WHY SOUTH AFRICAN CITIES ARE DIFFERENT? COMPARING JOHANNESBURG REA VAYA BUS RAPID TRANSIT SYSTEM WITH ITS LATIN AMERICAN SIBLINGS


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ABSTRACT
The objective of this paper is to shed light on the discussion about why Bus Rapid Transit (BRT) has structural operational indicator differences between South African cities and their siblings in Latin American. Under the understanding that BRT does (and will continue to) have a role in South African mobility, South African local and national governments are working together to better understand how does BRT work in the South African context and what type of subsidization would be needed as these systems expand. Inspired by the success of BRT systems in Latin American cities (LACs), Johannesburg pioneered implementing a BRT network in South Africa, along with Cape Town. As of 2016, 43.5 km of trunk BRT corridors were fully operational in Johannesburg and their results in terms of ridership and operating cost recovery from fares were approximately one-third of initial estimates. It is widely known that, as a result of apartheid, Johannesburg urban form is characterized by an average low density and spatial patterns where the poor are located very far from opportunities. This results into passenger travel demand patterns that have long, unidirectional trips with high peak-to-base ratios, which significantly differ to the travel patterns in dense LACs where there is high turnover and much shorter journeys. The paper provides a comparative analysis of Johannesburg’s BRT structural conditions and selected performance indicators with those BRTs in LACs that originally inspired their implementation in South Africa. The comparative analysis provides unequivocal evidence that Johannesburg’s (and South African cities’) BRT, as implemented, may not have the conditions to cover its operating costs from farebox revenue and therefore will typically present significantly different operation indicators to those of its LAC siblings.

Keywords: South Africa, Public Transport, Bus Rapid Transit.
1. INTRODUCTION

Rapid population growth and urban expansion, together with a rampant increase in motorization, are overwhelming large cities in developing countries. Johannesburg, like many other, is facing significant urban mobility challenges that are too complex and sizable to be able to catch up with despite the significant efforts being carried out. Local and national level governments are well aware of the challenges in Johannesburg (and in other South African cities) and have been implementing urban transport actions since the democratization of the country in the 1990s. This comprehensive response has included the introduction of policy changes, recapitalization of informal public transport providers, subsidization of public transport, and infrastructure investments across modes, with a special emphasis in rail and bus. The implementation of a Bus Rapid Transit (BRT) system in Johannesburg inspired by its success in Latin American cities (LACs) has been part of this response. The experience from the initial stages of implementation of Rea Vaya (Johannesburg’s BRT) is of critical importance since the city is expanding it and other South African cities are rolling out their own BRT systems using Johannesburg’s BRT (and Cape Town’s) as the model.

As of 2015 Johannesburg had successfully implemented its two first Rea Vaya BRT corridors which work in a trunk and feeder approach similar to Transmilenio BRT in Bogota, Colombia. Stations have gotten international awards for architectural excellence in transit, and the buses are operating with the unprecedented involvement of the incumbent operators after a facilitated negotiation process, therefore meeting policy objectives of empowering these entrepreneurial groups to being part of a modernized business model. However, currently Rea Vaya’s ridership is significantly lower than initially estimated. Furthermore, while no operating subsidies were expected, these are now required to cover an important operating deficit. The lower-than-estimated ridership figures and fare box recovery ratio (i.e. the fraction of operating expenses covered through fares) of Rea Vaya are the result of a combination of different elements. On one hand, Rea Vaya performance has been impacted by a combination of factors that are common in other cities of the developing world such as the presence of parallel informal services offering more convenient alternatives, a degree of lack of awareness by potential users on how to use and navigate the system, and instances of limited convenience for users to access and use the fare media, and, sometimes, an increase in the generalized transport cost of the trips with respect to the ex-ante situation. On the other hand, and as it is illustrated in this paper, there are other inherent factors that have to do with the structure of the urban form and mobility patterns in Johannesburg which are very different to the ones that Rea Vaya’s LACs siblings have, and that partially prescribe the BRTs potential cover its operating costs from farebox revenue.

While the need for operating subsidies is not a departure from current South African mass transit system operation funding practice (all other rail-based mass transit systems have historically been subsidized), these (and similar results in Cape Town, Pretoria and Nelson Mandela Bay) have triggered a profound discussion at both the national and local government levels about the robustness of the planning assumptions that triggered the implementation of BRT in South Africa. In this country, the implementation of BRT was originally advanced in the last decade based on, among other premises, an expectation that BRTs would be able to operate without subsidies based on LAC BRTs practice in the first decade of the 2000s (e.g. Colombia). However, the first years of experience of BRT in South Africa have shown that fare revenue is not covering operating expenses and, therefore, its operation is also requiring a subsidy. Under the understanding that BRT does (and will continue to) have a role in South African mobility, local and national governments are working together to better understand how does BRT work in the South African context and what type of subsidization would be needed as these systems expand.

The objective of this paper is to shed light on the discussion about why BRT has structural operational indicator differences between South African cities and their sister cities in Latin American.
Rea Vaya was chosen as a case study because it was the first BRT implemented in South Africa and would arguably provide a greater level of maturity of its operation performance indicators.

This paper introduces unequivocal evidence supporting why Rea Vaya operates differently to its LAC siblings by conducting a comparative analysis. This analysis include a review of Johannesburg and LACs urban and market structural attributes, and performance indicators of their BRTs. To do so, this article starts with a section that describes the limited available literature and information, and the methodology and data used. The following section describes Johannesburg’s specific urban form and passenger travel demand patterns. Subsequently, a section carries out a comparison between Johannesburg and LACs BRTs to shed light on the structural differences that these travel markets have and provides an analysis of the effects of Johannesburg passenger travel demand patterns in the performance indicators of Rea Vaya. Finally, the authors provide a series of conclusions and policy recommendations that hope to provide value to planners and policy makers in Johannesburg, South Africa and the international urban transport arena.

2. LITERATURE REVIEW

There is limited information on the effects of the Johannesburg (and South African cities) urban form in the mobility needs and performance of its public transport modes. Most of research papers and publications on Johannesburg (and South African cities) have to do with summaries of the urban transport policy evolution and challenges, and general characterizations of the city urban form and built environment. Most of the revised literature does recognize that the “special spatial patterns” of Johannesburg result in high transport costs to households (especially to the poorest), and that transport operating subsidies are large and have had a limited impact resolving affordability considerations. In fact, the best data available (not the analysis) comes from briefings and reports (not papers) which summarize supply, demand, and performance of formal public transport modes. These documents also recognize a limited-understanding and a gap of information regarding the informal public transport providers (which in fact carry more than 50% of public transport trips). Today there is not a publicly available study, report or memo that provides an assessment of the causes of the lower-than-expected demand of Rea Vaya. Hence, the limited available information does not provide the elements to quantitatively discern how much conventional factors are impacting Johannesburg passenger travel demand and performance of Rea Vaya vis a vis travel market structural factors (which are the result of the city urban form).

As later detailed on this paper, Johannesburg passenger travel demand patterns are more similar to a commuter transport typology than to an urban multi-purpose transport typology as a result of the city urban form. Unfortunately, no single publication addressing how a commuter transport typology affects the sustainability of public transport modes (in developed cities or in developing cities in Africa) was found. In general some publications such as Cervero (1) and Martin (2) recognize that “mass transit needs “mass”, or density” to succeed and provide some general numbers needed for BRT to thrive. However, as later described in the document, the low density is a hyper simplification of the Johannesburg urban form characterized more by its uneven distribution of population than by its low average density.

It would have been especially useful to have data or information such as average trips lengths, passenger km travelled, fleet km travelled and revenue hours for all transport modes, and differences in volumes between the supply and demand during the peak and the midday for all modes. Although such information exists (or can be inferred) from the transport demand model (3), that information is not readily publicly available. This demand model supported the design of the Integrated Transport Plans of 2003 and 2013 (4; 5), which are publicly available, but, unfortunately, these documents do not mention the aforementioned desired and relevant information.

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3. RESEARCH QUESTION AND METHODOLOGY

This paper researches how Johannesburg passenger travel demand characteristics (which define the public transport market structure) and urban form are very different to the ones in LACs with BRTs. This is done using a comparative benchmarking of indicators with those of cities with BRTs in LACs. The evidence presented on this paper and its scope of work do not intend to answer more complex questions such as what are the best urban transport alternatives to implement in Johannesburg, or what degree of subsidies are needed for the public transport systems of the city. Instead, it seeks to inform and enrich these and similar discussions in order to shed additional light to inform decision making and influence planning of the expansion of BRT networks in Johannesburg, other South African cities and cities in developing countries in general.

The data from Johannesburg was obtained from several sources including the National Household Surveys from 2003 (6) and 2013 (7), the Strategic Integrated City Transport Plan (5), the BRT database (8), a document on the built environment of South African Cities (9), and Rea Vaya smart card data. For the comparative analysis with LAC cities, data was gathered from the following cities with BRT systems: Barranquilla (Colombia), Bogota (Colombia), Bucaramanga (Colombia), Guadalajara (Mexico), Leon (México), Lima (Peru), Mexico City (Mexico), Pereira (Colombia), Porto Alegre (Brazil), and Santiago (Chile). Several sources were used with data from 2010 to 2014. Sources include the BRT database (8), CAF Latin America Urban Mobility Observatory (10), EMBARQ Bus Rapid Transit Case Studies from Around the World Publication (11), Across Latitudes and Cultures – BRT Centre of Excellence Expert advisory for the advance of comparative study for BRTs document (12), and Fedesarrollo Colombia Integration of Urban Transport document (13).

4. JOHANNESBURG URBAN FORM AND PASSENGER TRAVEL DEMAND PATTERNS

4.1 Urban Form

Johannesburg is one of the administrative bodies which form the Gauteng Region. The specific urban form of the Gauteng Region, Johannesburg, and South African cities are the legacy of apartheid patterns of urban segregation, by which the black poor were intentionally located in high-density peripheral townships away from the city center where social and economic opportunities mostly remained. The Gauteng Province is comprised of several urban conurbations which interact with each other; hence its branding as the Gauteng City Region (14). The Gauteng Region is the smallest province of South Africa but it accommodates more than 12 million inhabitants, 33% of the national Gross Domestic Product (GDP), and 10% of the African continent GDP (14).

Johannesburg accommodates more than 4.4 million inhabitants (15) with a rapid population (3.2% per year (15)) and a large informal urban growth. The number of residential units grew by more than twenty thousand per year from 2001 to 2009 of which only seven thousand were formal (14). About 44% of Johannesburg population falls within the national category of low income profile. The city density is 2,700 inhabitants per square kilometer which, while on average is low, does not reflects the wide variation in density across the city. Indeed, it could be more appropriate to characterize the Johannesburg, Gauteng, and South African cities by their uneven distribution of population than by its low average density (9) as shown in FIGURE 1. In general terms, the Johannesburg area could be characterized by high density low income “townships”, low density suburbs and single family detached low income housing, and great parcels of land in between with low density or scattered development.
4.2 Current Status of Johannesburg Urban Mobility

The decrease in the share of motorized public transport trips (at the expenses of an increase in the share of private automobile trips) is hindering sustainable mobility in Johannesburg. The Johannesburg 2003/2008 Integrated Transport Plan (4) lays out how in 1995 the “selective” (i.e. trip makers that can afford a car but are prepared to use public transport) and “stubborn” (i.e. trip makers that will only use car to get to work) corresponded to the 31.9% and 33.1% of the trips makers whereas in 2002 they corresponded to the 19.1% and 39.4% respectively. This may partially help explaining why by 2013 the share of morning public transport trips for work and study in the city was 50.7% whereas this number was 57.4% and 59.6% in 2003 and 1996 respectively (16; 17). Likewise, between 2004 and 2013 population increased around 37% (7) while the demand of both private and public transport increased 76% and 34% respectively (6; 7; 16).

Authorities are well aware of the challenges and have been promoting a sustainable transport agenda after the democratization of the country in the early 1990s. Gradually, there has been a shift from the “dominated concern for the convenience of private motorist” (9) to a concern for the convenience of people. Several policies, legislations, plans, and actions have been taking place for more than 20 years. For instance: the White Paper on National Transport Policy of 1996, Moving South Africa document, National Land Transport Transition Act from 2000 its respective amendments, a push for decentralization reflected in the agenda of devolution of competences to local authorities, bus contract restructuring processes, minibus (known as taxis in South Africa) recapitalization schemes, and investments in urban rail (Metrorail and Gautrain) and BRT systems. In addition, the National Government is providing significant funding for public transport. For fiscal year 2014-2015, National support to capital and
operating expenses of public transport was approximately USD 2.2 billion (16). However, if the current
tendency continues, travel demand will increase but the share of public transport will continue to
decrease. By looking in detail at the distribution of Johannesburg public transport trips, it is possible to
observe that the informal minibuses (known locally as taxis) carry 50% (or more) of the motorized trips.
The other 50% is split into 32% Metrorail, 6% formal subsidized commuter bus services (including
Putco), 5% formal urban public bus service (Metrobus), 4% Gautrain, and 3% BRT (Rea Vaya) (14).
Additionally, 18% percent of household at the national level are spending more than 20% of their income
on transport (7). Interestingly, informal minibuses do not require direct operating subsidies while all other
publicly operated modes do benefit from it.

Regarding Rea Vaya (which is in the focus of this paper), Phases 1A and 1B are already
implemented and have entered into revenue service (as of 2015). Its 2015 network was comprised of 43.5
km of trunk services, 14.7 km of complementary bus services operating in both preferential and mixed
traffic lanes, and 75.8 km of feeder buses services in mixed traffic lanes.

4.3 Passenger Travel Demand Patterns
There is limited available information about the passenger travel demand patterns in
Johannesburg. This vital information should exist (or can be inferred) from the transport demand model
(3) but this info is not publicly available. The Integrated Transport Plans (4; 5), which were based on the
transport demands model, are publicly available but do not mention important information such as
average trip distance, and passenger km for all transport modes.

Nonetheless, estimates could be inferred based on Rea Vaya and city information. Regarding trip
distances a typical example could be the trip distance between Soweto, the largest Johannesburg
Township with more than one million inhabitants, to Johannesburg Central Business District (CBD)
which is around 27 km. However, the average trips distances would arguably be longer since, for
instance, the distance between Soweto to Sandton (an affluent area north of Johannesburg CBD) is around
40 km. As a validation of the 27 km estimate, the 2013 Strategic Integrated Transport Plan Framework
mentions than in a desirable future scenario, with compact developments and an increased average
density of 4,000 inhabitants per square km, the average trip length would be 20 km (5).

On top of the lengthy trip distances, the demand peak-to-base ratio of Johannesburg is very high.
This ratio is a common way to measure the degree of passenger demand and is defined as the ratio of the
highest passenger demand in the peak period to the lowest demand during the midday. This statistic is not
publicly available but as a point of reference, data from Rea Vaya is presented. Using the smart card data
from such system the demand peak-to-base ratio was calculated at 8.9.

5. COMPARISON BETWEEN JOHANNESBURG AND LATIN AMERICAN CITIES WITH
BRT
Rea Vaya, or the “Jo’burg’s Latino Gaubus” as once called in a news article, was inspired in the
initial success of Latin American BRTs (18). Nonetheless, there are structural differences in the travel
demand patterns of Johannesburg and LACs BRTs that affect the performance of Rea Vaya.

This section provides a comparison on general city characteristics, urban form, travel demand
patterns, and BRT infrastructure and operation performance.

5.1 General and Passenger Travel Demand Patterns Comparison
In order to contextualize Johannesburg with respect to LACs, it is important to illustrate that
Johannesburg is in the range of the LACs population and modal share as shown in FIGURE 2 (a) and (b).
However its population density is significantly below LACs as shown in FIGURE 2 (c). Urban form has a
direct impact on passenger travel demand patterns. Due to the urban form features described above in the
paper, travel patterns in Johannesburg translate into long average trip lengths and high peak-to-base ratios (i.e. the ratio of the highest passenger demand in the peak period to the lowest demand during the midday). Using the 27 km average travel distance proxy based on the distance from Soweto to Johannesburg Central Business District (CBD), the comparison with average trip lengths for BRT systems in LACs presents a substantial deviation, as shown in FIGURE 2 (d). The closest number is from Mexico City, a city with more than 20 million inhabitants, that has an average trip distance 9 km shorter than Johannesburg (12).

More abrupt are the differences between Johannesburg and LACs in terms of public transport demand peak-to-base ratio, as shown in FIGURE 2 (e). Based on the fare card information from a typical day, it was estimated that this ratio is 8.9 for Rea Vaya. In contrast, LACs are typically in the range of 2 to 3 (Transmilenio in Bogota has a ratio of 2.8, Transantiago buses in Santiago de Chile have 2.4, and Metrolinae in Bucaramanga has 2.1). Moreover, the maximum loads are relatively low (around 5 thousand passengers per hour per direction (pphpd), as per 2014 data). This load is close to the ones in medium size cities (less than 1.5 million inhabitants) such as Pereira, and Bucaramanga, as shown in FIGURE 2 (f).

![FIGURE 2 General and Passenger Travel Demand Patterns Comparison between Johannesburg and LACs.](image)

5.2 BRT infrastructure and operation performance comparison

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Currently Rea Vaya has 43.5 km of trunk corridors (see FIGURE 3 (a)) constructed using typical Latin American BRT infrastructure features including segregated right of way, off board payment, large stations, level boarding, and articulated and regular buses serving trunk corridors, complemented with buses circulating in mixed traffic for feeder routes. Phases 1A and 1B of Rea Vaya were originally forecasted to transport 162 thousand journeys per work day (19). Phases 1A and 1B implemented currently report estimated 60 thousand journeys (i.e. a one-way movement that may comprise feeder, trunk and distributor components, paid or unpaid) per workday. This has led to a fare revenue to vehicle operating cost ratio of 32% (20) (21), significantly below the original planned estimates to cover direct operating cost with fare revenue. When comparing with LAC BRTs, both Rea Vaya ridership is significantly lower as shown in FIGURE 3 (b). When normalizing ridership per km of trunk corridors, Rea Vaya performs with 1379 riders per km of trunk corridor infrastructure, which is significantly below LACs BRTs as shown in FIGURE 3 (c). In terms of productivity, measured by passengers per bus-km and riders per bus, Rea Vaya is significantly lower than its LAC equivalents, as shown in FIGURE 3 (d) and (e). Lastly, when comparing the fare box recovery ratio (only for covering direct bus operating cost), Rea Vaya is two to four times lower than its LAC equivalents as shown in FIGURE 3 (f). Interestingly, even if the ridership forecast for Rea Vaya had been realized its weekday ridership per km of BRT trunk infrastructure, passengers per bus-km, and fare box recovery ratio would still be lower than the LACs that have been used for this analysis. For comparative purposes, it is important to caveat the following two considerations. First, direct bus operating cost, as defined per the National Grant Framework in South Africa, is the payment to operators to cover all costs of contract including overheads, labor, fuel, tires and vehicle maintenance. In LACs, the payment to operators also should cover the scrapping of old fleet, and the cost and depreciation of new fleet. Second, LACs were planned to use farebox revenue to cover direct vehicle operating cost but also fare collection, infrastructure – terminals in some cities-, and management of the oversight entity. As of today, few LACs have been able to cover for all those additional expenses leading to the need of “operating” subsidies.
5.3 UNDERSTANDING REA VAYA’S UNIQUE OPERATIONAL INDICATORS

The lower-than-forecasted operational performance of any mass transit service is the result of a combination of many interrelated factors associated with the urban form and transport market characteristics. For instance, the presence of parallel informal services offering more convenient and direct alternatives, high relative cost of providing scheduled and extensive feeder services; a degree of lack of awareness by potential users on how to use and navigate the system, instances of limited convenience for users to access and use the fare media, and, sometimes, an increase in the generalized transport cost of the trips with respect to the ex-ante situation. Some of them are common in LACs but, as illustrated in the section above, Johannesburg passenger travel demand patterns undeniably impact the operational performance indicators of Rea Vaya.

The effects of the commuter transport characteristics of Johannesburg (i.e. long average trip distances and peak-to-base ratio) as well as the low concentration of passenger volumes (even in the peak) has tremendous implications in the capital and operating cost of any conventional mass transit alternative due to three reasons detailed hereafter.

The first reason is that the fleet size and number of drivers needed in a system are directly correlated with route cycle times (which are directly related to lengthy and congested routes). When routes are short it is possible to run more trips with the same bus and driver. Rea Vaya’s longest roundtrip route is 50 km long. Moreover, longer routes require more fuel than shorter ones (even though fuel efficiency is better in a commuter-type due to fewer stops).

The second reason is that commuter transport has a low passenger turnover and unidirectional trips. A seat in an urban public transport route can be sold many times during one-vehicle trip (there are lots of passengers boarding and alighting) whereas in commuter transport case a seat is luckily sold once in a bus trip. In addition for a typical tidal flow arrangement busses tend to return back to its origin, to
start its next peak trip, with fewer passengers.

The third reason is that the low passenger demand during the midday in comparison with the peak (i.e., high peaking) translates into fewer opportunities to use efficiently both the fleet and operators. Rea Vaya carries 1.054 more trips during the busiest hour (between 6 and 7 am) than during the second busiest hour. The extra buses needed to serve this additional demand must be only amortized by the earnings generated during this hour. In contrast, buses needed to serve the passengers between 10 and 11 am can be amortized by the earnings generated over the whole day. A similar situation occurs with labor because there are operators that are only needed during one hour a day, as shown in FIGURE 4 (a). This situation is exacerbated if working rules give low flexibility to, for example, hiring part-time operators. Rea Vaya drivers are demanding to have similar conditions to ones of Metrobus in Mexico City (i.e., the bus system publicly operated buses of the city center) drivers. For example, in one of Rea Vaya’s strikes, drivers were explicitly complaining about “having to start [working] at 4am and have a break at 9am. And then be back on duty at 6pm and then knock off at 9pm”. (22). Lastly, in order to keep the service attractive in the midday, Rea Vaya is providing a minimum level of service (20 and 30-minute headways in most routes). However, the demand during such period is so low that even these long headways constitute both an oversupply and inefficient use of the resources.

To provide further evidence of the reasons behind the large operating cost, an additional comparison between demand and supply profiles is provided for Rea Vaya and other public transport systems are presented in FIGURE 3. Rea Vaya has to provide a minimum level of service during the midday hours requiring a larger fleet and “oversupply” services for that particular period. As a consequence, the supply of Rea Vaya services in the midday time period is 2.3 times greater than its demand needs, as shown in FIGURE 4 (a). Conventional BRTs in LACs, such as Transmilenio and Metrolinea (Bucaramanga), have a lower gap with a supply only 0.2 times larger than demand, as shown in FIGURE 4 (b and c). Transantiago buses, which combines BRT and conventional bus services, has a supply 0.6 times larger than demand, as shown in FIGURE 4 (d). As a reference, two other examples are used. The Fairfax connector bus in Virginia (USA), which has a similar weekday demand to Rea Vaya’s shows a demand profile which does not present such high peaking. This allows the system to have a supply only 0.5 larger than its supply, as presented in Figure 4 (e). Lastly, the Loudoun Country bus in Virginia (USA), a traditional commuter service, is shown in FIGURE 4 (f); despite its large demand peaking, its supply and demand profile are closer to each other because of the possibility of shutting down service during the midday -something Rea Vaya cannot do-

Another variable taking a toll in operating costs (bus operating cost, fare collection cost, station management costs and control center costs is some of the Rea Vaya BRT features. Some of these features (trunk operation with articulated buses only, median closed stations at every stop location along trunk routes, some of the very large stations with several platforms) may be a better fit for cities with structural attributes of the travel market where there is much higher passenger turnover and greater volumes of passengers (in terms of passengers per hour per direction, and number of passengers at stations). In the case of Rea Vaya, with the current maximum load in the busiest corridor during the peak period at approximately 5 thousand pphpd, some of these features may not be that cost-effective, both from the operating cost side but also from the capital cost side. For example in contrast, today Bogota’s BRT (Transmilenio) requires in its busiest corridor a capacity that can handle a load of 48 thousand per hour per direction (pphp) during the peak (8). This means that if only using articulated buses this corridor need to have 12-second headway. Hence, in order to deliver this headway Transmilenio does need all the “BRT features” –whereas Rea Vaya may need only some of them since the ridership is approximately nine times less than Transmilenio’s. In the case of Rea Vaya, where headways are currently no shorter
than 90 seconds, there is more potential for rethinking the service planning approach (and its corresponding capital planning) and to do it especially in the upcoming phases.

(a) Rea Vaya (Joburg, South Africa)  
(b) Transmilenio (Bogotá, Colombia)  
(c) Metrolinea (Bucaramanga)  
(d) Transantiago buses (Santiago de Chile, Chile)  
(e) Fairfax buses (Fairfax, VA. USA)  
(f) Londoun commuter bus (VA. USA)

Difference of ratios: **2.3 times larger**  
Difference of ratios: 0.2 times larger  
Difference of ratios: 0.2 times larger  
Difference of ratios: 0.6 times larger  
Difference of ratios: 0.5 times larger  
Difference of ratios: 0.4 times larger
6. CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Johannesburg Passenger Travel Demand Patterns are Structurally Different to Latin American Cities with BRT Due to Its Unique Urban Form

Comparative general characteristics such as population, size and income between Johannesburg and LACs with BRTs could arguably provide certain level of similarity. However, when comparing passenger travel demand patterns, significant differences of average trip lengths and demand peak-to-base ratio are identified. In addition, the maximum loads in the corridors of Johannesburg are significantly lower when compared to the typical BRT corridors in LACs. These patterns are the result of the unique urban form of Johannesburg characterized by: (i) long distances between townships (where the majority of job-related trips are originated) and opportunities (in the city centers) and (ii) an uneven population distribution with wide variation of densities along the BRT corridors.

In summary, Johannesburg passenger travel demand patterns more closely resemble a commuter transport typology than a typical urban transport travel pattern. The long average trip distance and high demand peak-to-base ratio of Johannesburg are more similar to a commuter transport travel typology than to traditional urban transport.

6.2 There Are Conventional Factors Affecting the Performance of Rea Vaya; however, the Effects of the Johannesburg Unique Travel Passenger Demand Patterns in its Operational Performance are Undeniable

The current performance of Rea Vaya is the result of many elements combined. Some of them are not uncommon in the LACs (such as the presence of parallel informal services which offer more convenient alternatives for users, lack of awareness of potential users about how to use and navigate the system, etc.) but the unique Johannesburg passenger travel demand patterns undeniably are also affecting the operational performance indicators of the system compared to those originally estimated. Johannesburg’s urban form has effects on the travel passenger demand patterns that is characterized by long average trip distances, high peak-to base ratio, and low concentration of passenger volumes (even in the peak). These characteristics influence the performance of Rea Vaya because: (i) they increase the fleet size and number of operators needed, (ii) they translate into a low passenger turnover, and (iii) they entail low productivity for fleet and labor during the midday off peak service. This applies not only to BRT but also to any public transport mode.

6.3 Any Public Transport Solution Introduced in Johannesburg and South African Cities needs to be Context Sensitive. “One-size does not fit all” when referring to urban transport solutions (23), and this is applicable to the successful LAC BRTs too.

Implementing context-sensitive transport solutions is germane for project success, especially when the urban form context and travel patterns are so different to those of the cities that inspired Rea Vaya. Unfortunately, the customization process needed when implementing a BRT, and described in the literature as a critical but difficult challenge (23), did not take fully into account the difference in travel demand patterns of Johannesburg. Structural travel market differences must be taken into account in the planning and technical and financial design of future BRT corridors and axiomatic assumptions such as BRT being able to fully cover direct operational costs through fare revenue cannot always be extrapolated.
6.4 For Johannesburg, the Unique Urban Form and Travel Passenger Demand Patterns Implies that the BRT Projects Implemented Ought to have Some Degree of Operating Subsidy

Even if the ridership forecast for Rea Vaya had been realized (today the numbers are only one third of the original estimates) weekday ridership per km of BRT trunk infrastructure, passengers per bus-km, and fare box recovery ratio would be significantly lower than the LAC cities studied and for whom covering direct operating costs with fare revenue cannot be taken for granted. While this paper has not studied the performance of other modes different to BRT in South Africa, arguably some type of subsidization will have to continue to support mass transit (commuter rail and BRT) in the near and medium term in South Africa as long as cities continue to present this urban form and implement BRT in the way they are laying it out in their metropolitan areas.

6.5 For South Africa, the “Flexibility of the Buses” Offered by a BRT Solution Needs to be More Exploited than the Mass-Level Transit Capacity They Offer.

BRT is defined by some authors as a “rapid mode of transportation that can provide the quality of rail transit and the flexibility of buses” (24). A more enthusiastic definition describes BRT has been “a high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services at metro-level capacities”. Current BRTs in South African cities are providing both “metro-level capacities” and the “quality of rail transit” but may not be very cost-effective solutions for the South African metropolitan areas urban form. Among the reasons behind the need for mass transit in dense cities are the high both volumes of passengers per hour per direction and the volume of passengers per stop during the peak. Rea Vaya, like other BRTs in South Africa, has neither of those. The challenges in Johannesburg are less on providing mass-transit capacity and more on how to address its unique travel passenger demand characteristics, which are more similar to a commuter transport. There is little literature on how to address commuter transport with a sustainable approach and even less literature related with this issue in the context of cities in the developing world, but researchers and practitioners need to approach service planning as the driving principle for bus transit solutions, and not as a concept to be resolved after infrastructure is designed or implemented. A good start could be capitalizing on the “flexibility of the buses” feature that current informal operators have and tailor the services to the relatively low mass transit demand, the high peaking, and the low demand in the off-peak periods with creative approaches that minimizes access times (walking and waiting) and perhaps could work as a demand-responsive service during non-peaks.
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