located using Google Maps. However, the names which could be identified begin to tell a story about where people are coming from within Diepkloof to access the station. Figure 16 provides some indication of the general location from which respondents walked to the station. It is evident that the concentration of users decreases at locations further away from the station. This makes intuitive sense, but as many of the street locations of respondents could not be identified, this does not necessarily provide a full account of where people had walked from. Furthermore, as streets are linear and as the survey did not ask for house numbers (to ensure confidentiality), the exact location of respondents along the streets is not provided.

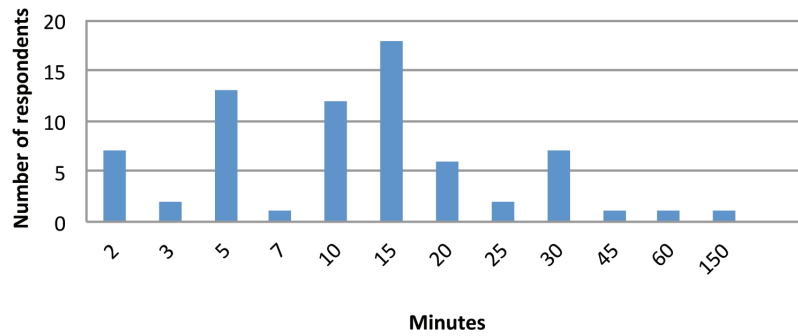
FIGURE 16: Mapped general street locations of respondents



Source: Image, Google Earth; Data extracted from research surveys conducted for this paper on 1 November 2013; graphics by the author

Respondents were also asked to give an approximation of how long it took for them to walk to the station. This information provides insights into the distance people are generally walking to access the station. Figure 17 shows that the vast majority of respondents live within a 20-minute walk from the station. However, the data does suggest that some people walk relatively long distances to access the station, with one respondent walking an hour to the station and another walking two and a half hours.

FIGURE 17: Time taken for respondents to walk to the station



Source: Data extracted from research surveys conducted for this paper on 1 November 2013, graphics by the author

One component of the survey asked, ‘Do you stop at any shops en route to the station?’ Retail activities generally cluster around public transport stations due to the high level of foot traffic generated. For passengers, the convenience of being able to purchase items on their daily travel route without having to make a detour drives up the demand for retailers to locate in close proximity to public transport. It is this concept of convenience which underpins the discourse around mixed use environments located within close proximity of public transport stations. Thus, this question sought to gain an understanding of the extent to which passengers demand goods and services on their daily commute, but also the extent to which retail activities in the area have oriented themselves towards the BRT station and access routes leading toward it. Responses to this question were varied but provided useful insight around passengers’ behaviour and potential demands while en route to public transport stations.

Of the 69 people who responded to the question, 68% said that they never stopped at any shops on the way to the station, while 32% said that they sometimes did so. One respondent mentioned that she stops at a crèche en route to the station. Interestingly, 9 respondents (13%) said that they did not stop at shops because there were no shops on their route to the station. One respondent reported that the reason was due to the fact that shops were not yet open at that time of day. These responses perhaps highlight that there is demand to stop on the way to the station but the opportunities to access retail activities are not available or are inconvenient.

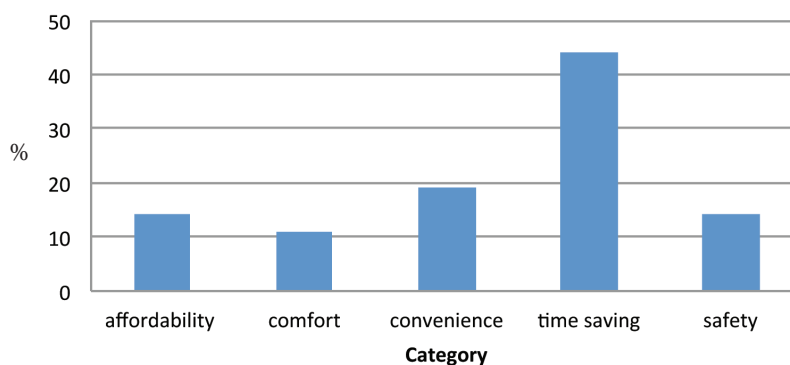
Respondents were then asked whether they use the BRT on the return trip, based on the assumption that they would be returning. Of the 70 people that responded to the question, 90% said that they did use the BRT to return, while 10% indicated that they returned via alternative modes of transport. Of those that did not return via BRT, all referred to the distance of the system from where they needed to get to or come from, and some respondents explicitly stated that they used taxis as that was more convenient. Of the people who did use the BRT system to return, 53% indicated that they did not stop at shops on their way home from the station while 47% indicated that they sometimes do.

Intuitively, it makes sense that a higher proportion of people would stop in the evenings on their way home as they would need to prepare food for the evening and possibly for the following day. People would also not want to carry groceries around with them all day, so the homeward commute would be more convenient. Respondents who said that they had stopped in the morning indicated that they were generally purchasing smaller items such as cigarettes or something to drink while there was a greater tendency to purchase groceries in the evening.

These insights provide an indication of how passengers of the BRT in Diepkloof are interacting with the broader built environment. It is clear that the system has had an impact on people's lives in Diepkloof, as users of the system have changed their behaviour patterns by shifting from a previous mode of transport to using the BRT. It is further evident that BRT passengers using the Diepkloof Station exhibit a relatively large spending capacity, and it is thought that the concentration benefits surrounding the station are yet to be capitalised on by developers and businesses.

The users of the system have undoubtedly been affected by the introduction of the system, and the survey results show that the vast majority of passengers use the service because it offers them greater benefits in terms of safety, convenience, comfort and affordability than other modes of transport. Many respondents gave multiple reasons for choosing the system, but the time-saving aspects appear to be most prominent (see Figure 18). This information is captured fairly regularly by customer satisfaction surveys carried out by the City. However, what this quantitative data analysis has begun to touch on are the less clear impacts that the system has on the broader urban environment surrounding the station. Furthermore, from an economic perspective, the passengers' pedestrian behavioural patterns impact on the vibrancy of the public realm. Much has been written about the heightened quality and safety of vibrant pedestrian activity in the public space (Jacobs, 1961; Project for Public Space, 2012). However, land economic theory suggests that the heightened access provided by public transport drives increases in the value of land as demand to be located in close proximity to the public transport station increases (Harvey and Jowsey, 2004). The qualitative component of the research attempts to gain insight into the extent to which physical and socio-economic change in the Diepkloof area may have resulted from the introduction of the BRT station.

FIGURE 18: Reasons for choosing to use the BRT



Source: Data extracted from research surveys conducted for this paper on 1 November 2013, graphics by the author

Perspectives on change in the neighbourhood: some qualitative insights

Before conducting the qualitative component of the research, it was assumed that the BRT would have had a significant impact on the perceptions of people living in the area and that it would be at the forefront of people's minds when discussing change. Furthermore, given the vast literature which exists on the land development impacts of high quality transport infrastructure and systems, it was assumed that there would be a series of noticeable changes to the built urban form of the area.

It was generally assumed that the BRT would have been a prominent response from people when we asked them about changes they have noticed in the area, largely because it represents a relatively substantial and highly visible investment which is unprecedented in previously marginalised areas of South Africa. The story to emerge from the interview responses, however, generates a far more nuanced understanding of the impact which the BRT has had on the area to date and raises a series of questions around the impact of public transport systems on broader built environment changes in Diepkloof and potentially across Soweto. Furthermore, the research has uncovered a story of the perceived impact associated with large-scale private

and public sector investment, highlighting the importance of aspirational dimensions when considering perceived impact. This section unpacks the responses from the qualitative interviews and distills some of the key themes and points of interest which emerged during the research.

Consistent intensification of formal housing stands

Acknowledging the impact on density of the removal of the Mandelaville informal settlement, all of the respondents who were residents understood that the densities in the formal housing stands in Diepkloof Zones 3 and 4 have been increasing incrementally over a long period of time. This is supported by the aerial photography analysis. Three out of the four residents who lived in Diepkloof since the 1960s (see Annexure E) stated that they had built additional housing units in the backyards of their properties to cater for their expanding families.⁵ These units had been built at various times; some respondents indicated that they had built backyard units in the late 1970s and 1980s, while respondent number 7 indicated that she had started building her backyard units about ten years prior to the interview. This highlights the long-term densification trend which has occurred within formal housing plots throughout the history of Diepkloof. The spatial analysis along with the insights gained from respondents illustrates that the trend has continued in more recent history.

One respondent was a tenant living in a backyard⁶ unit, indicating that backyard dwellings do not always cater for family growth. This was reaffirmed by respondent 9 who indicated that he had built several backyard units over time, starting in 2009.⁷ When asked why, he responded that he could afford to do so at the time; some of these units were for family while he rented out the other units. He said that the demand for units in the area was high: "You see, because Diepkloof is closer to Jo'burg people are always looking for a place here. So if you build a room it is occupied before you even get to the roof. People are always coming here looking for a place." He did indicate his plans to build more units once he raised the capital to do so.

An additional contribution to the building density in the area is the incremental growth of businesses located on residential properties. Respondents 1 and 2 had both upgraded their business structures over time to permanent structures. Both indicated that they had started out with shipping containers.

General observation confirmed that all of these development types were fairly consistent throughout the area. Where housing stands did not have additional units or businesses, most of them had upgraded the existing houses. Such extensions and upgrades were confirmed by respondents 6 and 12.

This analysis indicates that there is a significant level of private investment, which has contributed to the densification of Diepkloof. Research outcomes suggest that the densification is continuing and the demand to live in Diepkloof is relatively high. From general observation there seem to be relatively high levels of building activity taking place in stands within a few hundred metres of the BRT station. Respondent 12 indicated that there seems to be a higher demand to live in the area because it is so well served by transport. This was the first indication of growth being linked to transport. However, the Diepkloof Station was visible from this particular respondent's home. The extent to which the BRT has impacted on the densification of Diepkloof is not entirely clear. The interview responses did not seem to link individual investment or observed physical change to the BRT system directly.

The mall takes centre stage

When respondents were asked about the changes that they had noticed in the area, there was an overwhelming awareness of the recently developed Diepkloof Square shopping complex and the impact which it has had on residents and business owners. The reactions to the shopping mall were varied and depended largely on the perspective of the respondent.

Crowding out local businesses

Business owners in the area indicated that the mall had had a significant impact on their businesses. Many of them used to sell food and general household items, but since the introduction of the mall they have had to sell other products as they were unable to compete with the mall. Respondent 3 highlighted this when asked whether the goods they were selling had changed over time; she responded, "No, it's changed. We used to sell groceries but now we are no longer selling it; we are selling bunny chows" (Respondent 3, Interviewed 21 November 2013). When asked when this had begun, the response was clear: 'When they first opened that mall' (Respondent 3, Interviewed 21 November 2013). Interestingly, there is a relatively high concentration of

liquor outlets along Immink Drive. Both of the liquor store owners who were interviewed indicated that they had previously sold food items (Respondents 1 and 2, Interviewed 21 November 2013). Respondent 1 indicated that he had shifted to selling alcohol prior to the development of the mall, while respondent 2 shifted to only selling alcohol due to the presence of the shopping centre. For respondent 2 the impact of the mall was clear:

There was no mall and there was no Pick 'n Pay down there by the garage so I was doing well. Since there's the mall and everything, things are getting difficult for us. (Respondent 2, Interviewed 21 November 2013).

The former bus station located to the south of the shopping complex is now used as a market facility for local traders. An informal discussion with the security guard working at the facility further highlighted that the mall had reduced the level of trading activity at the market. Many stalls had closed, with only the most successful traders still operating at the market selling goods such as sheep heads, which would not usually be associated with a shopping centre.

General observation indicated that many other food-based businesses in the area were either closed or not operational during the time spent conducting the research in Diepkloof. This suggests that the opening of the mall has had a significant impact on the local businesses in the area. It is apparent that the mix of available goods and services along Immink Drive has contributed to a vibrant civic culture in the area. Respondents 1 and 6 both provided indications of the vibrant mixed use 'high street' nature of Immink Drive.

You know, Diepkloof has this aura of indulgence. People like indulging in Diepkloof and especially on this main road, Immink Drive... a lot of people call it the boulevard. This is where it's happening, this street. For me it has a sort of Melville, Seventh Street feel about it, especially on weekends. On a nice summer day you just see cars parked, people chilling. You can see from the structure itself. It's not that [Melville Seventh Street], but it has that kind of feel. If you look at it, I mean, you have the BRT development there. There's a lot of other same type of businesses, liquor, on this street.... There's a butcher... so it's like a business district. And for me, and this is what inspired me, it's the first street in Soweto. So that kind of pushed it as well.... (Respondent 1, Interviewed 21 November 2013).

Yes it has changed. This street has changed really, really.... I enjoy it because whatever we want here in this area we get it nearby.... Pick 'n Pay, petrol, drinks... and over there [gestures with his hands] there's Norman, drinks, everything you want. If you want to relax, you relax there with your girlfriend or whatever (Respondent 6, Interviewed 21 November 2013).

Respondent 6 explained that this change really started in 1994. The research has possibly uncovered that the introduction of the shopping centre has reduced this quality and diluted the mix of goods and services along the street.

The report has already positioned the lack of alignment of the shopping centre investment to the BRT as a missed opportunity. Less than a kilometre away from the station, the property development could have been more strongly aligned to the principles underpinning the existing Immink Drive "boulevard" qualities. Such principles resonate strongly with transit-oriented development, where shops open onto the street and can be accessed easily by pedestrians. Instead, the shopping centre prioritises access for private vehicles, with only a small entrance on the southern side for pedestrians. The issue of how to better guide private investment is argued to be a critical one and is discussed later in the report.

Improved access to higher-order goods and services

The mainstream affection for shopping centres in South Africa, along with the higher-order (or mainstream) goods and services which they provide, has meant that for many people living in Diepkloof the newly developed mall represents major progress for the area. Nearly every single respondent in the area mentioned that the mall has had a positive impact on their lives as they were now able to get goods in Diepkloof that they would previously have had to travel to the CBD (or other areas) to purchase. Respondent 12, for instance, stated, "Our main reasons for going to town were the big shops and now we have them here in the mall..." (Respondent 12, Interviewed 28 November 2013). Respondent 1 stipulated that people in Diepkloof had

become more concerned with the quality of products and services. This was taken to imply that people in South Africa from all backgrounds have become exposed to the 'desirable' ways of living in cities, and aspire to live in those conditions:

I think people are just more exposed to quality. And people want quality, you know, instead of maybe just settling for anything. People are just more into quality.... I think they've been exposed to that kind of life, through media, whether directly or indirectly. You can tell, a lot of kids don't go to local high schools. They are more exposed to the northern suburbs,⁸ you know. And that's where a lot of people party these days. Yes, we do a lot of nice places in the township. I think that gap has been bridged. People know what's quality and what's not (Respondent 1, Interviewed 21 November 2013).

This respondent acknowledged that he was referring to schools when he made the comment about people in Diepkloof aspiring to live in the conditions associated with those of the northern suburbs of Johannesburg. In an attempt to understand why Diepkloof Square has captured the minds of the area's residents, perhaps it is the aspirational dimension which has placed the shopping centre at the forefront of people's minds when they were asked to consider the changes the area had seen. The BRT is not generally associated with 'northern suburbs' living and would potentially not be an investment which speaks to people's aspirations.

A general sense from responses is that the BRT seemed to fit within a long-term understanding of infrastructural upgrades to the area; people often mentioned the road upgrades and pavement developments before mentioning the BRT. This is perhaps best highlighted by Respondent 1:

There've been a lot of infrastructural changes. I mean, like, when we were growing up this road here was like gravel. You know, it's like ... only that section here ... only that side was actually a road with tar and all of that. But I think it was 94/95, something like that, they started doing these upgrades; they were building these streets, street lights, traffic lights. Ya, man, this BP garage has changed like three times. And there were shacks, squatter camps over there, and now it's a complex, Diepkloof Square (Respondent 1, Interviewed 21 November 2013).

This is not to say that there was no mention of the BRT, but it seemed to be more peripheral in people's thoughts regarding change. Perhaps one of the reasons for this is that Diepkloof Square was a relatively new development and people had become accustomed to the presence of BRT in the area.

When people were asked specifically about the impact that the BRT had had on the area and on the people living there, the response was resoundingly positive. All of the respondents believed that it had provided an improved travelling experience for people living in Diepkloof, whether the respondents were users themselves or not. Respondent 7 explained:

there definitely has been [a positive response] because people come from far and they rush to it to go to town, and it's because they know it operates on time, but with a taxi it must stop and wait for people and you'd become late while in the taxi (Respondent 7, Interviewed 28 November 2013).

However, very few business owners seemed to think that the pedestrian traffic generated by BRT users was having a significant impact on their business. This is perhaps best highlighted by respondent 2 when he stated:

I don't think there's an impact [from the BRT]. Because people who walk on foot get off at the BP and they walk off straight to their homes, or they stop at the Pick n Pay. There's a Pick n Pay there by the BP; they buy whatever they want to buy and they go home. So there's no impact... nothing (Respondent 2, Interviewed 21 November 2013).

This was surprising due to the volumes of pedestrians we had observed filtering to the station in the morning; many had indicated they sometimes stopped at the shops on the way home.

A long-term land ownership dynamic

The research findings suggest that land ownership is generational in Diepkloof; people own land and properties for long periods of time without the intention to sell the property. Eight of the eleven respondents who were residents had lived in the area for over 30 years. One of the respondents referred to the long-term nature of Diepkloof residents stating:

They've been here forever, I guess. Because they were born here. Most of the people were born here (Respondent 4, Interviewed 21 November 2013).

During the interviews none of the respondents mentioned any increase in their property values in spite of acknowledging the general infrastructural improvements and shopping centre investment.

Drawing on understandings of the redevelopment potential associated with the development of BRT infrastructure which many commentators report (Deng and Nelson, 2010; Cervero, 2013b; Hook et al., 2013), it is interesting to observe that none of the respondents who were property owners mentioned the value of their property. It is acknowledged that this question was not specifically asked at any stage during the research. However, it was clear that the majority of houses are family homes which have been incrementally invested in over time. It is assumed that people would be largely unwilling to sell their houses, which is supported by Marx et al. (2008). Relocation would pose major questions around where they could afford to move to, which locations could exhibit similar benefits, and which could accommodate their growing families.

Furthermore, it is worth acknowledging that many families in the area have directly experienced relocation during their lives.⁹ Driving a redevelopment agenda around the public transport investment in Diepkloof as well as the broader Soweto area arguably runs the risk of crowding out existing residents and placing families under relocation pressures. The research has indicated that for many Diepkloof residents the value of the land is not derived from financial potential or financial worth, but rather from the stability it creates for family and the platform it provides for people to access the city. These land ownership dynamics along with a perception of poor 'townhouse demand'¹⁰ in surrounding areas have arguably limited the extent to which relatively large-scale private-sector residential development has occurred.

Diepkloof was once considered a relatively marginalised location, but is now considered to be a well-located area within the broader context of Johannesburg. Many respondents referred to the close proximity of the township to the inner city. This close proximity and relatively strong accessibility has arguably been heightened by the BRT system and station in Diepkloof. However, a redevelopment response which increases density around the BRT investment is understood to be essential to the long-term viability of the system; it will also provide greater levels of accessibility to a greater number of people. Ensuring that existing communities are not 'crowded out' in the process is one of the major foreseeable challenges.

Impacts of the BRT

Although the majority of respondents did not mention the BRT when asked about change, explicitly asking about them whether they thought the BRT had affected Diepkloof evoked relatively strong and somewhat varied responses.

Improved levels of accessibility and mobility

The vast majority of respondents indicated that the BRT system had profoundly improved the transport experience for people living in the area. Following are some of their responses on the impact of the BRT:

On me, I don't think it has [impacted] because since I am a student I don't use transport a lot. But for other people I can say that it has changed their lives because some of them don't like taxis and now they are happy with the bus. I think it's changed their lives. But for me... I've never even used it (Respondent 4, Interviewed 21 November 2013).

The BRT has had an impact on our lives in the township. We relied on taxis but taxis had bad service.... So when the BRT came, we all flocked to it. Those of us who live close to it, we ride it (Respondent 6, Interviewed 28 November 2013).

Yes. There definitely has been [a positive response] because people come from far and they rush to it to go to town, and it's because they know it operates on time, but with a taxi it must stop and wait for people and you'd become late while in the taxi (Respondent 7, Interviewed 28 November 2013).

These responses show that the BRT is perceived to be having positive impacts for those who are using the service.

Local taxi business compromised

While there is a clearly perceived positive impact for the users of the system, certain responses indicated that the impacts are understood relative to the particular perspectives and vested interests of individuals. For example, respondent 2, a taxi owner and operator, indicated that the introduction of the BRT had put his taxi operation out of business. When asked if his taxi business was still in operation he responded:

There's the BRT now. Everybody can go to it... After 8 there are no people. At least before and around 7 they are still rushing to get to work. Before [the BRT] you could get people even after 8 and 9 but now after 8 you could park the whole day waiting for people to fill your car (Respondent 2, Interviewed 21 November 2013).

This view was confirmed in a discussion with a representative from the Diepkloof Taxi Association who indicated that the BRT had severely affected the local taxi business in Diepkloof. The Diepkloof Taxi Association have an office in what used to be the bus station located south of the shopping centre. The association's representative indicated that they used to operate the entire rank, but now there were trading stalls occupying most of it and they operate out of a smaller part and on the street. He explicitly noted that the BRT had been the reason for the reduction in their business activity.

BRT-generated foot traffic and business: an unclear relationship

The response from business owners on the extent to which the BRT foot traffic is impacting their trading activity was mixed. Respondent 1, who was located within 50 metres of the station, seemed to believe that the presence of the station was having a positive impact on his business:

Well, it's definitely brought on a lot of movement. I think it's been a plus for business because you get people that use the BRT who live far away from here but they still walk down, and up, to and from work. So it has brought a lot of movement. Once again, it's quality again; it has brought a sense of respectability. People can use quality transport... a system. And then in terms of the business, you know; now people are more aware of this place. People that wouldn't have known, you know, but now they know about it because now they've passed here. So yes, it has helped, in a way. Slightly but yes, it has (Respondent 1, Interviewed 21 November 2013).

The perceived impact for other business owners interviewed was not as strong. Most of the other respondents simply stated that they believed that the system and the pedestrian activity it generated had no impact on their businesses. This view was expressed by both large formal businesses and smaller local businesses. Respondent 5, who was an employee of the BP petrol station, stated:

I've checked it in the mornings, when the BRT is busy, and I've checked it in the afternoons, when guys get off the station and whatever. They walk straight up... Even month end or December... or any peak... you never find them deviating and saying "well let me buy water". I'm even talking about small items, water and airtime and stuff like that... you don't see that sort of deviation, coming in and then out again. The only thing is that during soccer games... some of the guys use my forecourt as a parking lot (Respondent 5, Interviewed 21 November 2013).

Interestingly, the BP garage is directly opposite the BRT station and as such is well positioned to capitalise on pedestrian traffic generated by the system. However, as a fundamentally vehicle-oriented business, perhaps the access conditions limit the ease of access of pedestrians to the shop. Respondent 10, an informal trader in the area, made an interesting connection between the impact of the BRT and his business when he responded to whether he believed the system has impacted on his business:

I can't say that it has had an impact on my businesses. It is too far away. You see [points at a sign on the edge of the sidewalk], it is 290 metres away from here. But I can see how it has helped many other people. I also think that since it has given other people jobs, that's also good for my business because then they can buy (Respondent 10, Interviewed 28 November 2013).

This arguably provides another critical element of assessment when attempting to understand the local neighbourhood impacts of improved transport systems. The socio-economic benefits derived from local users and employees of the system assist in the profitability of local businesses and contribute to individuals' capacity to invest in their businesses and properties. These links are often difficult to ascertain in an ever-changing context.

BRT and building intensification

The research has not been able to clearly determine whether or not the BRT system has begun to generate a greater demand for housing in close proximity to the station, and as a result increase the levels of intensification taking place. Respondent 12 suggested that there had been an increase in building activity in the area, but the aerial photography analysis suggests that this intensification began to take place before the introduction of the BRT. There is no clear sign of rapid intensification since the system was introduced in 2009.

Conclusion

This study aimed to assess the impacts of the introduction of the BRT system in Soweto relative to the objectives of improved accessibility and restructuring of the apartheid city. The Diepkloof BRT station was used as a case study. The contextual analysis suggested that a series of changes have occurred over a relatively long period of time in Diepkloof, and that this dynamic context would make it challenging to assess the impacts of the BRT. When distilling the impacts of the BRT, the research provided the following findings.

There has been **a profoundly positive perceived impact on the users of the system**. Many of the respondents indicated that they believed that the system has improved the transport experience for people in the area. The quantitative analysis showed that many people were using the system because it reduced their travel time.

Pedestrian activity and travel patterns in the surrounding area have changed, as many people who would have walked to the taxi rank and bus station previously are now walking to the BRT station. The actual and perceived impact of this change in pedestrian foot traffic on businesses in the area is not clear, with mixed responses from the range of local business representatives interviewed.

The system has compromised the local taxi business. Responses from taxi industry owners and operators indicated that the system has reduced their market share.

The land development impacts are less clear. The literature on land use transport integration suggests that transport investment has a significant impact on the value and development demand of land adjacent to public transport stations. While there is a long-term trend of densification within formal housing stands in the Diepkloof area, the link between recent intensification and the BRT system is not very clear and needs to be explored in more detail. Furthermore, decision making around the large-scale private investment in the form of a shopping complex located 750 meters away from the station shared no links with the BRT investment.

The impact of the shopping complex investment was more prominent in people's minds than the BRT investment. In an attempt to grapple with why this was the case it has been argued that aspirational aspects of investment dramatically affect perceived impact. In addition, it was acknowledged that the shopping centre development was more recently introduced than the BRT, and would thus be at the fore of people's minds.

The shopping centre investment has had an impact on existing local trading activities. The shopping centre has largely been viewed by consumers to have positively impacted their lives as they are now able to access a range of goods and services which they would previously have had to travel to access. For

local traders and entrepreneurs it seems to have reduced their market share; trading activity seems to have decreased and traders have had to change their product offerings. This has resulted in a less diversified offering of goods and services along Immink Drive.

The findings around access and mobility benefits of the BRT system make a compelling argument for densification around BRT stations throughout Soweto, because it would provide an opportunity for more people to access the benefits which the system provides. Behrens and Grey (2013) provide a financial perspective on why density is critically important to the long-term sustainability of BRT systems. Acknowledging the difficulties around the dynamics of land ownership and existing perceptions around demand for residential property, a more concerted effort to capitalise (from a land development perspective) on the benefits of investment in public transport systems is urgently required. The South African Cities Network (2011) conducted some indicative research on the potential of land value capture around transport nodes. This research needs to be deepened, and appropriate strategies and tools need to be developed to ensure that redevelopment does not lead to the displacement of existing communities.

In relation to the earlier point around densification, Suzuki et al. (2013) state that transport investment alone does not lead to property development. Reflections on the outcomes of TOD intentions has shown that there are a range of institutional, financial, political and procedural elements which need to align to a TOD vision (Dittmar and Ohland, 2004; Transit Research Board, 2004). In this regard cities, and the City of Johannesburg in this specific case, need to develop a strategy which can more appropriately respond to varying contexts which BRT systems will traverse (Bickford, 2014).

While the shopping centre development in Diepkloof has had a positive impact on the lives of people in terms of the access to goods and services, it does not necessarily align strongly to the TOD vision of the city. Reflection on this leads to a series of questions. Could the shopping centre development not have provided the goods and services which it currently does, while providing the TOD solutions which the city is proposing? Would this development not provide a unique opportunity to explore the possibilities of TOD in a South African context? It is argued that exploring these avenues and opportunities will be an effective way to interrogate the TOD concept in a South African context.

This report has highlighted the aspirational elements of perceived impact. Shopping centres are traditionally associated with more affluent areas of the city, and they are often promoted as a major sign of progress, especially in previously marginalised areas of South African cities. It is argued that the aspirational elements of transport need to be more strongly considered when thinking about public transport investment. Investing in the same infrastructure in areas displaying different income levels projects a powerful message around equality. It is believed that as the Rea Vaya system expands, traversing different areas of the city, this implicit quality will be improved.

Further studies assessing the impact of public transport investment are required to provide a more detailed picture. However, the findings from this research provide a platform to develop more nuanced TOD strategies across South African cities in an attempt to provide a greater proportion of the population access to the travel benefits such investment presents. To date, significant land development activity seems not to have occurred in response to the BRT investment in Diepkloof. The opportunity to capitalise is evident, and a more nuanced and measured approach to achieving TOD objectives is thus required.

NOTES

- 1 While the minibus taxi industry may be privately owned, it can still be considered public transport.
- 2 Aspects of high-quality public transport include reliability, frequency, safety, comfort, predictability and capacity.
- 3 All but one of the respondents who had experienced forced removal in the 1960s mentioned the number of rooms in their homes.
- 4 Statement retrieved from the Shanduka Investment Holding Company website, <http://www.shanduka.co.za/investees/Diepkloof-Square/index.html?&re=1>, accessed on 13 February 2014.
- 5 Respondents 6, 7 and 11 all indicated that they had built backyard units to cater for children who had grown up.
- 6 Respondent number 8 indicated that she was living in another person's back yard before they decided to construct more permanent backyard structures; then she moved to her current location.
- 7 This is significant as it was the year in which the BRT became operational.
- 8 The northern suburbs are considered to be wealthy neighbourhoods; they were reserved for white people during apartheid.
- 9 Respondents 6, 7, 11 and 12 all indicated that they relocated from Alexandra to Diepkloof in the 1960s.
- 10 JPC representative, E-mail communication, 30 May 2014.

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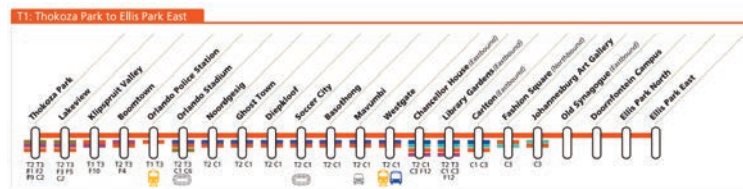
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Annexure A

Selecting a case study station

In selecting a station for the study, a desktop overview of station contexts was carried out. This involved assessing aerial photography of the stations and their respective surrounding contexts, looking for those which demonstrated significantly built-up areas immediately surrounding them. Three areas traversed by the trunk route were identified. These were Diepkloof, Orlando, and Moroka. An appropriate station for the purposes of this study was identified from each area and shortlisted. These stations were Diepkloof, Orlando and Thokoza Park Stations (see Figure 19). A site visit was then conducted to assess the viability of each station. The Diepkloof Station was identified as an appropriate station for the investigation of the impacts which the station had on the surrounding neighbourhood. It presents a mix of different land uses in the area immediately surrounding the station, with evidence of both formal and informal retail uses, established businesses and residential uses, with evidence of housing upgrades, single housing units and 'backyarding'.

FIGURE 19: Rea Vaya T1 Route Map



Source: <http://www.reavaya.org.za/consumer-information/the-routes>, extracted 11 February 2014.

As mentioned earlier, one of the envisioned challenges with the research would be the ability to draw clear linkages between the development of the station and changes to the surrounding context. In Orlando and Moroka, there has been relatively significant public-sector investment in the public environments surrounding BRT stations. In Orlando, the Orlando Stadium upgrade as well as the Orlando Metrorail Station upgrade (among many other apparent improvements in the public realm) and community facilities would compromise the ability to ascertain, with a relative level of certainty, that changes to the surrounding neighbourhood could be linked to the introduction of the BRT station. Similarly, in Thokoza there has been significant public-sector investment in the upgrade of the area. Although it is acknowledged that there have been some relatively minor upgrades to road and pavement infrastructure immediately surrounding the Diepkloof Station, there seems to have been less overall public-sector investment compared to the other two areas. It was thus assumed that changes to the surrounding neighbourhood over the past three to four years could be more clearly linked to the development of the BRT station and system.

Annexure B

Survey Form

Rea Vaya Diepkloof BRT impact study survey



1	Gender?	Male	Female			
2	Boarding or alighting?	Boarding	Alighting			
3	What mode of transport did you use to get here?	walk	bicycle	Putco bus	taxi	Metrobus
4	Where did you come from (street and suburb)?					
5	What is your Occupation?					
6	Monthly Income?	0-500	501-1000	1001-3500	3501-7500	7500+
7	Age	0-17	18-25	26-45	46-60	60+

8	How long did it take you to get here from your home?	mins				
9	Do you stop at shops on route to BRT stations?	Y	What type?	N-Why?		
10	Do you use the Rea Vaya on your return trip?	Y	N	N- why?		
11	If yes do you sometimes stop at shops or restaurants on your way home from the station?	Y	What type?	N-Why?		

12	How frequently do you use the BRT?	Mon-Fri	M-F + wknds	few days/wk	few days/mnth		
13	Where is your final destination this morning (suburb)?						
14	How long do you think it will take you to get to your final destination from here?	mins					
15	What modes of transport will you use to get to your final destination when you exit BRT?	Walk	Metrobus	Metrotrain	Gautrain	Taxi	Other

16	What is the purpose of your trip?	Work	Shopping	Education	Job seeking	Other	
17	Why do you choose to use the BRT?	Faster	Comfortable	Convenient	Affordable	Safety	Other

SCHOOL OF ARCHITECTURE PLANNING



Annexure C

Month	NUMBER OF TICKETS SOLD	Number of AFC Tap-Ins	Number of AFC Tap-Outs
1-Nov-09	-	-	-
2-Nov-09	1 805	-	-
3-Nov-09	1 530	-	-
4-Nov-09	1 494	-	-
5-Nov-09	1 291	-	-
6-Nov-09	1 370	-	-
7-Nov-09	613	-	-
1-Nov-10	1 830	-	-
2-Nov-10	1 435	-	-
3-Nov-10	1 204	-	-
4-Nov-10	1 095	-	-
5-Nov-10	1 105	-	-
6-Nov-10	469	-	-
7-Nov-10	120	-	-
1-Nov-11	1 139	-	-
2-Nov-11	989	-	-
3-Nov-11	878	-	-
4-Nov-11	859	-	-
5-Nov-11	345	-	-
6-Nov-11	175	-	-
7-Nov-11	1 343	-	-
1-Nov-12	1 760	-	-
2-Nov-12	1 020	-	-
3-Nov-12	941	-	-
4-Nov-12	859	-	-
5-Nov-12	975	-	-
6-Nov-12	338	-	-
7-Nov-12	291	-	-
1-Nov-13	-	641	423
2-Nov-13	-	157	115
3-Nov-13	-	33	26
4-Nov-13	-	623	443
5-Nov-13	-	671	464
6-Nov-13	-	678	477
7-Nov-13	-	665	477

Annexure D

- How long have you been living / owned a business / working / operating in the area?
- For what reasons have you located in the area?
- What kind of change have you noticed over the past few years?
- How has the BRT system impacted the area?

Annexure E

Interview Profiles

No.	Gender	Years in Diepkloof	Born in Diepkloof	Business Owner	Resident	Renting	Employee	Business on home premises	House extension	Backyard units	Interview location and observed site surrounds
1	M	30	Yes	Yes	Yes	No	No	Yes	Yes	Unknown	formal house with street fronting converted sphaza turned tavern inside stand
2	M	35	Yes	Yes	Yes	No	No	Yes	Yes	Unknown	formal house with street fronting converted sphaza turned tavern inside stand
3	F & F	32	Yes	Yes	Yes	No	No	No	N/A	No	container sphaza
4	F	10	No	Yes	Yes	Yes	No	Yes	No	Yes	formal house with informally built stall inside stand
5	M	8	No	No	N/A	N/A	Yes	N/A	N/A	N/A	BP Petrol Station Office
6	M	51	No	No	Yes	No	No	Yes	Yes	Yes	formal house with two backyard units
7	F	46	No	No	Yes	No	No	N/A	No	Yes	Formal house with 3 backyard units
8	F	3	No	No	Yes	Yes	No	N/A	N/A	Yes	In an informally constructed backyard unit, on a stand with a formal unit (respondent 5) and a number of backyard units
9	M	40	Yes	Yes	Yes	No	No	Yes	Unknown	Yes	Formal house with a number of backyard units
10	M	6	No	Yes	Yes	Unknown	No	No	Unknown	N/A	Informally constructed stall on the side walk
11	M	49	No	No	Yes	No	No	No	Unknown	Yes	Formal house with a number of backyard units
12	F & M	45	No	No	Yes	No	No	N/A	Yes	No	Formal house

NOTES

Urban Resilience Research Programme

This programme is part of the Global Change, Society and Sustainability Research Programme (GCSSRP). It is funded by the Department of Science and Technology, South Africa through a National Research Foundation administered grant (NRF Grant Number: 78645)

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Funded by the Department of Science and Technology,
and the National Research Foundation South Africa

