

BIKE SHARING IN JOHANNESBURG – TRENDY IDEA BUT IS IT FINANCIALLY FEASIBLE?

L De Beer, D Valjarevic

GIBB, P O Box 2700 Rivonia 2128

Tel: 011 519-4600; Email: Ldebeer@gibb.co.za

Tel: 011 519-4600; Email: Dvaljarevic@gibb.co.za

ABSTRACT

Bicycle share programmes are a fast growing trend in urban transportation. The premise of giving a community struggling to afford public transport access to a seemingly low cost bicycle alternative is attractive. The City of Johannesburg (COJ) has commissioned a technical and financial assessment of the viability of piloting a Bike Sharing Scheme (BSS) in one of five potential areas, with the desired outcome being a sustainable business model and contract specification. The study analysed potential passenger demand, topography, cycling infrastructure, technology options, operational models, and quantified expected costs and revenue. While considered technically feasible, none of the scenarios evaluated was estimated to cover its operational costs, and would therefore require subsidies. Internationally, most cities subsidise its BSS, arguing that it is an extension to their public transport system, which is not expected to be subsidy-free. This paper argues that Johannesburg could potentially make a bigger difference by investing in alternative programmes to increase access to cycling in the communities which were assessed in this study.

1 INTRODUCTION

The City of Johannesburg (COJ) has commissioned a technical and financial assessment of the viability of piloting a Bike Sharing Scheme (BSS), with the desired outcome being a sustainable business model and contract specification. The scope of the study emphasised commuter and educational trips, and was limited to five potential areas mainly housing lower to middle income communities namely **Diepsloot-Fourways, Alexandra-Sandton, parts of the CBD and Soweto**, and the route linking **UJ/WITS campuses** (CoJ, 2013). The technical feasibility study (GIBB, 2014) analysed demand, topography, infrastructure, technology options, and operational models for all five areas, and narrowed down the Alexandra-Sandton area for further consideration and financial analysis (GIBB, 2015).

ITDP's Bike Share Planning Guide (Gauthier A, et al, 2013), hereafter referred to as the ITDP Guide, was referenced extensively during the above study as the authors deemed it to be the most thorough and holistic guide available on bike share systems' history and current best practice, extensively referencing data from dozens of BSS programs worldwide to identify common performance metrics indicating a BSS system's success¹.

¹ Where relevant, more up to date information from referenced international BSS systems was accessed from the systems' websites, as most systems are continuously evolving and 2014 information may therefore differ from information in the 2013 Guide.

Cycling is an ideal transportation option for short-distance trips – faster than walking, potentially cheaper than using public transport and environmentally friendly (Pettinga, 2009). According to the ITDP Guide, providing a BSS can reduce a city’s congestion and improve air quality by encouraging a modal shift from private cars to public transport, through providing a more efficient “last mile” option, and it may even replace some short car or public transport trips. It further offers an active transport choice, exercise being widely accepted as providing both physical and mental health benefits. The Guide notes that a BSS, when implemented well, can also improve the image of cycling (cycling culture) and because cycling is a sustainable transportation option, the BSS can also improve a city’s image and branding as a “green” or innovative city, which in turn may result in attracting other positive spinoffs.

With all these purported benefits, it is no wonder that Bike Share Schemes (BSS) are rapidly growing, with more than 600 cities around the world having joined the trend (Gauthier A, et al, 2013). However, research that examines the broad impact of BSS on transport behaviour, emissions and congestion, as well as health and physical activity is limited, and while there is some evidence that BSS increases bicycle mode share, the majority of users have switched from another sustainable mode (walking, public transport and using their own bicycle) (Fishman, Washington and Haworth, 2013). Peer-reviewed literature is also largely silent on the financial sustainability of bike-sharing systems but there are numerous anecdotal references in online blog commentaries and the popular press on well-known BSS systems requiring substantial financial bail-outs (for example www.nytimes.com, 2014 and www.ft.com, 2015). Implementing a costly system may also divert scarce resources away from other important NMT projects such as provision of safer infrastructure for pedestrians and cyclists (Kumar, A., Meng Teo, K., Odoni, A. R., 2013).

The aim of this paper is to venture an opinion, based on the findings of the above study, on whether a suitable, financially sustainable BSS solution can be tailored to the local context. Although the paper also briefly summarises the main technical feasibility aspects that were considered, its focus is on the analysis and findings of the potential demand estimates and subsequently the likely financial performance of various alternative solutions. The paper concludes with alternative programmes that can be considered and suggestions for further quantitative research.

2 BENCHMARKING JOHANNESBURG

The demand for non-motorised transport within a particular area is highly correlated to the population density and income characteristics (Cui et al, 2014). To estimate the potential demand for cycling, and by extension the potential use of BSS bicycles, the study commenced with a literature search to identify cities that have successfully implemented BSS², which also have similar characteristics to Johannesburg in terms of size (geographic land area and population density) and income per capita.

A comparison of the cities comparing most closely on some of these measures to Johannesburg, is shown in **Table 1**. Paris and Mexico are also listed as they are considered by ITDP to be especially successful. Of the systems in **Table 1**, the Paris

² According to benchmarks for defining success proposed in the ITDP Bike Share Planning Guides

system is the only one that was positively confirmed to be self-sustaining and turning a profit for the operator (Dutrieux, J., Madoda, D. 2014). Other African and Asian cities tend to have lower incomes per capita, but typically have significantly higher densities and were therefore not considered comparable to Johannesburg.

The city most similar to Johannesburg in terms of income and geographic size is Rio de Janeiro, but its density is more than twice Johannesburg's. Milan and Toronto on the other hand are closest to Johannesburg in terms of size and population density, but its income per person is substantially higher than Johannesburg's. The BSS of Toronto, Brisbane, Milan and Miami were studied in more detail to assist with defining the system coverage and other characteristics of the potential study areas within the study scope.

Table 1: Comparison of Key Characteristics of Selected Cities with BSS

City	Area (km ²)	Population (M)	Density (pp/km ²)	Indicative GDP per capita, (\$) ³	BSS: Bikes/Stations [Coverage] ⁴	Use ^(*)
Johannesburg, South Africa	1645	4.4	2700	\$21 140	-	-
London, UK	1623	8.3	5170	\$82 250	10 000+ / 700+ [>70 km ²]	A
Rio de Janeiro, South America	1580	10.8	6530	\$18 200	600 / 60 [Varies]	A
Toronto, Canada	1655	4.3	2650	\$59 843	1000 / 80 [9 km ²]	B
Brisbane, Australia	1603	1.5	950	\$70 955	2000 / 150 [16 km ²]	B
Milan, Europe	1554	4.3	2750	\$50 000	4050 / 216 [25 km ²]	A
Miami Beach, USA	2891	4.9	1700	\$52 043	1000 / 100 [15 km ²]	A
Paris, France	2723	9.6	3 540	\$70 720	16 000 / 1200 [>120 km ²]	A**
Mexico, Mexico City	2072	17.4	8 400	\$20 240	4000 / 275 [34 km ²]	A

Source: GIBB, 2014

* Use: A = above and B = below DITP (Gauthier. A. et al, 2013) benchmark

** Velib in Paris is the only BSS in the above list that could be confirmed as not requiring any subsidies.

³ Approximate order of magnitude of income per capita was calculated by averaging the latest figures available from the following web-based sources: "Global City GDP 2013-2014". Brookings Institution; "Global City GDP rankings 2008-2025". PWC; "The Most Dynamic Cities of 2025", 2012. McKinsey Global Institute Cityscope database 2.0.; "Economic Growth Widespread Across Metropolitan Areas In 2012", U.S. Department of Commerce: Bureau of Economic Analysis. September 17, 2013

⁴ Gauthier A, et al, 2013, supplemented by the following web-based sources: www.tfl.gov.uk, www.mobilicidade.com.br, www.bikesharetoronto.com, www.citycycle.com.au, www.bikemi.com, www.decobike.com, www.velib.paris, www.ecobici.df.gob.mx, 2014

3 DEMAND ESTIMATION

The travel patterns revealed in the 2013 Household Travel Survey (HHTS) (COJ, 2013) were used as the basis for the demand estimates. While all five areas were analysed extensively during the technical feasibility stage, this paper mainly reports on the findings for the Alexandra-Sandton route, which was considered to be the most feasible area to pilot from a technical perspective and was subsequently analysed for financial performance.

The main factors that explain bicycle ridership are closely related to socio-economics, demographics, and built environment attributes including density of population, housing and employment (Saelens et al., 2003). Pucher et al. (1999) also considered convenience (availability, cost, and speed) of competing modes. Factors that negatively reduce the propensity of cycling include the limited availability of segregated cycle facilities, bicycle parking and levels of experience (Hunt and Abraham, 2006). The high level demand estimation was done by estimating the total number of trips that could potentially be done by bicycle, by estimating the current trip distribution, and thereafter applying an assumed market share (based on the current actual mode share of cycling) by trip purpose and income group, taking into consideration the time and cost of cycling (using the proposed BSS) compared to that of the available competing modes.

3.1 The distribution of all trips to and from the study areas

Fishman, Washington and Haworth, 2013, using survey data from 5 BSS systems in Australia, America and the UK, found that these systems generally replaced relatively few car trips (on average only 15%), the remainder diverted from walking, public transport and using their own bicycles. The focus of the demand estimation in the Johannesburg Study was therefore placed on quantifying walking trips and public transport trips originating in the study areas, in order to estimate the potential diversion to the proposed new BSS. This is a conservative assumption to avoid overestimation of demand, given limited data to prove otherwise. Given the typical coverage area of BSS in the cities benchmarked, a 2.5km radius was selected around the routes specified in all the areas except for Soweto, where the whole built-up area within a 10km radius from the center of Soweto was considered.

The trips that were assumed to be eligible to use the BSS as a replacement for their current primary transport mode, were trips originating in each coverage area that also have destinations within the area served by the BSS. The percentage of those trips ranged from only 26% in the Johannesburg CBD, 55% in the Sandton-Alexandra area and up to 69% in Soweto. Trips to destinations outside the coverage area cannot be served with the typical BSS model, as the BSS bicycle has to be returned to a kiosk within a limited time period⁵.

The average “last mile” walking time of public transport users with trips ending in the Johannesburg and Sandton CBDs, the two most significant employment nodes in the

⁵ BSS as a feeder to existing public transport were not included in the analysis as research indicated that new trips generated by BSS is limited, finding that the average proportion of new trips generated in the five systems analysed were less than 4% (Fishman, Washington and Haworth, 2013). In the case of Alexandra, if the longer distance public transport trips were assumed to increase by 5% due to the availability of BSS, this would add approximately 20% to the estimated BSS trips.

study area, was also analysed using the household survey data. The analysis indicated that the average walking time of public transport users are generally below 10 minutes and weighted by mode it is only 3.5 minutes and 4.7 minutes in Johannesburg and Sandton CBDs respectively. It was deduced that this can be explained by the fact that the majority of public transport users use mini-bus taxis, which drop off fairly close to passengers' final destinations. It was therefore considered unlikely that many of these passengers would switch to cycling using BSS, given the additional inconvenience of walking to the nearest BSS station and checking out a bicycle, even if the cost thereof was not significant. From the data, the user group with the longest walk time is Gautrain users that don't make use of the Gautrain feeder bus (12 and 15 minutes in Sandton and Johannesburg CBDs respectively) and some of these may consider using a bicycle. However, as this high income user group represents a very small proportion of all trips to the CBDs, the number of potential BSS users in this market is expected to be negligible and they were not considered further.

3.2 Current Mode Share of Cycling by Trip Purpose and Income Group

From the household survey data, educational and commuter trips account for 80% of all trips in the morning peak (COJ, 2013), and the analysis therefore focussed on these market segments in order to size the system. The current mode share of cycling in Johannesburg as a whole is only 0.2%, but if the analysis is contained to trips less than 10km (for which cycling is considered to be a viable transport alternative), cycling's mode share rises to a maximum of 6.9% for low and medium income commuters, as indicated in **Figure 1**. The mode share of cycling by high income commuters was found to be negligible, even over the shorter distances, and because of the relatively low proportion of this income group in the coverage areas, was excluded from further analysis. The mode share of cycling for educational purposes was found to be zero in all income groups.

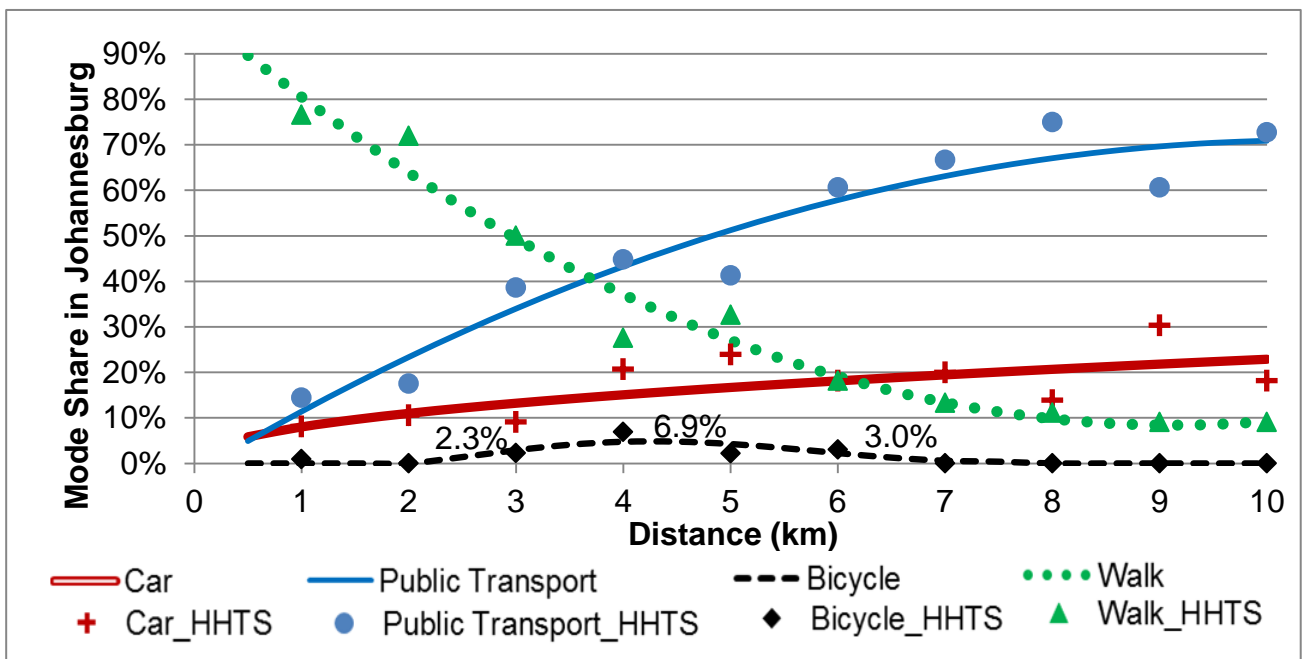


Figure 1: Current Mode Share of Low and Medium Income Users up to 10 km
Source: GIB, 2014

3.3 The Time and Cost of Cycling using the BSS Compared to the Use of Other Modes

The generalised cost of low income commuter trips up to 10 km long was estimated by mode, to determine the order of BSS fees that would likely be affordable when compared to the other existing available options, refer to **Figure 2**. The generalised cost was estimated by adding the cost of using the mode, and the value of time to cover the distance. Key assumptions used in the generalised cost calculations for the existing modes are R6/hr value of in-vehicle time (low income), minibus taxi fare ranging from approximately R7 for local feeder trips, up to R10 for a 10km trip, and car's perceived cost per kilometre (fuel only) was taken as R1.30/km (GDRT, 2013 escalated at 6% p.a.). For the new mode, an average cycling speed of 10km/hr and a monthly BSS fee of R50 (equating to a fee of R1.25 per trip for commuters using it 5 days per week) was used⁶.

Figure 2 indicates that for low income commuters, using a bicycle (at the assumed fee if R50 per month) is the optimum option in the range of 2km – 6km, corresponding to the distance range where cycling is most prevalent as indicated in **Figure 1**. Furthermore, after using a car, walking is the next most efficient mode up to 2km. At 4.5km (+- 1 hr walk), minibus taxi becomes a better proposition than walking.

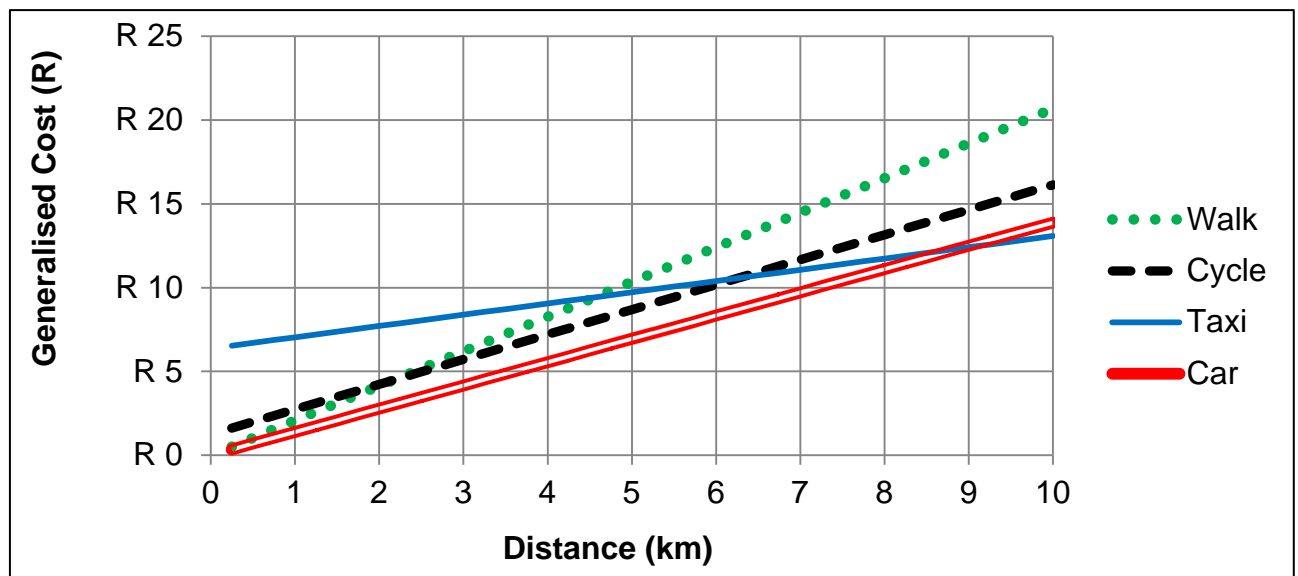


Figure 2: Generalised Cost of Modes (Low Income Commuters)

Source: GIBB, 2014

Similar calculations using the higher value of time of middle and high income users indicated that car and minibus taxi is the most cost effective modes for all but those trips less than 0.7km (approximately 10 minutes' walk). This is deemed to explain why the household survey data indicates such low bicycle mode share for these user groups and it is furthermore deemed highly unlikely that these user groups would shift to the use of bicycles on cost and time saving grounds only.

⁶ The BSS fee was varied to change the slope and intersection of the BSS generalised cost function to find the fee that would result in bicycle being the choice mode in the distance range within which the observed cycling mode share as obtained from the household survey data in Figure 1 is the most prominent.

3.4 Weighted Market Share, Population and Trip Rates

The assumed cycling mode share per market segment, which ranged between 2.5% and 10%, based on the current actual mode share of cycling in Johannesburg over shorter trip distances (up to 10km), was weighted by the proportions of low and medium income commuters and scholars. The resultant mode shares ranges between 3.4% and 7.4%. Next the total uptake percentage was calculated by multiplying the weighted average mode share for each market segment, by the percentage of trips eligible in terms of the distance. Finally, the population in the catchment area, determined from Census 2011 data (Stats SA, 2012), was multiplied by the trip rates per person in the AM peak period (calculated from the COJ Household Survey Data 2013), and the total cycling uptake rate, to determine the total trips that could potentially be attracted to cycling.

The number of bicycles required to satisfy the estimated demand was then calculated with the assumption that there will be only one trip per peak period per bicycle, so that the re-distribution of bicycles is avoided. If more than one trip is made in the peak hour per bicycle, less bicycles will be needed (but re-distribution will be needed if the flow is mostly one-directional, which is a characteristic of Alexandra-Sandton area) and the assumption is therefore deemed considered conservative for the purpose of system sizing. Lastly the number of BSS stations needed was calculated assuming 10 bicycles per station, as recommended in the ITDP Guide.

Table 2 shows the population in each coverage area (Census, 2011), the AM peak trip rates per person (COJ Household Survey Data), the estimated take-up rate calculated as described above, and finally the resultant number of bicycles and BSS stations, average BSS station spacing⁷ and coverage and the calculated number of bicycles per 1000 population. The table headings also contain the ITDP recommended benchmarks, demarcated by the * symbol.

From **Table 2** it can be seen that the best performing areas are Diepsloot and Alexandra. The demand in the CBD and on the UJ/WITS corridor seems to be limited. BSS station spacing in Diepsloot and Alexandra is not significantly more than the ITDP recommended benchmarks, and with further refinement of the areas to be served, it may be possible to concentrate the number of stations into a smaller area without losing too many potential system users.

⁷ The average BSS station spacing is calculated by taking the square route of the area covered per BSS station, assuming an even spread of the calculated number of BSS stations over the total catchment area.

Table 2: Estimated Bicycles and BSS Stations

Area	Coverage Area Population and (AM Peak trips/person)	Estimated Cycling Uptake Rate: *3-6%	AM peak period Bicycles & (BSS Stations)	Ave. station spacing: *300m [Coverage: *10km ²]	BSS per 1000 residents: *10 - 30
Diepsloot	137 955 (0.4)	0.6%	301 (30)	406m [5 km ²]	2.2
Alexandra	166 355 (0.3)	0.5%	288 (29)	638m [12 km ²]	1.7
CBD	256 888 (0.3)	0.1%	79 (8)	1 513m [18 km ²]	0.3
Soweto	1 641 601 (0.2)	0.6%	2 220 (222)	854m [162 km ²]	1.4
UJ/WITS	605 613 (0.3)	0.2%	386 (39)	1923m [143km ²]	0.6

Source: GIBB, 2014

* ITDP Performance Benchmarks (Gauthier et al, 2013)

Although Diepsloot has a somewhat higher estimated uptake than Alexandra, Diepsloot was considered too far from the nearest large commercial node (taxis are considered more efficient for this trip given the comparison of generalised cost between these modes as discussed in **Section 3.3**), and the topography is also extremely hilly between Diepsloot and Fourways.

Although the estimated uptake for the Soweto area is similar to that of the Alexandra area, the coverage area is deemed too large for a pilot project, resulting in station spacing far exceeding the recommended benchmarks. If a pilot project were to be implemented in Soweto, it is recommended that more stations should be provided to reduce the average spacing to 300m (which is likely to reduce the usage of the system per bicycle and increase costs), or that the system need to be made more compact (at the risk of losing some trips due to the coverage area becoming smaller).

The Alexandra-Sandton area was selected for further assessment of technical and financial feasibility due to cycling infrastructure planned to link these nodes (CoJ, 2014), which will improve the safety of cycling, as well the potential to link the public BSS to a for profit electrical bicycle share system being proposed in Sandton by a private operator (www.decongest.org.za).

4 TECHNICAL FEASIBILITY

4.1 Topography

For cycling infrastructure, ideally a maximum gradient of 3% is recommended, 5% over a distance of up to 100m where steeper slopes are unavoidable, and 7% over a distance of up to 30m (Ove Arup & Partners, 2008). The gradient of the proposed Alexandra to Sandton route is steeper than these gradients on more than 50% of the route, which is likely to limit the uptake of cycling as a preferred mode for the longer trips between Alexandra and Sandton. However as the analysis showed that the majority of trips originating in Alexandra are within the Alexandra coverage area, and not between Alexandra and Sandton, it should not impact significantly on the estimated demand.

4.2 Bicycles and Helmets

According to the ITP Guide, Bicycles should be robust and low maintenance (to resist very frequent daily usage), have a one-size fits all step-through frame (unisex), have multiple gears to deal with the hilly terrain, have the necessary safety features (bright colour, reflectors) and should have a front basket. Ideally, its parts should not be interchangeable and easily removable, to reduce the incidence of theft. Most BSS bicycles also have advertising space, and a Radio Frequency Identification (RFID) Tag embedded in the handle bar to enable tracking of trip times (charges) and bike inventory at BSS stations (Gauthier et al, 2013).

BSS bicycles ranges in cost from R 1000 in Asian systems (although anecdotal evidence suggest that quality and longer term durability is questionable) to R20 000 for bikes with GPS and satellite-operated unlocking systems in Europe (Gauthier. A. et al, 2013). Discussions were held with Qhubeka (Motallini, G., 2014) with the aim of determining if their locally assembled Buffalo Bicycle could be modified for use in a BSS. This bicycle (with some modifications) was considered by the authors as a potentially viable option as its track record demonstrates that this custom design (to cope with rough operating conditions) is thoroughly proven in Africa to be durable and low maintenance. In addition it was considered by the authors to be excellent value for money (R2150 including helmet, pump, utility tool and cable lock) when compared to other low cost imported bicycles.

However, the single speed and rear break only Buffalo Bicycle would need some structural modification (step-through frame and 3-speed gears) as well as minor additions (basket, advertising space and RFID tag). As the step-through frame would require substantial reinforcement to strengthen the frame and the gears would add significant maintenance, Qhubeka was not perceptive to developing a separate BSS model at the time of the interview and declined to provide a cost estimate for the above modification for use in the analysis. A high quality off-the-shelf imported brand name commuter bicycle, with a value of R4 500, was therefore used for the purpose of costing.

The use of a helmet is obligatory in South Africa, and potential barriers to helmet use such as affordability and reluctance (for hygienic reasons) to use a helmet worn by someone else, may deter some riders (Jennings, 2011). Practically it may be difficult to prevent loss or theft (since there is no way of attaching a rented helmet securely to a docked bicycle). The mandatory helmet law in Mexico City was repealed for reasons of social equity (affordability) (“Bike Sharing Goes Viral” (The Star, 2014, p. 27)) and Australia’s poor performing BSS are often blamed on its mandatory use of helmets (Gauthier. A. et al, 2013). For the purpose of the costing, it was assumed that regular users of the system would provide their own helmets, while occasional users would use helmets by means of paying a refundable deposit.

4.3 BSS Stations

The feasibility study considered the internationally implemented model of **fully open automated electronic payment and check-out kiosks**, where bicycles are not typically sheltered but locked in place by an electronic locking mechanism, as well as a **manual, manned system**, with or without a closed lock-up facility for the bicycles.

The latter option (with lock-up facilities) was considered to be the most appropriate in the local context as vendors could help with checking the bike in or out after user verification and payment, as well as provide auxiliary services such as cycle repairs and maintenance. This option was also assumed to create more jobs than the automated kiosk system. It was further deemed by the Authors a more secure option to reduce theft and vandalism, and requires less technological complexity at BSS stations. The cost of a 6m container accommodating up to 20 bicycles, with modifications such as adding a service counter, insulation, ventilation and branding was quoted by vendors at R30 000 per BSS station, excluding the implementation costs.

4.4 Technology Options and Payment Mechanisms

4.4.1 RFID bike tracking solution

Bike tracking (inventory management) is accomplished by installing an RFID tag in the bike's handle and the identification (ID) of the tag is transmitted to a receiver and stored as an event when a bike crosses an antenna, located at the entrance to the BSS station. The stored events are then read by the Back Office System (BOS) via General Packet Radio Service (GPRS) modem over a secure network Access Point Name (APN) (Gauthier. A. et al, 2013).

4.4.2 Kiosk/Station System Solutions

Three options were considered in the study:

- **Tablet:** the vendor validates a person's membership and registers new members via an application (app) that retrieves information from the BOS' central database. The BOS will send a reminder SMS to a user when the rental period is over. Transactions paid via the Point of Sales (POS) device are linked to the rental transaction by importing bank transactions. Credit, Debit and Rea Vaya smart card transactions are possible via the POS device.
- **Kiosk Based System:** all the functionality of the tablet based system is integrated into a fixed device that is located at the BSS station.
- **Manual Cash Based System:** similar to the Inner City parking system where vendors are employed to manually charge users. It does not require back office hardware or software as the BOS will be provided by the system provider, who levies a fee of between 13% and 20% on all cash transactions⁸. A tablet is provided to management to access the transaction information available on the system provider's portal. RFID bike tracking and inventory management is not a viable solution for this cash-only option.

4.5 Subscription Rates and Fees

The majority of BSS charge registered users a fixed annual membership fee, allowing the first 30 to 45 minutes of every ride for free, which encourages usage of the system for short trips (Gauthier. A. et al, 2013). The monthly cost (of an annual subscription) typically ranges between R28 in Mexico City (with similar per capita income to Johannesburg), to R85 in Toronto, which has a much higher income profile. Given the relative cost of the main competing modes as discussed in Section 3.3 and the low affordability levels of the target market, it was recommended that the

⁸ Theron, L. 2014. Cooperation with Xpressa (Personal Interview, 5 November 2014. Johannesburg)

subscriptions should be no more than around R50 per month or R600 per year (GIBB, 2014).

In Johannesburg, users would need to be Financial Intelligence Centre Act (FICA) registered with an ID document and proof of address before getting access to the system to minimise the risk of theft and to make users responsible for their trips. Accessing the system by using a credit card to lay down a deposit is not deemed feasible in the local context as it is likely to exclude the urban poor (Jennings, 2014), although it may be provided as an additional, optional extra.

4.6 Marketing and Advertising

Most BSS systems require some combination of membership fees or tax revenues, supplemented by advertising and or sponsorship, to cover their operating costs (Gauthier. A. et al, 2013). JCDecaux, as the only outdoor advertiser in South Africa known to operate BSSs internationally, was approached for input. Internationally, their portfolio includes the Velib system in Paris, stated by JCDecaux representatives to be self-sustaining and profitable.

Consultation with JCDecaux revealed that the Paris advertising business model is unfortunately fundamentally different from the Johannesburg advertising business model, limiting the likelihood of replicating it locally, because in the Paris business model, the operator (advertiser) signs a long term contract to exclusively exploit city-wide advertising space on a particular subset of street furniture. As Paris have very stringent outdoor advertising controls to minimize visual pollution (for example no billboards are allowed), the limited advertising spaces permitted on areas such as bus shelters, are a very valuable commodity. In Johannesburg, however the substantial degree of clutter as a result of poor outdoor advertising control would require a significant “clearing up” of the area, which is unlikely to be feasible in the near term as most of the advertising contracts already concluded by the City only expires in 20 – 25 years’ time (Dutrieux, J., Madoda, D. 2014).

Locally, outdoor advertising sites are typically graded based on the affluence of the area, traffic congestion (high, medium or low-number of views), clutter (presence of other advertising materials) and proximity of the sign to passing traffic⁹. The higher the number of advertising locations that are contracted to the operator in prime locations, the higher the potential income from advertising (GIBB, 2014).

4.7 Operators

The organisational structure establishes the relationship between the City and operator. The City typically oversees the planning, implementation, and operations of the BSS. The operator typically handles the day to day operations such as managing the maintenance and general cleanliness of the bicycles and BSS stations, redistribution of bicycles, handling the customer service, payment processing, and marketing and brand management. The City can of course also operate the system itself, but this is not commonly done. The Operator’s ownership of assets can range from owning all the assets and carrying all the risks (infrastructure and bicycles),

⁹ Web-based research on factors influencing outdoor advertising rates from the following website: www.adreach.co.za

owning the bicycles only, or no ownership of assets, in which case the City carries all costs and risks but has most control (Gauthier A, et al, 2013).

5 FINANCIAL FEASIBILITY

5.1 Scenarios Analysed

Ten scenarios were modelled, as summarised in **Figure 3**. Due to the difficulty in accurately quantifying some items, a range of costs were considered for each scenario (low, central and high). For the sake of brevity this paper only reports the central case but generally the trends identified in the central case were found to be similar for the lower and upper cases.

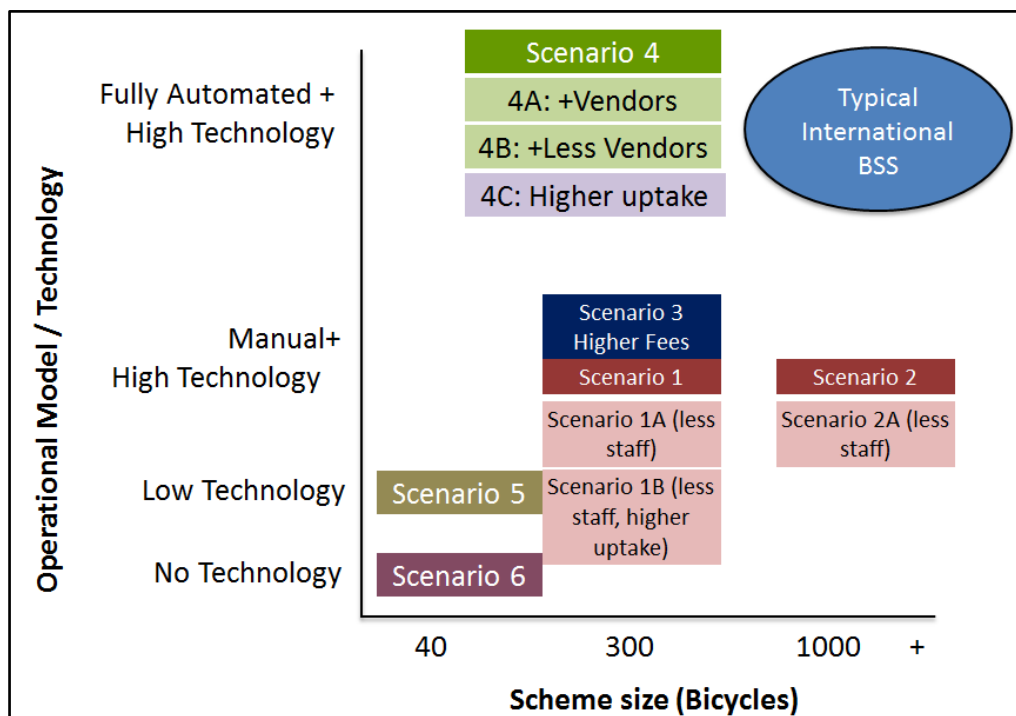


Figure 3: Scenarios Analysed

Source: GIBB, 2014

Scenario 1 – 300 bicycles and **Scenario 2** – 1000 bicycles, are manual systems manned by one vendor per BSS station assisting customers to check bikes in or out, considered to be the most appropriate to the Johannesburg context. **Scenarios 1A and 2A** is similar to Scenarios 1 and 2 respectively, but with a reduced staff complement to reduce operational costs. **Scenario 3** tested the impact of higher fees. The conventional high technology fully automatic docking stations model was also tested (**Scenario 4**). **Scenario 4A** added a vendor stationed at each automated kiosk to assist customers and improve security. **Scenario 4B** is similar to Scenario 4A but assumed one vendor roaming between 2 BSS stations. **Scenario 4C** is similar to Scenario 4B, but with an increased uptake assumed, which increases fee revenue somewhat. Lastly **Scenarios 5 and 6** considered a very small, point-to-point, low or no-technology system (40 bicycles) operated by a local entrepreneur with limited requirements, oversight and control from the City.

5.2 Costs

5.2.1 Implementation or start-up costs

The ITPD manual lists one-time establishment costs to include planning, ground work, and cabling of BSS stations, set-up of workshop and logistics operations, installation, commissioning and training on the RFID and smart tablet/kiosk system, back-office software, and POS devices, communication and interface testing and administration. The total implementation costs (excluding capital costs) depends on the scenario and was estimated to range from R300 000 for the small entrepreneurial Scenario 6 (40 bicycles only and low tech model) to R12.5 million for the bigger full automated kiosk system which has 1000 bicycles. For the demand driven scenarios (300 bicycles), implementation costs ranges between R3.9 million and R5.8 million depending on the technology solution (GIBB, 2014).

5.2.2 Capital costs of stations/kiosks, bikes, and back-office's hardware and software

The estimated split between the capital cost for BSS stations and bicycles as calculated in this study is given in **Table 3**. This split for the fully automated scenario is similar to the ones found in European cities, where the value of the station costs are much higher and therefore takes almost 80% of the total capital cost (Buttner, J. et al, 2011). European station cost is high because in most cases they include docking points and kiosks. In Johannesburg, where a manual system is considered preferable, with stations of the container type, the station costs could be significantly lower. The estimated capital cost ranges from under R300 000 for the small system with low technology, to R14.7 million for the larger 1000 bicycle manual system. The 300 bicycle manual system's cost estimate is R4.9 million, significantly less than the fully automated kiosk system's cost of R8.7 million (GIBB, 2014).

Table 3: Capital Costs Split Between BSS Stations and Bicycles (Central Case)

Capital Costs					
	Scenario 1: Manual	Scenario 2: Manual	Scenario 4: Automated Kiosks	Scenario 5: Small System Basic Technology	Scenario 6: Small System Low Technology
	300 Bikes	1000 Bikes	300 Bikes	40 Bikes	40 Bikes
BSS Station	72%	69%	84%	86%	38%
Bikes	28%	31%	16%	14%	62%
Cost	R4.94 M	R14.68 M	R8.72 M	R1.30 M	R0.29 M

Source: GIBB, 2014

5.2.3 Operational and Maintenance Cost

Because of high levels of unemployment, poverty and crime in Alexandra, and the fact that the area has a high population turnover, which may weaken the sense of community accountability or ownership of the system, management of the bike share system is viewed as extremely challenging (Dutrieux, J., Madoda, D. 2014). The operating hours of the system is proposed to be limited from 6:00 to 18:00, but operating 7 days a week.

The typical split between the components of operational costs is given in **Table 4** along with the estimated annual costs. The operational cost for the larger (1000 bikes) system is the highest at R18.9M. The cost for the smaller operation (40 bikes) is estimated to range between R1.2 million and R1.4 million per year depending on the technology employed.

Table 4: Typical Annual Operational Costs (Central Case)

Operational Cost Components	Operational Cost (%) per Scenario					
	1 300 Manual)	2 1000 Manual	4 300 Automatic	4A 300 Auto. + Vendors	5 40 Basic IT	6 40 Low IT
Station maintenance	4.9%	6.1%	9.3%	5.8%	3.2%	3.7%
Bike maintenance	2.0%	2.5%	3.7%	2.3%	1.3%	1.5%
Redistribution of bikes	8.8%	3.3%	16.6%	10.3%	29.7%	34.4%
Back-office system	3.6%	1.6%	6.7%	4.2%	15.6%	0.2%
Point of Sale Device	0.3%	0.4%	0.7%	0.4%	0.3%	7.6%
Administration	2.9%	2.1%	5.6%	3.5%	5.0%	4.7%
Bike replacement	14.8%	18.4%	28.0%	17.4%	9.5%	11.0%
Staff cost (No. of personnel)	62.6% (38)	65.6% (121)	29.4% (7)	56.2% (34)	35.5% (5)	36.9% (4)
Total	100%	100%	100%	100%	100%	100%
Annual Cost	R6.8 M	R18.3 M	R3.6 M	R5.8 M	R1.4 M	R1.2 M

Source: GIBB, 2014

The operational cost for the 300 bikes manual system proposed for Alexandra is estimated to cost between R3.6 million p.a. for the fully automatic system, and R6.8 million p.a. for the manual system.

It is evident from **Table 4** that the most significant cost component in all the scenarios considered is the staff costs. The staff complement that was assumed per shift for a fully manual system was one vendor per BSS station, one supervisor per five BSS stations, one field checker for maintenance, and a driver and two assistants for the redistribution truck. Non-shift staff includes two operational managers and a general manager. In contrast, for the fully automated system with no personnel at kiosks, staff costs comprise only 36% of the operational costs (7 staff), compared to 63% for the 38 staff for the manual 300 bike system.

The second notable cost component is the replacement of bicycles because of theft and/or vandalism, which could be significant, particularly in the first year of operation. Big systems such as the one in Paris which now has 16 000 bicycles, had almost 20% of bicycles lost or stolen and 40% were vandalized or damaged. JCDecaux indicated a 100% turnover of bicycles per year is not unusual in European systems. In contrast, U.S. systems have had very few problems with only 0.4% lost or stolen and 2.5% vandalized or damaged bicycles, most likely due to their requirement for members to register and place a deposit or credit card hold before renting a bike,

providing accountability and a disincentive to steal or lose the bike (www.streetsblog.org, 2015). In Johannesburg, annual renewal of the bicycle fleet was assumed to be 50% in the low scenario, 75% in the central scenario and 100% in the high scenario. With these assumptions, the bike replacement costs for the manual system with 300 bikes ranges between 15%–28%.

5.3 Revenue

5.3.1 Advertising Revenue

Section 4.6 discussed the typical grading of local advertising sites. The assumptions in terms of unit rates and number of sites by type, as well as the expected advertising revenue, for the 300 bike system are indicated in **Table 5**.

Table 5: Advertising Revenue for the 300 Bicycle (30 Station) System

Site Type	Unit Rate Range	Revenue Scenario		
		Pessimistic	Central Case	Optimistic
Premium	R7000 - R15000	3	5	4
Impact	R5000 – R8000	6	7	8
Strategic	R2100	21	18	18
Per bike	R175 – R200	300	300	300
Annual Revenue		R1.8M	R2.0M	R2.7M

Source: GIBB, 2014

5.3.2 Fee Revenue

The estimates of potential annual revenue, calculated using the demand discussed in **Section 3**, and the subscription and casual fees described in **Section 4.6**, ranges from approximately R450 000 per annum for the small 40 bikes systems, R660 000 for the manual 300 bike system, R930 000 for the 300 bike system with higher fees (both manual and automated scenarios), R1.92 million for the 1000 bike system and R1.39M for the 300 bike system with higher fees and an uptake of 1.5 times the base uptake (estimated based on existing cycle mode shares).

5.4 Operating Surplus or Deficit

The total estimated annual revenue, operational costs, and operating surplus for the various scenarios analysed is summarised in **Table 6**. Unfortunately, of all the scenarios tested, none of the scenarios broke even (i.e. operating costs covered by revenue). Although only the results for the central case are shown, this also holds for the lower and upper cases. In general, the larger the system, the larger the deficit.

The lowest operational deficit is around R0.5M for the small no-technology entrepreneurial system, however this is quite high per bicycle (R12 750) and thus not very efficient. The best performing 1000 bike size system is Scenario 2A, fully manual but with less staff, at R5.4M (R5 370 per bike), indicating the benefit of economy of scale. The 300 bike size system with the most jobs created (Scenario 1) indicates a deficit of R4.2M (around R14 000 per bike). With a reduced staff compliment, the deficit reduces to R2.9M.

Scenario 4 (the fully automated system with higher fees) performed better than the manual system of the same size, indicating a R0.7M deficit (R2 300 per bicycle). The best performing scenario is Scenario 4C, which tested higher fees and a higher uptake. The 50% increase in uptake reduces the deficit to around R0.25M. This scenario is also estimated to break even and could potentially show a R0.4M profit, should the lower case cost and the middle case revenue be achieved. The scenario where the mid-range costs and the high revenue case materialise shows a profit of R0.6M. However this scenario, **with no station staff present and no night-time lock-up of bicycles**, is considered a very risky option in the local context. Furthermore, it is doubtful if COJ can rely on both the lower costs and the higher revenue cases materialising, given the limitations on potential advertising revenue as discussed in Section 4.6.

Table 6: Total Annual Operating Surplus or Deficit (R Million) – Central Case

Scenario.	Size (Bikes)	Description	Total Revenue	Operating Cost	Surplus / Deficit
1	300	Fully Manual	2.67	6.83	-4.16
1A	300	Fully Manual but less staff	2.67	5.51	-2.85
1B	300	Fully Manual, less staff, HIGHER UPTAKE	3.00	5.54	-2.54
2	1 000	Fully Manual	8.60	18.35	-9.75
2A	1 000	Fully Manual but less staff	8.60	13.97	-5.37
3	300	As Scenario 1 but higher fees	2.93	6.83	-3.90
4	300	Fully Automated, higher fees	2.93	3.62	-0.69
4A	300	Fully Auto, +full staff, higher fees	2.93	5.83	-2.90
4B	300	Fully Auto.+ less staff, higher fees	2.93	4.51	-1.58
4C	300	Fully Auto, higher fees , HIGHER UPTAKE	3.40	3.65	-0.25
5	40	Small, low technology system	0.71	1.42	-0.71
6	40	Small, now technology system	0.71	1.23	-0.51

Source: GIBB, 2014

6 CONCLUSIONS

While considered technically feasible on most criteria (the most uncertain being the estimated demand, which is very low when benchmarked against international BSS systems that are widely mooted in the popular press as being successful), none of the scenarios evaluated are expected to cover its operational costs. For the Alexandra-Sandton BSS of 300 bicycles, the operational subsidy for the manual system with reduced staff (Scenario 1A) is estimated to be in the order of R2.9M per year or around R9500 per bicycle.

The implementation of a BSS of 300 bicycles and 30 BSS stations to link Alexandra and Sandton was further estimated to require up front city funding, grants and/or commercial sponsorship totalling R8.8M for the recommended manual (manned) system.

The main reasons for the estimated subsidy requirement are inferred to be

- The low estimated uptake of cycling, which is based on current cycle mode shares in Johannesburg. The current cycle mode share in Johannesburg is considered to be this low mainly as a result of the relatively high number of long distance trips (beyond the effective range of most cyclists) as a result of the City's relatively low density and historic spatial development patterns, as well as a significant proportion of shorter distance trips more conveniently served by walking (free) than cycling (requiring both a bicycle and the ability to cycle). There are many other factors contributing to lower cycle mode shares, not specifically quantified in this study, such as the lack of safe segregated bicycle facilities and lack of a well-established cycling culture (Wardman et al, 2007). Due to more accurate quantitative data on the choice factors influencing cycling demand (such as purposely designed stated preference data) not being available, the study tested a few scenarios with a higher uptake (1.5x the estimated uptake, based on research in the UK on factors influencing the propensity to cycle to work¹⁰). This was done to take into consideration the potential impact of future improved cycling infrastructure and other factors not specifically quantified, but these scenarios also did not break even.
- The low cost recovery through fees as a result of the target market's affordability level (higher fees would make this option more expensive than the current competing public transport fees and is expected to reduce the uptake) and
- The relatively limited potential to cover the operational deficit through advertising due to the nominal value of advertising in Johannesburg compared to international advertising models studied.

The demand estimates used in this study indicates uptake factors that are in the order of a factor of 5 -10 times lower than the benchmarks recommended in the ITDP Guide, based on what this institution consider the most successful international BSS systems. While it is acknowledged that cycling in Johannesburg comes off a low base, and might therefore be expected to increase rapidly with the provision of safer cycling infrastructure, there is limited local data that could be used to support assumptions on significantly higher bicycle mode shares materialising as a result of the provision of BSS, than what is currently observed in terms of cycling's mode share. Before making optimistic assumptions on potential future demand, it is recommended that a local stated and revealed preference study be commissioned that can estimate the factors that influence the propensity to cycle in Johannesburg, with a higher level of confidence. Such a study would also be invaluable to identify the optimum strategy to increase cycling in Johannesburg.

¹⁰ The study concluded that in the UK (with a 2.9% commuter cycle mode share in 2001), even an unfeasible scenario of universal provision of fully segregated cycle ways (i.e. along 100% of all routes used by cyclists to commute), would only result in a 55% increase in cycling and a slight decrease in car commuting (Wardman 2007).

Given the uncertainty on demand, instead of a R2.9M annual subsidy spent on the proposed BSS, the city could buy and give away around 1350 bicycles of R2150 each per year, and spend the upfront capital costs of a minimum of R8.8M either on dedicated bicycle infrastructure to improve cycling safety, or on community educational and awareness of safety campaigns.

To improve a recipient community's ownership and accountability for the assets made available, (either a free or subsidised bike), the COJ can consider a distribution model where community members earn bicycles in exchange for work done to improve their communities and the environment (for example by growing a specified number of trees or recycling a pre-determined quantity of waste), similar to Qhubeka's business model. Owning a bicycle will also have the advantage that the owner is not restricted to the limited catchment area of the BSS but is free to use it whenever and wherever needed. New bicycle owners can even potentially earn an income from informally renting out the bicycle when not needed, or doing deliveries (GIBB, 2014).

Other options that in the authors' opinion may increase access to bicycle ownership include the facilitation of

- Micro loans to finance bicycles (www.micro-loans.co.za). For example, a R2500 outlay at 8% interest p.a., with payment over 24 months, requires a monthly loan repayment of R113 per month.
- Shared ownership clubs similar to a Stokvel - an invitation-only club of twelve or more people serving as a rotating credit union or saving scheme. Members contribute fixed sums to a central fund on a weekly, fortnightly or monthly basis and the accumulated money is paid out to members as stipulated in the club's constitution. Defaults on contributions are reportedly rare¹¹. For example: 12 members contributing R104 p.m. each can buy a bicycle to the value of R2500 every 2 months, i.e. each member will have their own bicycle after 2 years, but could agree to share it in the meantime.

By subsidising say 50% of the cost of the bicycle, the City can provide affordable access to bicycle ownership to 2700 community members per year, for the price it would cost to subsidise the estimated 300 bicycles required to operate the Sandton–Alexandra BSS. At a 50% sponsorship, each recipient would need to pay in around R50 – R60 per month, which is in line with the recommended bike share annual fee (per month) that would make the cycling option attractive enough to the targeted community, relative to the existing available modes.

Although the study concluded that bike sharing was not financially feasible in any of the five study areas specified to be assessed, it does not necessarily mean it cannot succeed commercially in a high income business node such as Sandton or Rosebank, where the assumptions on the type of system and therefore its running costs, and the fees that users may be willing to pay, is likely to be very different to those assumed in this study. However a purpose designed stated preference survey would be extremely valuable to better understand the demand for the slower modes

¹¹ Web-based research from the following websites: en.wikipedia.org/wiki/Stokvel, www.etfsa.co.za/stokvels.htm, <https://www.fnb.co.za/savings-account/stokvel-account.html>

of transport (walking and cycling), so that improved demand models can be developed to forecast mode choice under different future cycling policy scenarios.

7 REFERENCES

“Bike Share’s Rough Ride”. Available at: www.nytimes.com. (Accessed: August 2014).

“Bike Sharing Goes Viral”. The Star. p. 27. 17 Sep 2014

Buttner, J. et al. 2011. *Optimising Bike Sharing in European Cities*. Europe.

“Characteristics of the systems”. Available at: www.tfl.gov.uk, www.mobilicidade.com.br, http://en.wikipedia.org/wiki/Bike_Rio, www.bikesharetoronto.com, www.citycycle.com.au, www.bikemi.com, www.decobike.com, www.velib.paris, www.ecobici.df.gob.mx, www.ibiketo.ca (Accessed: August 2014).

COJ. 2013. *Household Travel Survey*. COJ. South Africa.

COJ. 2013. *Terms of reference: A523 for Technical and Financial Assessment for the Viability of a Bike Share System Resulting in a Sustainable Business Model and Contract Specification*. COJ. South Africa.

Cui, Y., Mishra, S. and Welch, T.F. 2014. *Land use effects on bicycle ridership: a framework for state planning agencies*. Journal of Transport Geography. <http://dx.doi.org/10.1016/j.jtrangeo.2014.10.004>

“Decongest Sandton”. Available at: www.decongest.co.za. (Accessed: August 2014).

Dutrieux, J., Madoda, D. 2014. Cooperation with JC Decaux. (Personal interview, 6 October. Johannesburg.)

Fishman, E., S and Haworth, N., 2013. *Bike Share’s Impact on Car Use: Evidence From The United Washington States, Great Britain and Australia*.

Gauthier, A. et al. 2013. *The Bike-Share Planning Guide*. ITDP. USA.

GIBB (Pty) Ltd. 2014. *Technical and Financial Assessment for the Viability of a Bike Sharing Scheme Resulting in a Sustainable Business Model and Contract Specification, Interim Report 1: Technical Feasibility*. COJ. Johannesburg.

GIBB (Pty) Ltd. 2015. *Technical and Financial Assessment for the Viability of a Bike Sharing Scheme Resulting in a Sustainable Business Model and Contract Specification, Interim Report 1: Financial Feasibility*. COJ. Johannesburg.

GIBB. 2013. *Gauteng 25 Year Integrated Transport Master Plan - Demand Model*. Gauteng Department of Roads and Transport (GDRT). South Africa.

Hunt, J.D. and Abraham, J.E. 2006. *Influences on bicycle use*.

Jennings, G. 2011. *A challenge shared: is South Africa ready for a public bicycle system?*

Jennings, G. 2014. *Finding our balance: Considering the opportunities for public bicycle systems in Cape Town, South Africa*.

Kumar, A., Meng Teo, K., Odoni, A. R. 2013. *A Systems Perspective of Cycling and Bike-sharing Systems in Urban Mobility*.

“List of Cities by GDP”. Available at: http://en.wikipedia.org/wiki/List_of_cities_by_GDP. (Accessed: August 2014).

Motallini, G. 2014. Cooperation with Qhubeka. (Personal Interview, 8 September 2014). Johannesburg.

Ove Arup & Partners Ltd. 2008. *Cycle Infrastructure Design*. DOT. UK.

Pettinga, A. et al. 2009. *Cycling Inclusive Policy Development: a handbook*. GTZ.

“Research in Transportation Business and Management”, Available at: <http://dx.doi.org/10.1016/j.rtm.2014.09.001>. (Accessed: September 2014)

Stats SA. 2012. *Census 2011 Statistical Release – P0301.4*. Stats SA. South Africa.

“The Largest Cities in the World by Land Area, Population and Density”. 2007. Available at: www.citymayors.com/statistics/largest-cities-area-125.html. (Accessed: August 2014).

“Theft and Vandalism Just Not a Problem for American Bike-Sharing”. Available at: www.streetsblog.org/2010/11/29. (Accessed: January 2015).

Wardman, M.R., Tight, M. and Page, M. 2007. *Factors influencing the propensity to cycle to work*. Transportation Research A, 41 (4) pp. 339 – 350. ISSN 0965-8564

“Wheels come off China’s bike-share schemes”. Available at: <http://www.ft.com/cms/s/0/815c5378-33e2-11e4-85f1-00144feabdc0.html#axzz3aOsJdhug>. (Accessed: May 2015).

“Xpressa Point of Sale”. Available at: www.xpressa.co.za/xpressa-point-of-sale. (Accessed: November 2014) and Theron, L. 2014. Cooperation with Xpressa (Personal Interview, 5 November 2014. Johannesburg).