BIKESHARE ON A UNIVERSITY CAMPUS: LESSONS FROM A PILOT PROJECT AT THE UNIVERSITY OF PRETORIA

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ABSTRACT

In 2018 the University of Pretoria implemented a bikeshare system as a pilot project on its campus to test its feasibility, and to help develop the capacity of City of Tshwane officials to implement future bicycle promotion schemes. Innovative aspects of the pilot included the inclusion of both electric and manual bicycles in a hybrid fleet, the development of a web-based booking and registration system, and the continuous GPS tracking of bicycles for security and data collection purposes. Pre- and post surveys and focus groups provided information on the demand for bikeshare, and how it was used. The paper reviews this evidence, concluding that there is a demonstrated role for bikeshare in certain niche markets in South African cities. Bikeshare's biggest benefit is its potential to expand the mobility of current pedestrians, although it also demonstrated a modest ability to capture trips from car users and to support public transport as a first/last kilometer solution.

1. INTRODUCTION

Bikeshare refers to the shared use of bicycles, typically in exchange for a fee, and used for short, point-to-point journeys (Shaheen, Guzman, and Zhang 2010)[1]. Bikeshare has been growing very fast internationally – in 2017, an estimated 1600 schemes were in operation worldwide, of which more than 200 were launched in that year alone (Moon-Miklaucic et al. 2018). Bikeshare has been contributing to the growth in bicycling as a mode, offering bike users convenient, affordable, and on-demand access to bicycles (Institute for Transportation Development Policy (ITDP) 2018). The economic, social and health benefits of bikeshare for cities have been firmly demonstrated; they include growing awareness of biking as a daily mobility option, enhanced first- and last-kilometer connectivity to the public transport network, reduction of greenhouse gas emissions, and increased physical activity for users (Moon-Miklaucic et al. 2018; Shaheen, Guzman, and Zhang 2010).

Partly due to its fast growth, bikeshare has been challenging cities' ability to plan, regulate, and manage its integration into the urban transport system. Its successful implementation requires cities to gain a new understand of people's changing mobility needs and preferences, of technology options and their implications, and of potential business

[1] Bikeshare is distinct from short-term bicycle rentals, usually aimed at tourists, which require onerous deposits to be paid every time a bike is checked out, and is usually priced for durations of one or more days.

models. Many of these factors are specific to each city and require local knowledge and learning to evolve.

There has been some tentative interest in bikeshare in South African cities, but no move towards city-wide adoption. Hesitancy is driven in part by concern with the unknown demand for bikeshare amidst the lack of a cycling culture, and its associated cost and subsidy implications. This paper aims to contribute to the critical consideration of the potential role for bikeshare in SA cities, by reporting on a small-scale home-grown pilot project in a campus environment at the University of Pretoria. We elaborate on several innovative aspects of the project, such as its testing of electric and manual bikes in a hybrid system, and the integration of digital technology within the project design. As the success of a city-wide bikeshare programme depends on scale and access to a wide user public (Moon-Miklaucic et al. 2018), this project cannot speak to the question of city-wide adoption. Yet valuable lessons can be learnt regarding the role of bikeshare within a niche market such as a campus environment, and some of the elements needed for its success. The paper thus briefly describes the project and its elements, against the background of previous bikeshare studies in SA, and then focuses on user-related aspects, including demand patterns and user perceptions. Technical aspects related to bike performance and operational management are not covered in any depth. Finally, lessons and conclusions are discussed.

2. PREVIOUS RESEARCH ON BIKESHARE

The cities of Cape Town, eThekwini, and Johannesburg have examined the feasibility of bikeshare as a means of promoting their non-motorised transport goals. None have implemented any. Considering the institutional, environmental, financial, and cultural obstacles to implementing bike-share systems in Cape Town, Jennings (2011) identifies key barriers as minimal bicycle infrastructure, theft and vandalism, compulsory helmet laws, and lack of public funding. Our spatial patterns, with long distances between formal transport interchanges and destinations, inhibit bicycle use in general. Cost is also an issue: people who don't own bicycles are unlikely to be able to afford the deposits, and most people who already own bicycles do not use them for commuting (Jennings 2011). Jennings (2015) suggests that Cape Town can do more to improve access for those unable to purchase their own bicycles by promoting a publicly financed, long-term rental scheme, located in multiple middle- and low-income areas across the metro, designed for the 'first' rather than the 'last' mile and complemented by significant investment in quality public transport and bicycle infrastructure. It needs to be clear for what purpose and for whom the system is designed.

The City of Johannesburg came to largely similar conclusions. After undertaking a technical and financial assessment of the viability of piloting a bikeshare scheme in five lower to middle income areas, De Beer and Valjarevic (2015) conclude that it was not financially feasible in any of the areas, and that substantial subsidies would be needed to sustain it. A more in-depth study focusing on ways to promote cycling amongst students of the Universities of Johannesburg and Witwatersrand noted that the estimated demand was very uncertain, but likely to be very low when benchmarked against international bikeshare systems (De Beer 2017). On the one hand, low density and historic spatial development patterns create many long-distance trips too long for cycling; on the other, a significant proportion of shorter distance trips are more conveniently served by (free) walking than cycling. De Beer and Valjarevic (2015) note, however, that this does not mean that bikeshare might not succeed commercially in a high income business node such as

Sandton or Rosebank, where the system characteristics and users' willingness to pay is likely to be very different.

There is evidence that university campuses may be a more successful test bed for bikeshare than elsewhere. In general, bicycling is more popular on campuses, as the mode is well-suited to the mostly young and fit population, who tend to live within biking distance from campus (Van Heeke, Sullivan, and Baxandall 2014). University campuses are also suited to experimentation and innovation. For example, the University of California, Irvine created California's first fully automated bikeshare program, in 2009, long before it was adopted by major US cities (Van Heeke, Sullivan, and Baxandall 2014). North America's first electric-bike sharing system (cycleUshare) was launched in 2012 at the University of Tennessee, Knoxville, as a small pilot test with two stations and 20 bikes (Langford et al. 2013). Incidentally, it was found that the integration of electric bicycles (e-bikes) with bike sharing increased the attractiveness of bike sharing by reducing some barriers to bicycling and increasing the amount of prospective users. Other university campuses partner with urban bikeshare programs in the surrounding community, often at subsidised prices. In 2013 it was estimated that there were at least 33 campus-based bikeshare programs in the United States (Maynard 2013); the current number is likely to be higher.

Closer to home, the University of Nairobi launched a bikeshare system featuring one central station with 20 bikes geared towards serving students and staff traveling around campus (C4DLab, 2016). In South Africa, the Nelson Mandela University (NMU) offers a bikeshare service using 10 electric solar charged bicycles, called the uYilo eBike Programme (uyiloebike, 2019). Longer-term rental programmes (not bikeshare) are offered by Stellenbosch University (Matie Bikes), and the University of Cape Town (Jammie Bike), in terms of which students can rent bicycles for a semester or year for an annual fee of R1000 (Stellenbosch University, 2019; BicycleCapeTown.org, 2014), plus a refundable deposit.

3. PROJECT DESCRIPTION

3.1 Project scope and objectives

The University of Pretoria implemented a bikeshare system as a pilot project between 2016 and 2018. The dual objectives were to test the feasibility of implementing a bikeshare scheme amongst students and staff, and to help develop the capacity of City of Tshwane officials to assess and roll out such a scheme as part of their municipal transport service delivery function. The project was funded by a research grant via the Tirelo Bosha Public Service Improvement Facility, administered by the Department of Public Service and Administration. Key project partners included Enterprises University of Pretoria (project management), the UP's Centre for Transport Development (research lead), Royal HaskoningDHV (technical sub-consultant), and the City of Tshwane's Roads and Transport Department, Research and Innovation Department, and City Sustainability Unit.

Key components of the project are shown in Figure 1. These include:

- Procurement of ten manual and ten pedal assist electric (e-bikes) bicycles. The reason for this hybrid fleet was to test the hypothesis that e-bikes significantly improved the utility and attractiveness of bikeshare, by extending the range of cycling and making it more convenient. The bicycles were selected on criteria such as robustness and quality, price, and local availability of parts. The selected bicycles

were the Avalanche EGO Electric Bike and the Avalanche Charge 10. The e-bike has a top-speed of 24 km/h and a battery life of approximately 15 hours.

- A single kiosk was constructed where bikes were dispatched and returned to, bike maintenance conducted, and bikes stored overnight. While a single kiosk was not ideal in terms of serving diverse travel patterns, it was considered adequate for the pilot project. The kiosk was located on the Hillcrest campus, near several student residences, and about 1.5 km from the main campus. Its location away from main campus allowed users to use bikes for commuting to and from class or work on main campus.
- The kiosk was staffed by unemployed youth identified via the City's Extended Public Works Programme. Staff were trained in bicycle care and maintenance.
- Two Information and Communications (ICT) technologies were integral to the project. Firstly, all bikes were tracked using GPS equipment installed in the bikes. This provided real-time information on bike location, for use during bike management and for security, and also stored data on bike use that could be used for later analysis.
- The second ICT component was an online booking system that was developed to allow users to register, book bicycles in advance, and to communicate with the kiosk staff. Booking was considered essential given the limited number of bikes available.

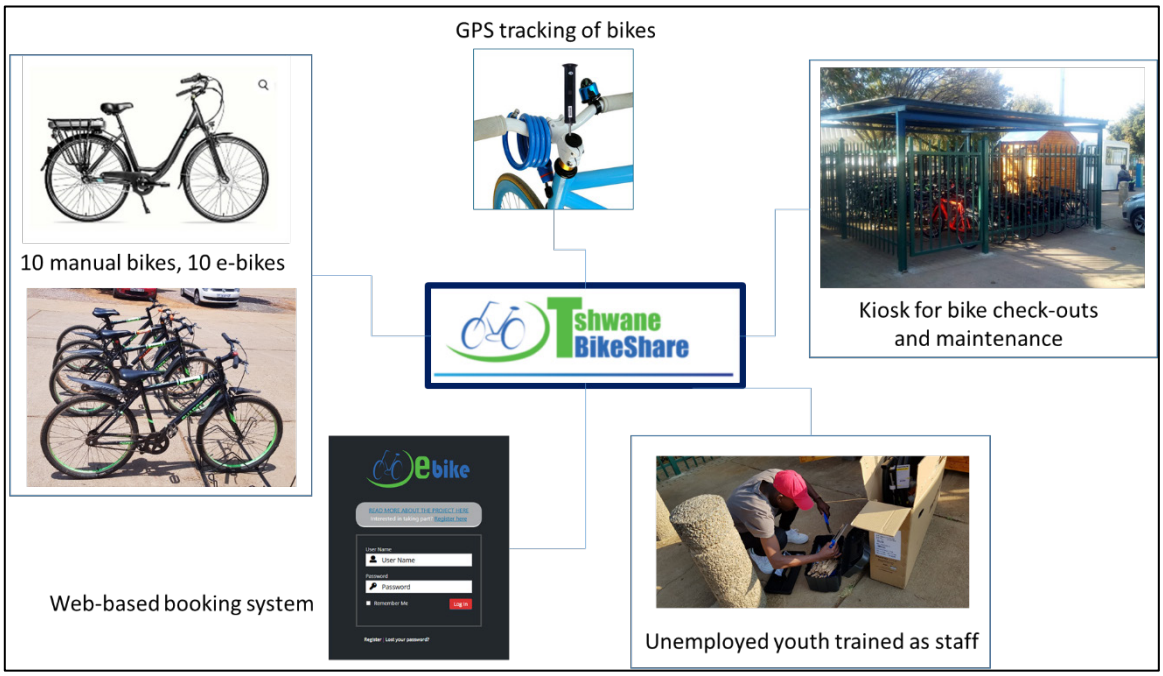

Figure 1: Key system components

The bikeshare scheme operated between mid-July and the end of November 2018. The initial cost for using the bikeshare was R5 per day, payable via credit/debit card at the kiosk. The price was dropped to zero (thus a free service) after an initial slow uptake of the service. When checking out a bicycle, users were also issued with a helmet and a lock.

3.2 Data collection approach

The research component of the study focused on collecting data on usage patterns, user characteristics, and perceptions. Usage patterns were collected from booking data and GPS tracking data. Data on user perceptions and characteristics were collected via online survey instruments and focus groups. The surveys were implemented in a before-after design to track changes in perceptions. Upon registering for participation, users were invited via email to complete the pre-use survey. After completion of the pilot, the post-

survey was completed. An additional survey was implemented among non-bikeshare users, to provide data that could be used as a control group as a way of determining to what extent bikeshare users are self-selected (i.e. in what ways people that are attracted to the bikeshare differ from the general population). The survey was identical to the pre-bikeshare survey.

The sample sizes for the pre, control, and post surveys were 65, 65 and 38 respectively. This represents 40% and 23% of the population of 164 users, respectively.

Two focus groups were also held with bikeshare participants in the last two weeks of the pilot. The purpose was to probe more qualitatively into users' experiences and perceptions of bikeshare.

4. RESULTS

4.1 Demand for bikeshare

Initial interest in the service was very low, but after scrapping the fee, and expanding marketing from the use of posters to include social media and newspaper advertisements, a dramatic improvement was seen in the number of users. By the end of the project (30 November 2018), there were 363 registered users, resulting in more than 830 bookings, by 164 unique users. On average, between 16 June and 30 November, there were 14 bookings per day, with the maximum number of bookings being 40 – two trips per bike per day (Figure 2).

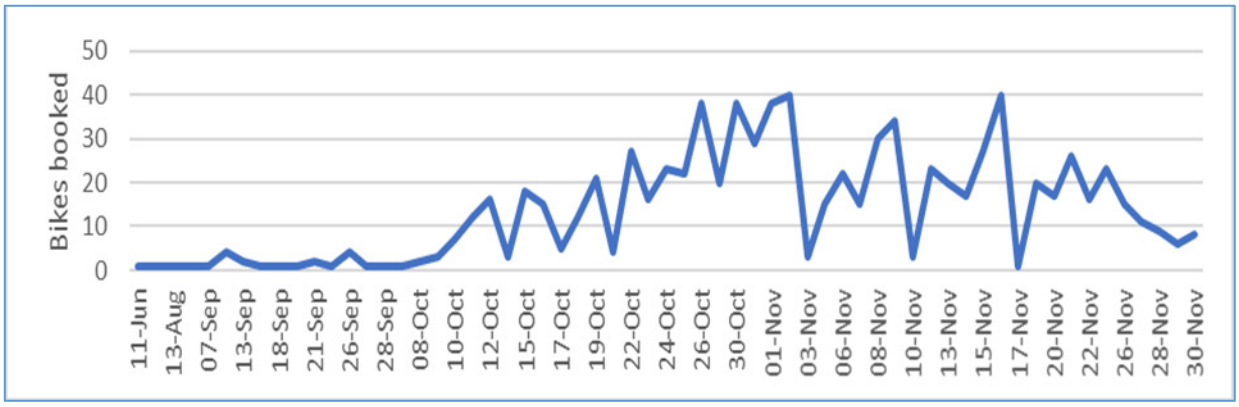

Figure 2: Bike bookings per day

There was some interest in weekend bookings as well, although the service was only operational on weekdays.

4.2 Characteristics of user population

User characteristics were what would be expected from this predominantly student population. Most users were young (below 24 years), although the bikeshare system was also attractive to a small number of older staff members – about 8% of users were staff, and 11% were older than 30. In terms of gender, the user population was considerably skewed towards men: three-quarters of users were male. This matches the percentage of bicycle users in the general UP population that are male (81%), as captured in UP's 2017 transportation survey among students and staff. It appears that the bikeshare system is only slightly more attractive to women than cycling in general. If an aim of a bikeshare

programme were to improve the mobility of women, then more would have to be done to overcome general barriers to bike use among women. The focus group participants confirmed this, noting that female students more frequently do not know how to cycle, or are concerned with traffic safety while using a bicycle.

Figure 3 shows the level of fitness reported by respondents. Forty-three percent of users considered themselves fit or very fit, while only 6 percent thought they were unfit. By comparison, only 36% of the general population (control group) consider themselves fit or very fit, and 11 percent unfit. This suggests that the bikeshare system is more attractive to people who already have some reasonable physical ability. What is more, the percentage of respondents describing themselves as fit or very fit jumped from 43% to 72% in the post-use survey (not shown in figure). It appears that bikeshare has the potential to improve fitness and health amongst its users.

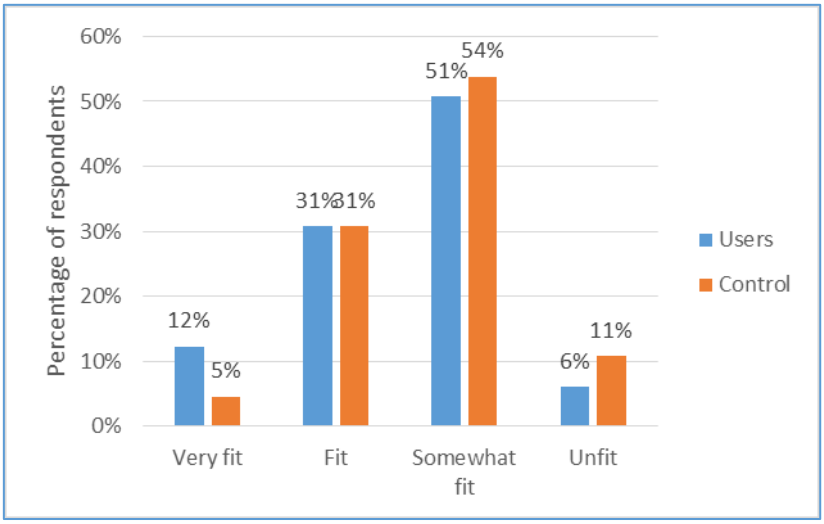

Figure 3: Self-reported level of fitness (users vs control group)

Table 1: Summary of bicycle usage statistics (September to November 2018)

	Electric bicycles	**Manual bicycles**
Total number of daily uses	102	105
Average number of daily trips per bicycle	10	11
Average distance of daily usage	16.8 km	17.6 km
Average speed	11.2 km/h	11.5 km/h

Focus group participants confirmed this. Several mentioned using bikeshare (regular) bikes for fitness and exercise (especially biking around the Hillcrest sports campus). Interestingly, biking was also appreciated "*to destress, think, see the environment and for a change of scenery".* It is seen as "…*good for your mental health… I am happier when cycling"*. Thus, the bikeshare might also help contribute to improving physical and mental health amongst students.

4.3 Bicycle usage patterns

Table 1 shows the usage statistics for the two types of bicycles, obtained from the GPS tracks, for the period September to November 2018. The manual bicycles were used slightly more than the e-bikes, for slightly longer average trip distances, and at slightly higher speeds. The difference is however not statistically significant. This is one surprising finding of the study – people seem not to use e-bikes any differently from regular bicycles. This could perhaps reflect the dense urban environment around the Hatfield campus, where the absence of uninterrupted stretches of road and bike lanes restricts the speed at which any bicycles can be used.

Figure 4 shows a heat map of the density of tracking points across the Hatfield area. It shows firstly a diversity of use across the entire suburb, suggesting that bikes were used for trips to a great variety of destinations. In fact, individual tracks revealed trips of up to 16 km, made to adjacent suburbs and the Pretoria CBD (not shown here). Two major hotspots reveal frequent destinations (Figure 4): the entrance to the UP main campus, and the area around the Hatfield commercial node. This suggests that, apart from commuting to campus, bikes were frequently used for social or shopping trips concentrated in places where students hang out.

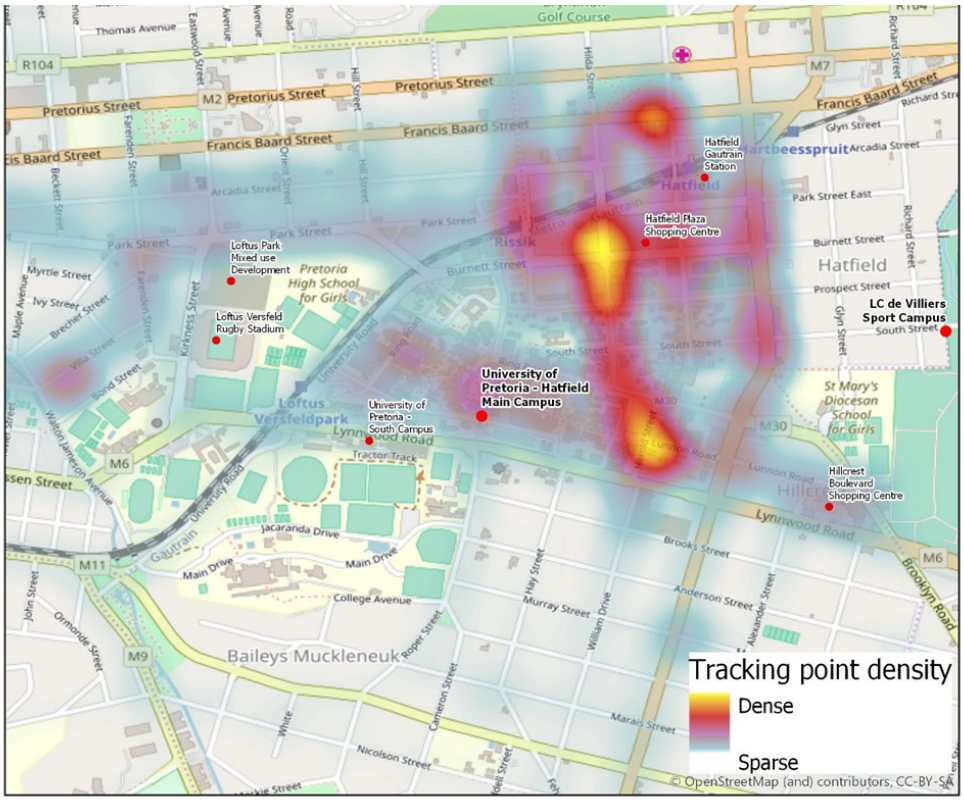

Figure 4: Heat map of movements around the greater Hatfield area

4.4 Impact of bikeshare on travel patterns

The purpose of this analysis was to determine how users used the bikeshare service, and how it affected their travel patterns. Figure 5 shows that the majority of bikeshare users were used to walking as a main way of travelling from home to campus, between campuses (e.g. between Hatfield (main) and Hillcrest (sport) campuses), and for getting around the Hatfield area. It suggests that having access to a bike is largely attractive as a means of reducing the effort and time involved in making short-distance trips on foot.

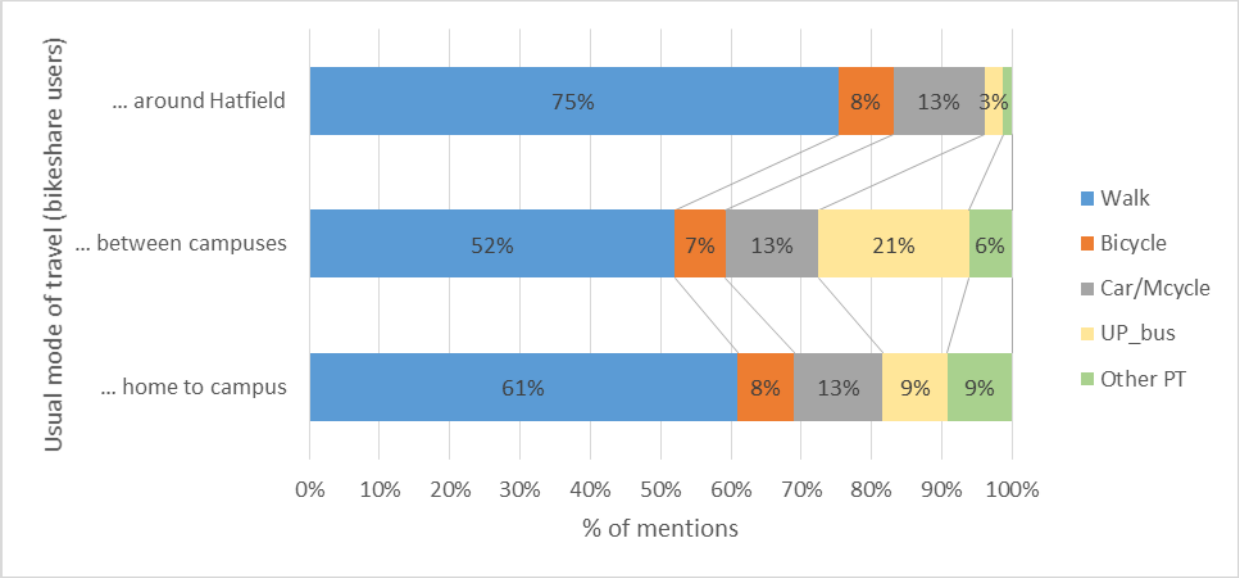

Figure 5: Usual mode of travel (bikeshare users, pre-survey)

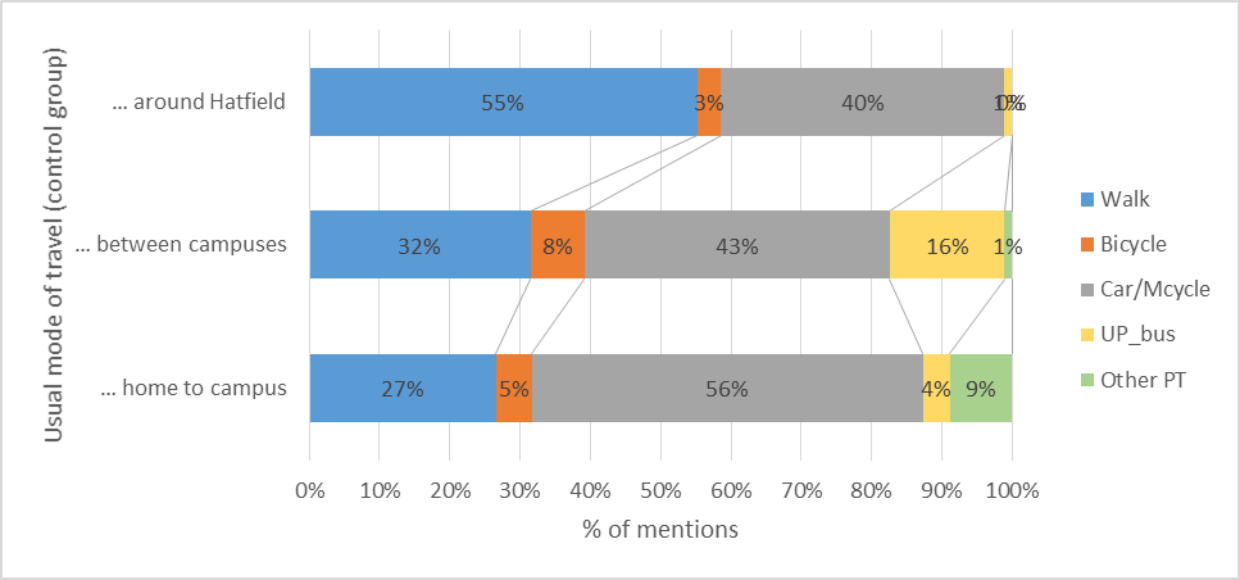

Figure 6: Usual mode of travel (control group)

There were relatively few bikeshare users who previously used their own bicycles for local trips or commuting from home – about 8% (Figure 5). A further 37% mentioned using bicycles not daily but for exercise somewhat regularly (not shown). Thus about 45% of bikeshare users were already regular users of their own bicycles, suggesting that a portion of the market for bike sharing comes from people who are already familiar with biking and its advantages.

Small numbers of users were current public transport (18-27%) and car (13%) users for local trips. Fifteen percent of users own a car. Comparing mode use between bikeshare users (Figure 5) and non-users (Figure 6), it is seen that car users were relatively underrepresented amongst the bikeshare population. It appears that the bikeshare pilot was not very attractive to current car users. This is not surprising given the location of the single kiosk close to campus: users were primarily drawn from nearby residents (two-thirds of users live within Hatfield, including UP's residences). The way in which some car users used the bikeshare was as a last-mile mode, after driving to the UP park-and-ride site which is located right next to the bikeshare kiosk.

How did bikeshare change people's travel patterns? Firstly, bike usage went up amongst users. Figure 7 shows that the percentage of people using a bike at least once a week jumped from 45% to 75%. The bikeshare pilot did not simply capture existing bike trips, but attracted people from other modes.

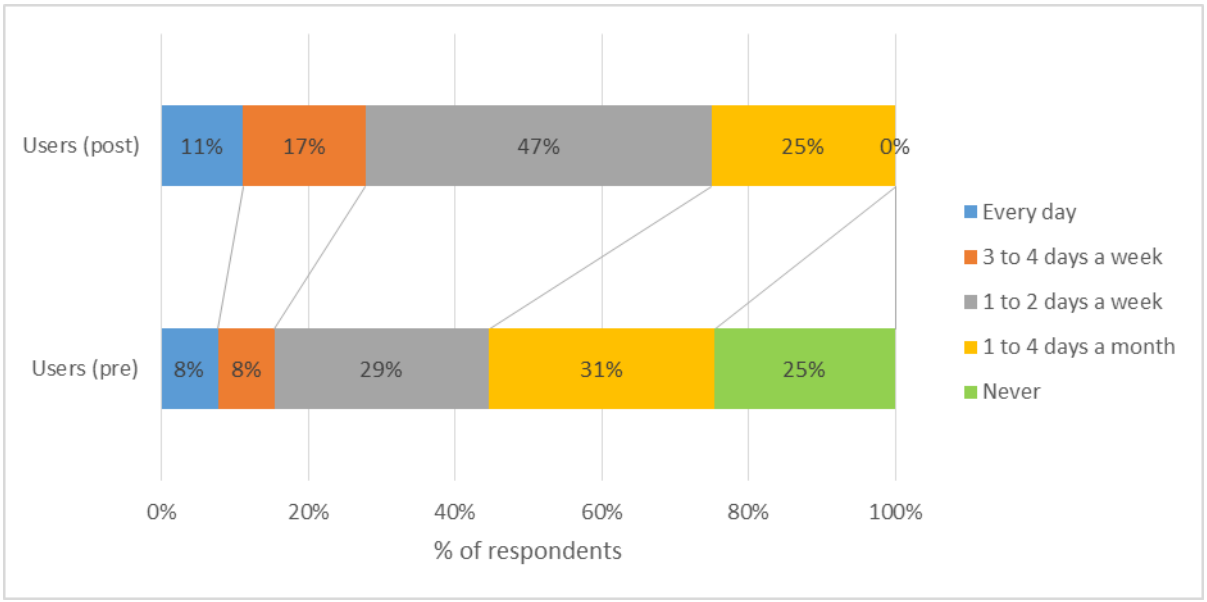

Figure 7: Frequency of bicycle usage for commuting or exercise (pre and post-use)

Figure 8 shows which modes the bikeshare trips came from. Asked what other modes they would have used to make the same trips, about two-thirds of bikeshare users indicated that they would have walked, five percent switched from using their own bicycles, eight percent from using their cars or motorcycles, 13 percent from using the UP-bus system (inter-campus shuttles), and 11 percent from other public transport such as minibus-taxis or A Re Yeng (BRT).

This confirms firstly the very significant demand for bikeshare amongst people who currently get around on foot. This mirrors international findings regarding bikeshare on university campuses, and its limited environmental benefits in terms of reduced emissions (Langford et al. 2013). Secondly, bikeshare did have a modest ability to attract people from their cars, thus promoting sustainable modes and reducing congestion. Amongst bikeshare users the share of car and motorcycle trips within Hatfield (including between campuses) fell by 5 percentage points, from 13% to 8% (not shown). Thus, bikeshare had the potential to make a modest contribution to reducing car use and congestion within Hatfield, even given the restrictions imposed on possible trip patterns by the single kiosk.
Thirdly, there is evidence that bikeshare also captured some trips from public transport, including campus shuttles. The implication is that some trips on public transport are short enough to be more efficiently served by bicycles, once available. However it also points to a potential trade-off in terms of sustainable transport: increased bikeshare might reduce revenues of public transport modes.

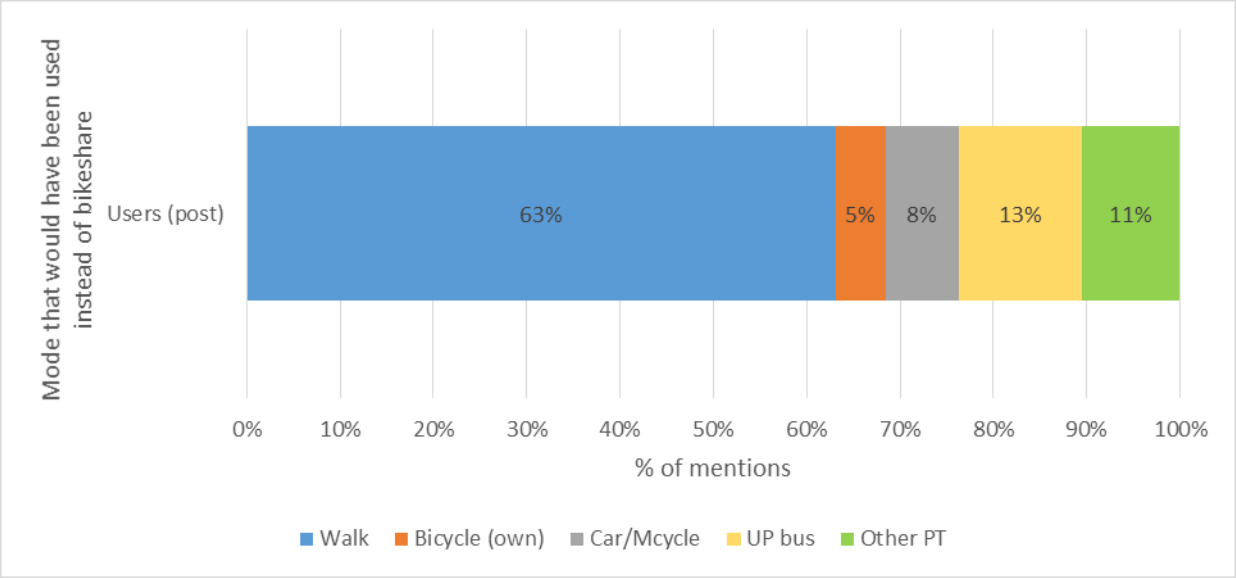

Figure 8: Alternative mode that would have been used instead of bikeshare

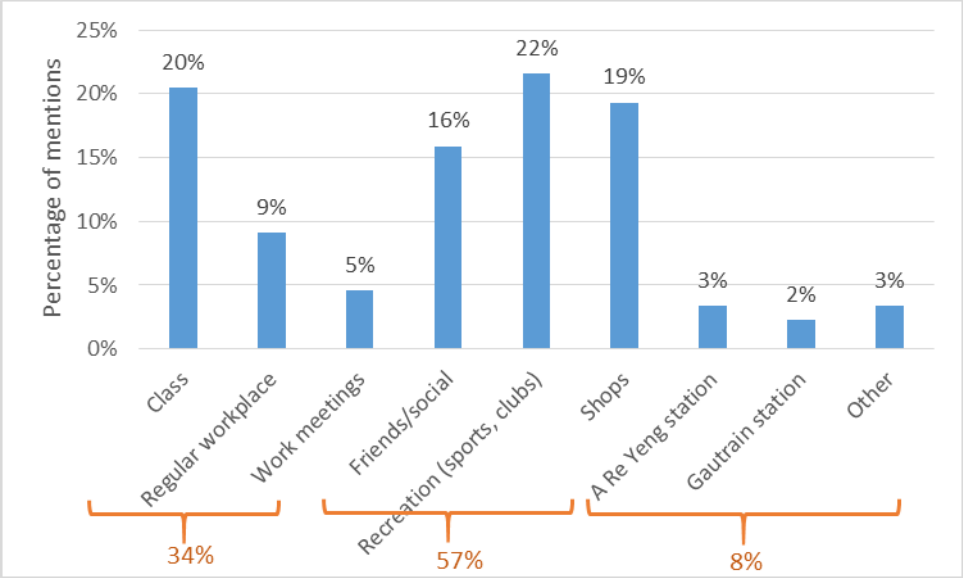

Figure 9: Trip purposes of bikeshare users

Regarding the types of trips users made with the bikeshare bicycles, usage can be grouped into three main categories (Figure 9). About a third of users used the bicycles for travelling to and from class (typically at Hatfield main campus), and work places. The most frequent use of the bicycles was for social and recreational purposes (including shopping, visiting friends, and sports) – these accounted for 57% of users. And 8% of users used the bikes to commute to A Re Yeng (BRT) and Gautrain stations, confirming that bikeshare can play a role in supporting public transport more broadly by solving first/last mile connectivity problems.

The category of "Other" included an interesting and unexpected use of the bikeshare. Some students working for a local online business used the bikes to make deliveries of low-cost food. Discussions with the young entrepreneur behind the business made it clear that having access to the (free) bicycles became a very beneficial driver of his business success, enabling him to extend his business' range and productivity. This points to the potential role that a service such as bikeshare could play in supporting entrepreneurial job creation by providing cheaper access to working bicycles.

4.5 Users' opinions on bicycling and bikeshare

Questions were asked to gauge respondents' current concerns with transport in general and bicycling in particular. Figure 10 (bottom) shows that respondents were most concerned with the security of their bicycles (58% agree or strongly agree), and the cost of transport (55%), while traffic safety (49%) is of less concern. Security from theft and transport cost are both factors that can be expected to help push people towards bikeshare, as users do not have to face the constant pressure of keeping their own bikes safe, or having to buy one.

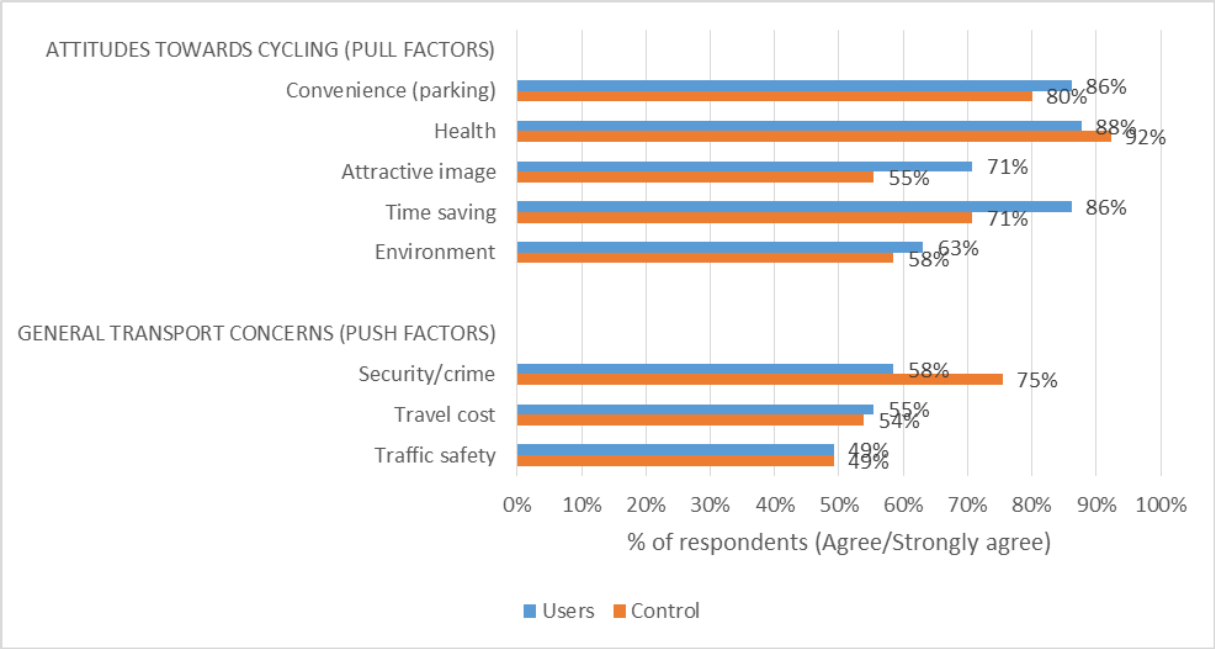

Figure 10: Differences in Attitudes and Concerns between users and non-users (control group)

While safety from accidents can be expected to be of concern to bikers and pedestrians, who are vulnerable in the road environment, this appears to be a lower priority amongst users than expected. This is interesting, given the fact that almost no bike lanes are provided in the Hatfield area. Focus group participants did confirm that current infrastructure was insufficient: narrow roads, uneven pavements, and a lack of bike lanes were identified as problems. But it is likely that bikeshare users already accepted compromised traffic safety as a condition of biking. In terms of security, no incidents of theft of bicycles were encountered, and only one minor accident (a bike-car collision) was reported.

The questions aimed at gauging attitudes towards cycling give a sense of "pull" factors seen as positive attributes of cycling (Figure 10, top). The strongest pull factors are convenience, particularly related to the ease of parking, and the health and time saving benefits of cycling (more than 85% of respondents agreed or strongly agreed). Many respondents also see cycling as creating an attractive image. These issues might be useful in further marketing and messaging during efforts to promote cycling, especially among the youth. Just over 60% of respondents are concerned with environmental issues, while about 25% are not concerned. This suggests that the environmental benefits of cycling are less of a universally strong pull factor than the other factors.

Figure 10 also compares the attitudes of bikeshare users with non-users from the control group. It shows that users are different from non-users in three important respects: users are more aware of the positive image that they get from cycling, more aware of its time savings benefits, and less concerned with the threat of having their bicycles stolen. This suggests that future marketing campaigns should focus on creating positive and attractive images around cycling, and emphasise its time savings and security benefits to reduce barriers to its adoption.

Overall, users were very positive about their experience with the pilot, with 54% of respondents rating it as *excellent* and 38% as *good*. Aspects with which respondents were most satisfied include the cost (as can be expected for a free service), the service quality of the booking system, and the service offered by the kiosk attendants. As one focus group respondent put it, the project "*made a difference to a lot of people*". Specific aspects that need more attention in future projects include expanding the number of kiosks, paying closer attention to the quality and maintenance of bicycles, and taking action to promote safer bicycling conditions on the street network.

4.6 Willingness to pay

Lastly, the post-use survey asked bikeshare users to reflect on whether they would be willing to pay for the service. Almost all respondents felt that they would be willing to pay something for using the bikes. The most common figures mentioned was R3.00 and R5.00 per trip, with a smaller number of people willing to pay up to R10.00 per trip (Figure 11). It suggests that, at a price of R5.00 per trip, two-thirds of current users would still use it. Focus group participants supported this, noting that making the bikes free removes the motivation for people to take care of the bikes they are using, and leads to abuse. Furthermore, respondents also indicated a preference for subscription-based pricing, where a monthly or annual fee allows unlimited bikeshare use. Subscription pricing does however remove the big advantage of bikeshare, which is the way in which it encourages bicycling amongst occasional users. The need to pay high lump-sum fees may also be a barrier to use amongst cost-sensitive users. The optimal pricing model may well be a mixture of subscription and per-ride fees.

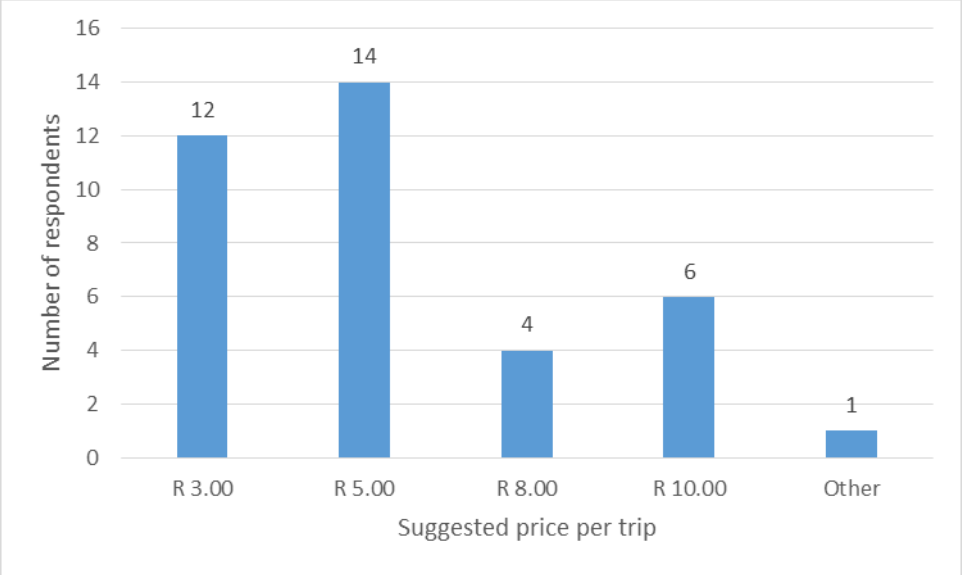

Figure 11: Users' opinions regarding fair price to pay for a single bikeshare trip

5. CONCLUSIONS

The limited bikeshare pilot undertaken at the University of Pretoria in 2018 provided some insight into the actual potential for bikeshare in South African cities. Without generalising to the broader population, it was demonstrated that a definite demand for bikeshare exists, at least in some niche markets. After solving initial teething problems, the system was running at almost full capacity for the duration of the project. To be sure, some of its popularity was due to the fact that bikeshare use was free. But it also demonstrated that some of the other factors that have been identified as potential barriers to bikeshare adoption in SA cities, including mandatory helmet use, theft and vandalism, and limited bicycle infrastructure, need not prevent its successful implementation.

Demand for bikeshare was by far the largest amongst users who get around on foot. In this sense the pilot confirmed earlier arguments (e.g. De Beer and Valjarevic 2015; Jennings 2015) that bicycling – with or without bikeshare -- could have a role to play in reducing the mobility burden in terms of time and effort spent walking in low-income communities. There is indeed a demonstrated willingness amongst young people to increase their use of bicycles, for a variety of trip types. The pilot also showed that bikeshare has a discernible, but modest, ability to attract car users and contribute to environmental goals and congestion relief, but only for a subset of trips. The findings suggest that marketing of bicycling or bikeshare should focus on creating positive and attractive images around cycling, and emphasise its time savings and security from crime benefits to reduce barriers to its adoption. The limited offer of electric bikes, though expensive and of uncertain utility to users, might form part of this strategy.

What about the financial sustainability of bikeshare systems? As a free service, the pilot did not provide evidence on users' willingness to pay for bikeshare. It is clear that affordability is a key constraint amongst potential users. However, after experiencing the service, users indicated a definite willingness to pay for bikeshare, indicating its utility for them. It is unlikely that user fees will cover the full costs of bikeshare systems in South Africa (except perhaps those aimed at high-end users such as tourists), but arguments can be made in favour of public subsidies for bikeshare on the grounds of its promotion of sustainability objectives. Subsidies might also be rational on the grounds of bikeshare's demonstrated ability to attract some users from cars, and to support public transport as a first/last mile service. Financial support might be secured through partnerships with major employers in the area or advertising.

Overall, the pilot suggests that there is a role for bikeshare (as distinct from long-term bike rental) in niche markets in South Africa. Campus environments are one such market, where short trip lengths, the ability to control and closely monitor access to the system, and the characteristics of the user population are factors favouring its success. More experiments are needed to test other variations of the concept in other niche markets, including other funding and operational models. One particularly promising extension is to test the ability of bikeshare to promote entrepreneurship and job creation, not just to serve commute trips. A proposal to test the bikeshare system amongst a larger population with more realistic operating and pricing conditions is currently being considered in Tshwane, and will provide further opportunities for research. But given the fact that travel habits formed during people's early years tend to affect behaviour later, bikeshare might be a useful investment in terms of reaching long-term sustainable transport goals.

7. ACKNOWLEDGEMENTS

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