Bike Share - Options for Adelaide

Stage Three: Design and Options Assessment

Prepared for the City of Adelaide by
the Institute for Sensible Transport

April 2016

Institute for
Sensible Transport
www.sensibletransport.org.au

This page has been left intentionally blank

Executive Summary

The City of Adelaide has supported the *Adelaide Free Bikes* program since 2005, which includes 200 bicycles, available for free hire at 19 hire nodes. Unlike most contemporary bike share programs, *Adelaide Free Bikes* are only available in staffed locations, such as libraries. Whilst this program has strong public support, the rapid pace of international bike share development since 2005 opens up several possibilities to modernise the provision of bike share in Adelaide.

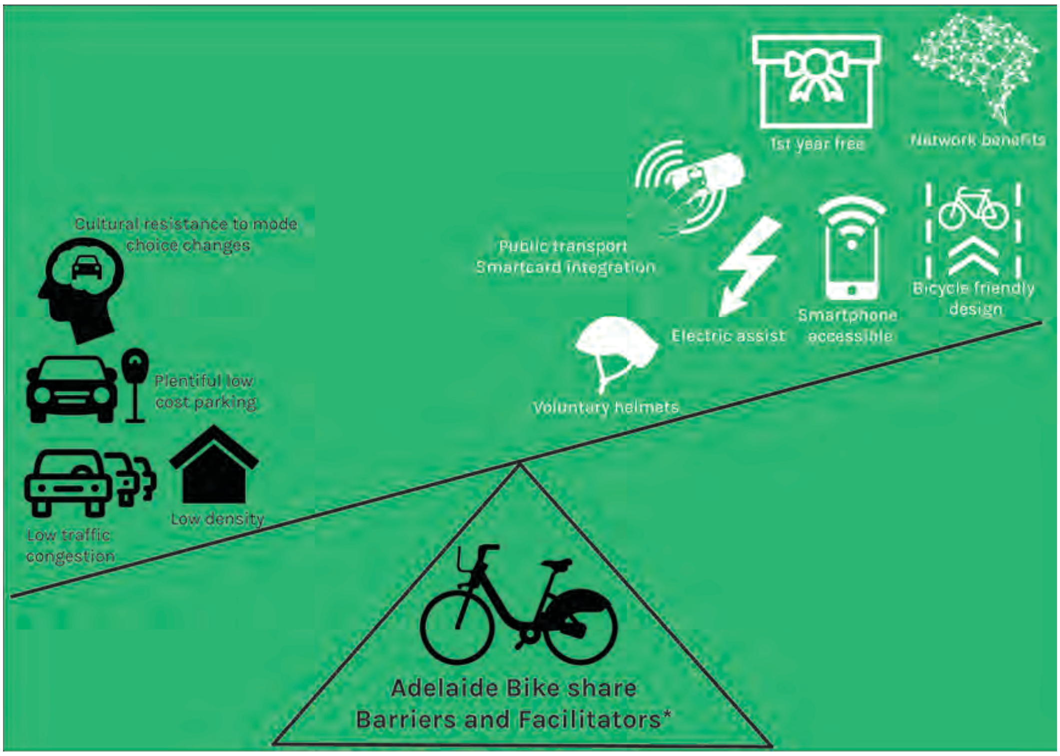
The report is the final component of a program of research assessing the initial feasibility and options for a modern bike share program in Adelaide. These include a recommended set of design features to maximise ridership, including hardware, technology, catchment size, pricing and integration with public transport.

There are currently over 1,000 cities that operate bike share programs, up from just 13 in 2004. Many of these systems are well used, boosting levels of sustainable transport access. Many cities are expanding their bike share program to include larger portions of their urban area. The Australian experience has not been as positive. Melbourne and Brisbane launched bike share programs in 2010 and neither program has enjoyed the same usage levels as is commonplace internationally. Usage levels typically remain less than one trip per day, per bike in both Melbourne and Brisbane. Some of the reasons for these low usage levels include mandatory helmet legislation, limited network of protected bicycle infrastructure, small catchment size, and poor marketing and promotion.

Bike share offers cities several important benefits, including enhanced transport choice and flexibility, increased levels of physical activity, and reductions in congestion, transport costs and air pollution. A strong strategic alignment between bike share and Adelaide's strategic version has been identified. Adelaide's vision to be a *'smart, liveable boutique city full of rich experiences'* and the themes of *'smart, green, liveable and creative'* are supported by a high quality, technological advanced bike share system that meets the needs of locals and visitors. Further, bike share may enhance Adelaide's reputation as a festival city, by offering a low cost, sustainable and fun way to experience the city. Bike share may also help to *normalise* the image of cycling, transforming it from a lycra based, high performance pursuit, to a more relaxed, slower paced activity undertaken as a part of everyday life.

Despite the benefits of bike share there are important risks associated with the introduction of a large scale, modern bike share program in Adelaide. The most important of these risks is the potential for *low usage levels*. Adelaide's low density urban form, relatively low traffic congestion levels, and ease and low cost of car parking in central Adelaide all work to reduce the attractiveness of bike share, relative to existing transport options. Moreover, the relatively immature bicycle infrastructure network also reduces the likelihood of bike share use. The choice to use bike share must be seen as a complex decision making process that involves an assessment of *all* potential modes of transport. Therefore the prospects for an Adelaide bike share program are also dependent on how the program competes with the car, and other modes, in terms of providing a compelling value proposition to potential riders. If it cannot compete with other modes, on a time, cost and convenience basis, it is unlikely to attract strong ridership levels.

The figure below summarises the barriers and (potential) facilitators to bike share use in Adelaide.

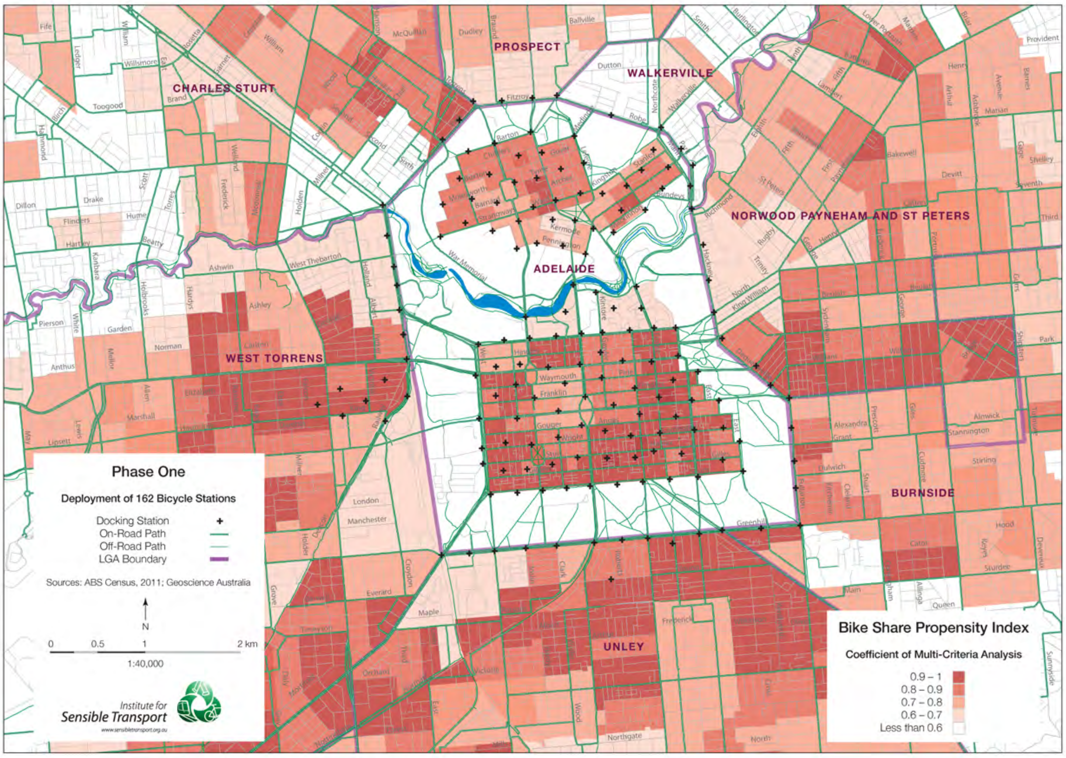


The limitations of the bike share programs in Melbourne and Brisbane, combined with an assessment of the local context and best practice examples from overseas has informed the development of a set of design options for an Adelaide bike share program. This assessment has found that Adelaide does not currently have the necessary pre-conditions to support a successful bike share program. A number of policies and actions have been recommended to create the conditions required to ensure a future bike share program is able to flourish in Adelaide. Recommended design futures and supportive policies include:

- Electric assist, GPS connected, solar powered bicycles.
- Public transport smartcard integration.
- Smartphone unlocking of bicycles using Near Field Communication technology.
- High-density catchment design (a docking station every 300m).
- Comprehensive marketing and branding strategy.
- Organisational and contract structure to incentivize operator to maximise usage.
- Free basic fair structure (at least for first year).
- Safer bicycle infrastructure network and lower motor vehicle speeds.

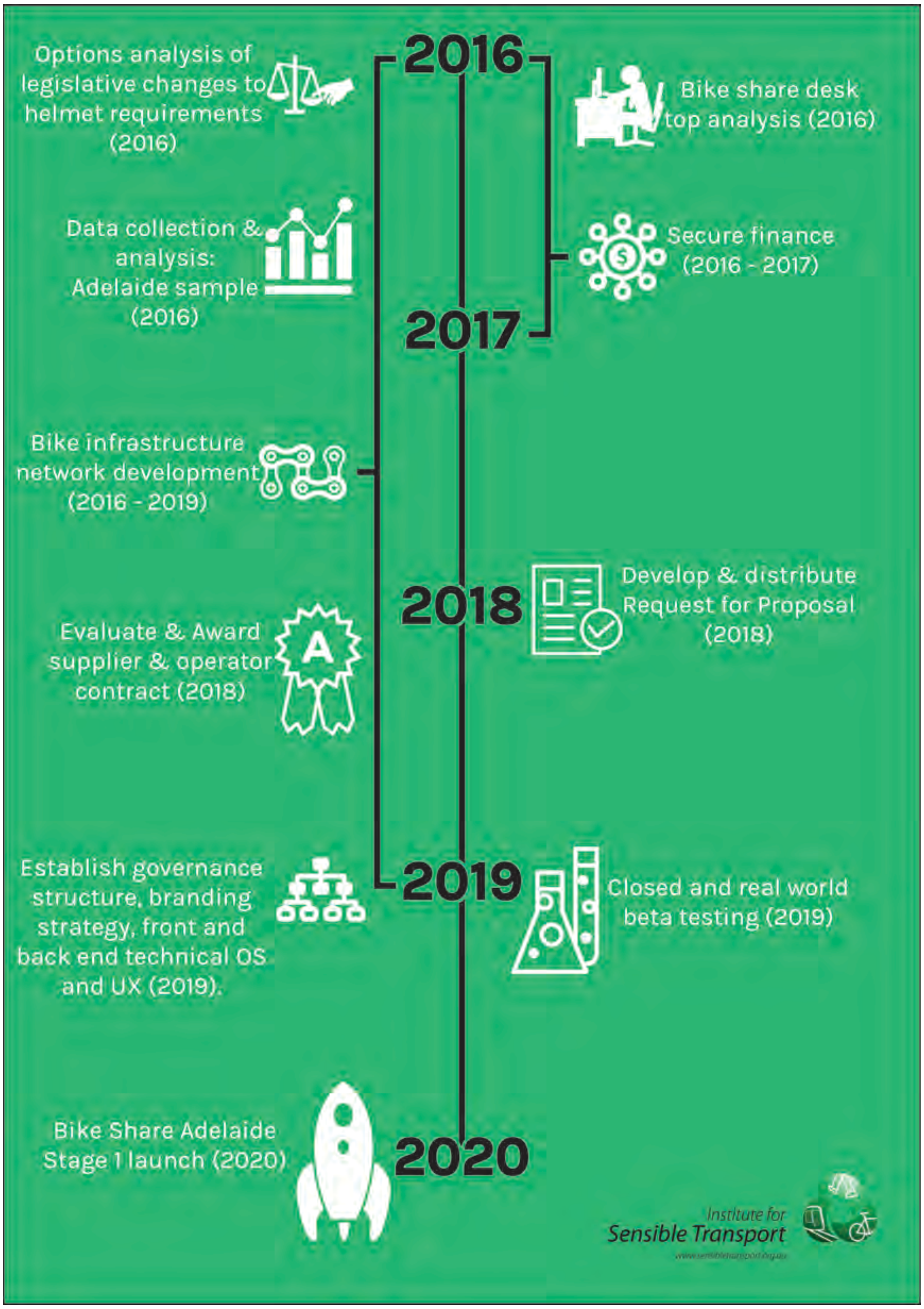
- Investigation of overall population health impact of mandatory helmet waiver for bike share.

A *Bike Share Propensity Index* has been created, to identify the areas of Adelaide that display characteristics likely to support higher levels of bike share use. This is shown below with a conceptual placement of a proposed Phase One catchment, consisting of 162 docking stations, encompassing a fleet of 1,620 bikes. The darker the region, the higher the *relative* level of forecast bike share use.



A significantly larger catchment has also been identified, presenting a second stage of development, designed to help make bike share an option across inner Adelaide. Should Adelaide choose to develop a bike share program consistent with design and policies identified in this report, it is expected Stage One to cost between $9.7m and $21m in capital expenditure, depending on the hardware and technology options. This includes the cost for 1,620 bicycles and twice the number of docking spots, with an annual operating cost of between $2,000 and $4,000 per bike. Ridership, whilst difficult to forecast with certainty, is estimated at around 1.5 – 2.5 trips per day, per bike.

Creating the physical and policy conditions supportive of bike share in Adelaide is a long-term process. It is unlikely the necessary pre-conditions for bike share will be met in less than four years and the following illustrates the suggested sequencing of preparatory activities.



The report concludes with a number of 'triggers' – actions that are considered necessary before a bike share program becomes viable in Adelaide, as well as essential research activities.

Implementing a bike share program that satisfies the pre-conditions identified above will provide Adelaide with the best possible prospect of success. However, there are limits to the impact these actions can have on ridership, as they do not eliminate the negative impact on usage associated with a low-density city and a transport system still heavily in favour of car use. Thus, this assessment of bike share options for Adelaide has found that although it is unlikely Adelaide will achieve the high usage levels of some bike share cities (e.g. Paris, with up to eight trips per bike, per day), bike share should be seen as a positive step Adelaide can take to begin the transition to a more sustainable, carbon neutral transport system.

This page has been left intentionally blank

CONTENTS

Figures

Tables

About this report and project

This report represents the third and final component in a program of research to assess the initial feasibility and options for a modern bike share program in Adelaide. The Institute for Sensible Transport have been commissioned to undertake this work by the City of Adelaide. The central objective of this Stage Three report is to develop a set of options for a bike share program in Adelaide, centred on best practice principles. The Stage One Report, shown in Appendix Two provides a detailed discussion on bike share literature relevant to Adelaide, including an analysis of the Melbourne and Brisbane bike share programs. Readers are encouraged to familiarise themselves with the Stage One Report prior to reading this report. Stage Two of this project involved a professional stakeholder workshop, with participants drawn from the City of Adelaide and other Adelaide based municipalities.

Background

Adelaide City Council has financed the *Adelaide Free Bikes* program since 2005. *Adelaide Free Bikes* includes 200 bicycles, which can be rented at 19 hire nodes. Users are limited to the opening hours of the node, as these are staffed locations (e.g. libraries). The program does have strong support, but given developments in bike share internationally, there is a need to investigate the feasibility of a more technologically advanced, larger scale program.

1. Introduction

In the past decade, the number of cities with a bike share program has increased from 13 in 2004 to over 1,000 in 2016. The global bike share fleet is estimated at 1,258,500 bicycles (Meddin & DeMaio, 2016). Since 2010, two bike share programs have operated in Australia, in Melbourne and Brisbane, with 545 and 1,832 bicycles respectively. Both these Australian programs have operated at less than forecast usage and it is therefore incumbent on those cities seeking to explore the possibility of bike share in Australia to undertake a careful examination of the various costs, risks and benefits these programs present in the Australian context.

This report presents an analysis of bike share options for Adelaide, including a recommended set of design features to maximise ridership, including hardware, technology, catchment, pricing structure and integration with public transport.

2. Bike share in Adelaide – contextual factors and risks

2.1. Introduction

An overarching implication from research conducted in Brisbane, Melbourne, London and Washington, D.C. is that the critical factor motivating bike share use is *convenience* (as described in greater detail in Appendix Two). A bike share program that offers the user a cheap, easy and safe way of getting from A to B, in a time competitive manner (compared to existing transport options) is likely to attract strong ridership levels.

The Melbourne and Brisbane bike share programs have suffered lower levels of use when compared to other bike share programs. There are a range of factors contributing to this lower usage level, as identified in Appendix Two (e.g. small catchment size, limited consideration of mandatory helmet implications, poor marketing and promotion as well as safety concerns).

This section is designed to use the experience from Melbourne and Brisbane as a platform upon which to design a bike share program for Adelaide that accounts for the lessons from Melbourne and Brisbane, as well as relevant factors associated with Adelaide's unique context.

A framework has been developed that can be applied to the Adelaide context, in order to inform the design of a future bike share program, and leverages off the lessons learnt from the Melbourne and Brisbane bike share experience, as well as successful bike programs in other countries. This framework is shown in Figure 1, and is described in greater detail in the Stage One Report (see Appendix Two).

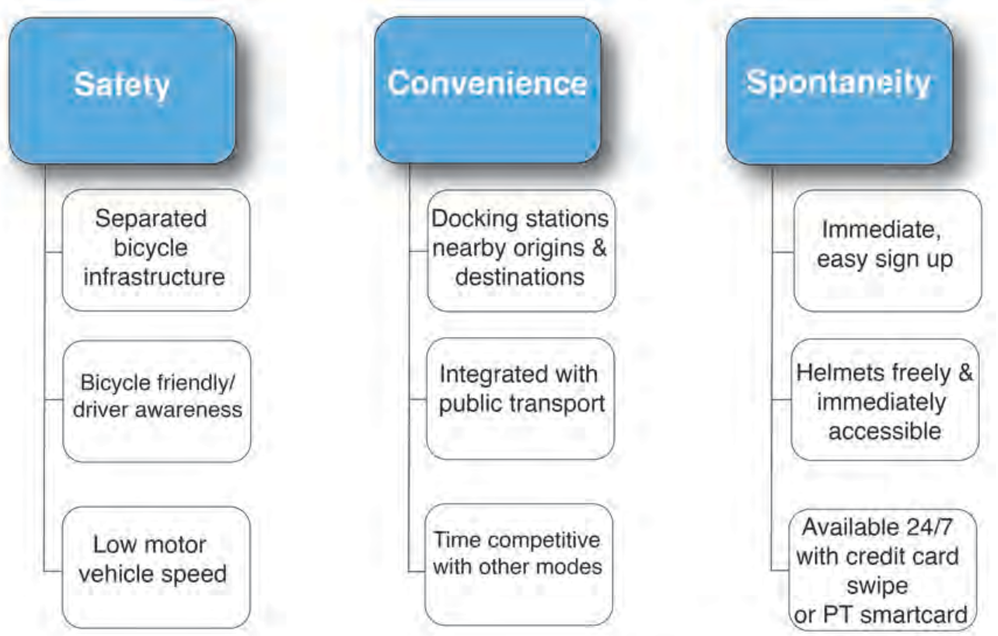


Figure 1 Framework for designing a successful bike share program

2.2. Safety concerns

Safety is the major barrier to private bike use generally in Australia as well as bike share. The Stage One Report identified that people that do not currently cycle are more sensitive to the degree of protection from motorised transport (compared to those that do cycle). In terms of best practice, London, Paris and New York City (among others) all embarked on bicycle infrastructure campaigns in the years prior to the establishment of bike share. This infrastructure included a large number of protected bicycle lanes/paths and these helped to provide prospective users with the confidence necessary to start using bike share. In Paris, the infrastructure also included many targeted *'contra-flow'* lanes, that allowed two-way travel for cyclists, but only one-way travel for motorists. This helped to increase the *value proposition* for bike share over motorised forms of travel. In London, a large number of continuous, protected bicycle lanes, have now been added to the network, helping to provide safe conditions for cycling. London has also embarked on a campaign of establishing what has become known as *'mini-Hollands';* precinct based changes to the street network to encourage everyday, safe cycling.

By contrast, very little bicycle infrastructure was developed in the planning of the bike share programs in Melbourne and Brisbane and both have, according to residents of these cities, a level of hostility to cyclists, reducing bike share's attractiveness (Fishman, Washington, & Haworth, 2012a).

The overwhelming theme emerging from an international assessment of bike share program success is that a substantial investment in protected, connected bicycle lanes and paths should be undertaken prior to the establishment of bike share. Moreover, as shown in New York City and London, lowering speed limits *before* bike share launches is likely to enhance not just bike share ridership, but also reduce road trauma generally (i.e. not just for bike share users).

2.3. Convenience

As identified in Section 2.1, the most consistent finding in the international literature on bike share is that people choose to use bike share when it meets their convenience criteria. *Convenience* often suffers from a lack of specificity (i.e. what do people really mean when they cite *'convenience'* as a motivation for use?). In the context of bike share, it is best thought about in terms of the *value proposition*. What is the value proposition bike share offers a potential user? Central to the success of bike share therefore is the degree to which bike share competes with car use for short to medium car trips. If car use is faster, door-to-door, it will be difficult to attract people to bike share. Thinking about the bike share service in relation to competing modes is central to providing the level of convenience necessary to attract ridership. Moreover, best practice bike share cities, in addition to providing relatively large systems, have also worked to integrate them into the existing public transport network. Data on user attitudes and behaviour show a very strong desire to make multimodal journeys that involve segments of walking, bike share and public transport. Although by no means an industry standard yet, integrating bike share access into public transport smartcard ticketing taps into a very strong user preference to have an *access all modes* pass that works on both bike share and other forms of public transport. Emerging technological developments suggest that in the near future it will be common for bike share users to be able to access both bike share and public transport through the use of a smartphone. Ultimately, what much of the research and user surveys suggest is that bike share needs to be *time competitive* with competing modes. This is especially the case for commuting trips (in which users are more time sensitive).

2.4. Spontaneity

The average bike share trip is between 12 and 16 minutes in duration (Fishman, Washington, & Haworth, 2014). These short trips are very often not planned well in advance. The evidence from Australia and abroad is that people wishing to use bike share would like to gain access *immediately* in many cases, especially for their first trip (to 'try it out').

Programs that require a user to sign up days in advance have lost large numbers of potential users. Generally, existing best practice is to allow for credit card swipe sign up, that offers immediate access to the user, 24/7. As highlighted earlier, in Brisbane, especially in the early phase of *CityCycle*, users were asked to listen to over 20 minutes of legal disclaimer and were not permitted to use the system after 10pm or before 5am. These factors severely limited the ability of new users to sign up as fast as they would have liked, with many forgoing the opportunity (Fishman, 2014).

Mandatory helmet use hampered the spontaneity with which people were able to use the bike share systems in Australia. For the first 12 months of both Australian bike share programs, very little was provided in terms of immediate access to free helmets on the bicycle itself, and this further damaged usability. Eventually helmets were provided with many of the bicycles. Although this did have the effect of increasing usage, many people had become accustomed to seeing the bicycles sit un-used. Figure 30 in Appendix Two illustrates a typical scenario seen in both Melbourne as well as Brisbane in the early months following the launch of bike share. Interested users walked up to the bikes, showed some interest, but left upon realising they needed a helmet in order to legally use the system – and no helmets were provided.

The experience from Brisbane and Melbourne show that everything needs to be done in the early months to capitalise on the public's intrigue with bike share. The best marketing strategy for bike share is for people to see other people riding (Fishman et al., 2012a), and unfortunately this was lacking in the launch of bike share in both Brisbane and Melbourne.

2.5. Benefits of bike share for Adelaide

The City of Adelaide has a daily user population of 262,000, with 122,700 people employed in City based businesses. Moreover there are 86,000 students in institutions located within the City and a resident population of 22,690 (City of Adelaide, 2016). The growth of activity within inner Adelaide increases the potential for bike share to offer an additional transport options for those living, working or visiting Adelaide.

It has become increasingly well recognised over the last decade that cycling offers a range of important public policy and individual benefits (Fishman, 2016). Bike share, it is purported, provides benefit in terms of increasing transport choice and flexibility, reduced congestion and greenhouse gas emissions and increased levels of physical activity. Bike share has also been shown to reduce transport costs (Parkes, Marsden, Shaheen, & Cohen, 2013; Shaheen, Guzman, & Zhang, 2010). A more extensive quantification of the benefits of bike share is included in the Stage One Report (see Appendix Two).

There is a strong strategic alignment between the benefits of a successful bike share scheme with the City of Adelaide's vision and associated policies. The Vision included in the 2016 – 2020 Strategic Plan is *'Adelaide is a smart, liveable, boutique city full of rich experiences'* (City of Adelaide, 2016). The four themes underpinning the City of Adelaide's Vision are *smart, green, liveable* and *creative*. Bike share provides a high degree of support to these themes, as bike share is generally seen as part of the wider *New Urban Mobility* paradigm (Hoffmann, Kandt, Smith, & Graff, 2015) whereby cycling for short trips is seen to enhance smart, urban, sustainable living. Indeed many of the cities that have successful bike share programs proudly market them as an integral part of a sustainable city, enhancing the liveability of its residents, as well as the visitor experience.

In addition to the benefits highlighted above, bike share has also been shown to play a role in *normalising* cycling as a regular aspect of urban life, rather than strictly a lycra-based sporting activity. Research from London found that bike share users were far more likely to wear regular clothes and travel at a lower pace than private cyclists (Goodman, Green, & Woodcock, 2013). For Adelaide, which currently has low levels of cycling participation, a bike share program may help foster a culture in which the bicycle is seen as an accepted mode of transport for short to medium trips.

Adelaide is also a city of festivals, including WOMAD, the Adelaide Writers Festival, and the Adelaide Fringe. In January each year Adelaide hosts a world class cycling event (Tour Down Under), bringing thousands of visitors to Adelaide with a predisposition for cycling. Bike share offers those visiting Adelaide with a unique, memorable and affordable method of exploring inner Adelaide, travelling at one's own pace, with the flexibility to customise their experience of the city.

Adelaide also has a relatively large CBD compared to its population (Allchin, 2013) and although low density generally has negative implications for bike share use, it is possible bike share may offer advantages in navigating Adelaide's relatively large city centre.

There is an emerging body of evidence suggesting that bike share also reduces the risk of a collision with a motor vehicle. Although a detailed explanation for the mechanisms underlying these trends are yet to be fully explored, several studies have arrived at similar conclusions – bike share's introduction appears to reduce overall crash risk. This may be due to the so called *safety in numbers* phenomenon (in which the more riders there are, the safer it becomes, per rider), as well as the upright, slow speed cycling that characterises bike share use (Fishman & Schepers, 2016). The safety implications of bike share are discussed in the Stage One Report in Appendix Two.

Bike share has also been found to increase transport choice and flexibility. Among the most common reasons bike share members use bike share is the ability to combine it with other transport modes. For instance, bike share allows users to ride one way, without being compelled to ride the return journey. This may be useful in situations of bad weather, or if riding in the dark is undesirable. Evidence from Melbourne and elsewhere has also shown that bike share users often combine their bike share journey with public transport, helping to reduce door-to-door travel time. Bike share has become known as a *last-mile* solution to public transport. Related to this, the integration of bicycling with public transport can increase the catchment of the public transport network by a factor of 15, as shown in Figure 2.

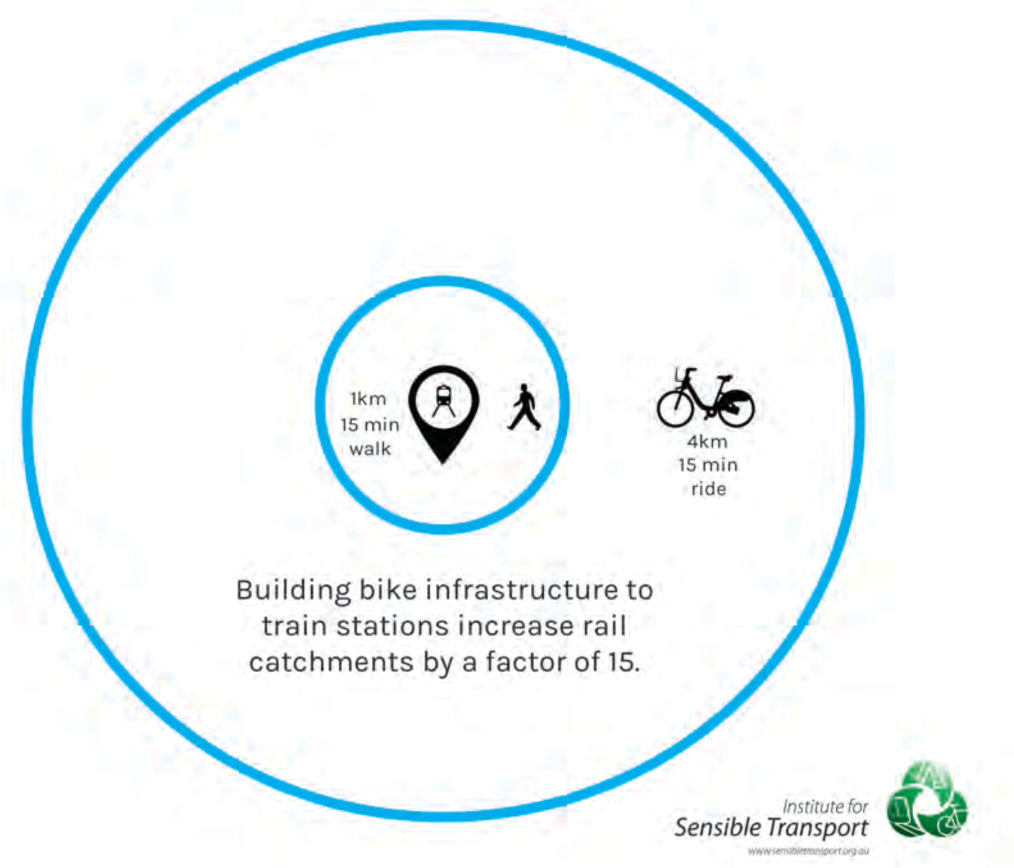


Figure 2 Increasing the catchment area of public transport with bike share

In China, the country with the largest number of bike share programs, combining bike share with public transport is overwhelmingly the most common usage pattern. Research from Melbourne has shown that docking stations located in areas with relatively poor public transport accessibility (represented by areas of light shading) are used *more* heavily, as shown in Figure 3. The thicker the blue line, the larger the number of trips between these docking stations (represented by the blue bicycle symbols).

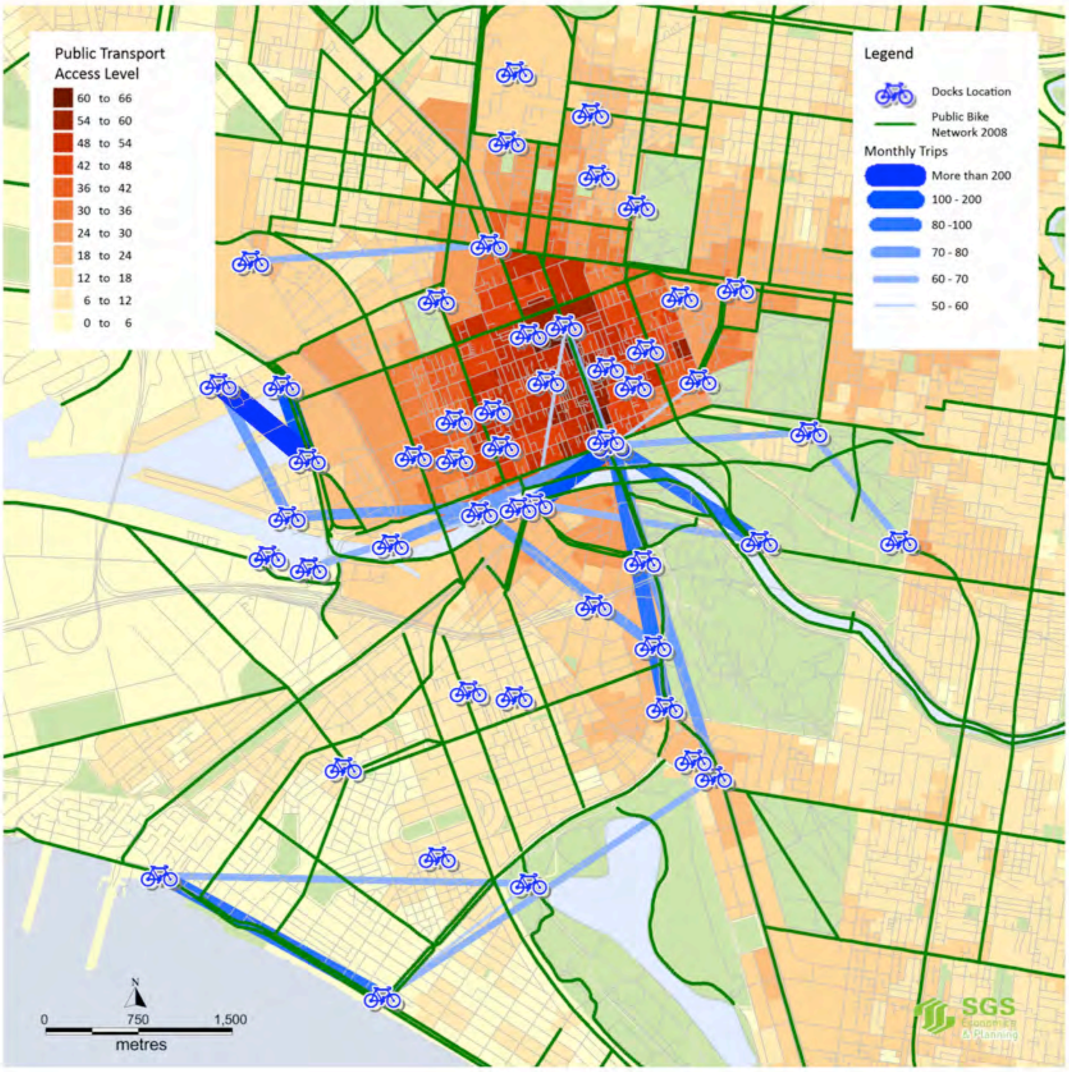


Figure 3 Relationship between docking stations and public transport accessibility

Source: Fishman, Washington, Haworth, & Mazzei (2014)

Ultimately, one of the key reasons cities choose to establish a bike share program is its potential to reduce car use. Evidence from Melbourne, Brisbane and other cities shows that as long as a reasonable proportion of bike share trips replace motor vehicle journeys, the net impact is for a reduction in vehicle kilometres travelled, as described in the Stage One Report shown in Appendix Two. Based on data from Melbourne and Brisbane, it is reasonable to expect around 20% of bike share use in a future Adelaide bike share program will replace a trip formally conducted by car.

2.6. Risks

There are potential risks associated with any public policy, and this includes bike share. An assessment of the international and domestic bike share experience suggests that the dominant risk for a bike share program in Adelaide is a potential lack of use (compared to usage levels in larger, higher density cities).

2.6.1. Low usage levels

Few bike share programs internationally have suffered from very low usage levels (less than one trip per day per bike). The Melbourne and Brisbane bike share programs have, as shown in Figure 5 of the Stage One Report (Appendix Two), failed to achieve forecast ridership levels. Melbourne for instance was forecast to have around five trips per day per bike, but typically achieve between 0.5 and 1 trip per day per bike. Brisbane's bike share program has lower usage levels than Melbourne.

The physical characteristics of Adelaide (e.g. density, land use mix, bicycle infrastructure) do not appear to be any more favourable to bike share use than Melbourne. The density and land use characteristics of Adelaide are unlikely to change substantially over the next four decades. Bicycle ridership in Adelaide is no higher than Melbourne or Brisbane. A future bike share program in Adelaide will need to operate under less than optimal conditions. Optimal conditions for bike share involves a combination of high density, apartment style housing stock, high cost, low availability car parking, connected, high quality protected bicycle infrastructure, low motor vehicle speed and car ownership levels. These characteristics are present in the cities with the highest level of bike share use, such as New York City, Paris, and Barcelona.

Whilst low usage levels are a significant risk for an Adelaide bike share program, there are substantial improvements that can be made from the experience in Brisbane and Melbourne, as discussed in more detail in Section 3. These include a relatively large catchment, to optimise the network benefits, seamless connection with public transport, world leading bike share technology and instantaneous accessibility via Smartphone.

2.6.2. Other risks

As highlighted above, low usage levels are the most pertinent risk factor for bike share in Adelaide. There are some other, albeit lower level risks, which are briefly discussed below.

Safety has sometimes been suggested as a major risk associated with the introduction of a bike share scheme, however this has been found to be invalid (Fishman & Schepers, 2016). In fact, as highlighted earlier and in the Stage One Report (Appendix Two), in the few studies that have looked at the safety impact of bike share, the number of cycling related hospitalisations actually goes *down* in the cities that have established bike share (Graves et al., 2014).

The financial risk associated with partnering with a third party supplier and operator should also be considered a risk. There have been some situations in which the hardware provider or operator has experienced financial difficulties and this risk may then be passed onto the government agency responsible for the bike share program. This risk cannot be entirely discounted for a future Adelaide bike share program. The risk is however no greater than for other transport providers. Due diligence should be exercised when selecting an appropriate provider/operator, to ensure they have a strong record of project delivery and management.

Finally, there is a risk of *opportunity cost*, i.e. could the capital required to establish and operate a bike share program be put to better use? This could be in the form of another cycling encouragement program, or another public policy altogether. As will be described in Section 5, the costs involved in a best practice bike share program are significant, and a careful analysis of the risks and opportunity costs is necessary before a commitment to bike share can be made.

3. An optimised bike share program for Adelaide – recommended options

An analysis of available bike share design options has been undertaken, with the view of creating the best possible conditions for bike share to flourish in Adelaide.

3.1. Hardware

The scan of bike share technology included in Section 9 of the Stage One Report (see Appendix Two) provided the basis for the following set of hardware recommendations designed to make bike share as user friendly and well utilised as possible.

3.1.1. Near Field Communication

Near field communication (NFC) is a form of wireless data transfer that detects and then facilitates compatible devices within five centimetres to communicate directly, without using the Internet. NFC is increasingly being used in a wide range of applications, such as in store, contactless payment (e.g. PayPass), as well as public transport mobile ticketing (e.g. Portland's *Mobile Tickets* and Chicago's *Ventra Mobile App*). *Apple Pay* and *Google Wallet* use NFC to enable subscribers to pay using their Smartphone.

Significant potential exists for bike share to use NFC to make accessing bicycles as easy as possible. Potential users could use their Smartphone (providing it has NFC functionality) to pay for and release bicycles, lowering the 'friction' that can sometimes prevent those who have not yet used bike share to begin the process. Moreover, for existing users, a Smartphone could replace the current key or '*fob*' they currently required to use bike share as long term subscribers. It is the authors understanding that most large bike share operators are currently working to make their systems Smartphone accessible, through the use of NFC, and at least two current commercial bike share suppliers have delivered systems that employ NFC.

Recommendation:

- Include NFC capabilities within the hardware requirements for a future bike share program for Adelaide, enabling public transport smartcard integration and accessibility via Smartphone.

3.1.2. Electric assist

The growth of bike share has coincided with a similarly rapid growth in e-bike performance, affordability and usage. In recent years a number of cities have launched bike share programs that offer electric assistance, known as pedelecs (e-bike share). These cities include the European capitals of Copenhagen (reporting 2,000 bicycles) and Madrid with 1,560 bicycles. There are currently over 14 electric assist bike share programs in Italy as well as one in Stuttgart and at least two in Japan. Richmond, Virginia has soon to launch an electric assist bike share program and Birmingham, Alabama did so in 2015. Barcelona and Milan have introduced a hybrid fleet with a combination of regular and electric assist bicycles.

Many of the cities with established bike share programs that are looking to renew their fleet are considering electric assist bicycles. Moreover, for those only beginning to launch bike share programs, electric assist has become sufficiently reliable and affordable to offer a compelling proposition. In fact, some recently established systems that have a mixed fleet (some electric some conventional) have found the electric assist bicycles are used at five times the rate of the conventional bicycles. Figure 4 illustrates the electric assist bicycles that form part of the Birmingham bike share program in the US. The solar canopy above provides the electricity that charge the bicycle battery.

Figure 4 Electric assist bike share in Birmingham, Alabama
Image: Bewegen Technologies Inc.

For Adelaide, electric assist offers a sensible option for a future bike share program because:

- Adelaide experiences hot summer weather and e-bikes reduce the level of physical exertion and perspiration, whilst still providing physical activity benefits.
- E-bikes widen the potential market for bike share.
- E-bikes make bike share a more time competitive alternative compared to conventional bike share, which is especially useful given Adelaide's low-density built form.

As highlighted earlier, low usage levels are the biggest risk factor for a future Adelaide bike share program. This risk factor can be mitigated against via electric bicycles, which provide a more compelling value proposition to potential users.

Recommendations:

- Include electric assist bicycles conforming to current Australian regulations within the hardware requirements of a future bike share program in Adelaide.[1]
- Include minimum service levels related to battery storage capacity and range within a future bike share contract.

3.1.3. GPS

In the period 2005 – 2010, GPS integrated bike share was rare. In the past five years however GPS has become an increasingly attractive option, as it provides a number of benefits to the operator (security and tracking), the city (data on usage and route selection) and the user (real time information on availability).
At current prices, it would appear that the benefits of a GPS integrated system outweigh the costs. Indeed Copenhagen's new bike share program, established in 2014, already has a GPS-embedded fleet as well as on-board tablet computer and Wi-Fi hotspot functionality. The on-board tablet is used to assist riders in wayfinding/route planning. Additionally, local businesses can partner with the bike share operator, to offer specials/discount offers to riders, based on their proximity to the business.

City governments are able to benefit from GPS enabled bike share by providing a 'geo-fence', detecting when a bicycle has moved outside a given area (Fishman, 2015). Operators may also use GPS to assist with the challenging task of re-distributing bicycles across their fleet via the use of real-time tracking. Users may benefit by enhanced real-time information on bicycle availability. The automated data collection offered through GPS provides new opportunities for data analysis, which may not only be useful for bike share operators to understand how their system is being used, but also from a wider transport planning perspective. Openly available GeoJSON data files may assist governments plan and evaluate bicycle route usage and effectiveness.

In summary, GPS offers significant benefits, to the government agencies supporting bike share, the operator, as well as the user. These benefits outweigh the cost by a substantial margin.

Recommendation:

- Include GPS as part of the hardware/technology requirements of a future bike share program for Adelaide.
- Include data sharing agreements in accordance with privacy regulations that require the bike share provider to share detailed usage data from the bike share program, including:
    - Number of trips, per day, per week, etc.
    - Data on the length of trips.

---

[1] The current Australian regulations require electric bicycles to stop providing assistance at speeds above 25km/h. It is recommended electric assistance stop at a speed of between 20 – 22km/h for an Adelaide bike share program, to maximise safety, especially if mandatory helmet requirements are waived (see separate recommendation).

- GeoJSON files route choice, for every trip undertaken on the system.
- Disaggregate data by age, gender, membership type, time of day and day of week.

3.1.4. Solar Power

Solar power is now widely employed by bike share providers. Many bike share systems use solar powered docking stations to avoid the costs of excavation to connect to the grid. Moreover, for electric assist bike share fleets, it is possible to integrate a solar powered canopy, as shown in Figure 4. Finally, for so called fourth generation bike share, in which the technology is housed within the bike rather than the docks, solar panels are used to provide a standalone energy source, as shown in Figure 5.

Figure 5 Solar panels are used to power on board technology
Image: SocialBicycles

In addition to the operational benefits of integrating solar power with bike share systems, there is also an obvious synergy between renewable energy and sustainable mobility. This is especially relevant to Adelaide given its commitment to become a carbon neutral city (see Department of Environment Water and Natural Resources, 2016).

Recommendation:

- Include requirements within a Request for Proposal for supplier to maximise solar generating capacity to meet the needs of a bike share program in Adelaide.

3.1.5.Turn-by-turn navigation

Recently, a number of technologies have emerged that offer *turn-by-turn* navigation integrated within a bike share bicycle (e.g. SmartHalo). These systems are likely to enhance levels of safety and useability by helping those unfamiliar with Adelaide's bicycle lane/path network maximise their use of these routes. Moreover, for visitors to Adelaide in particular, turn-by-turn navigation can assist in efficiently finding an unfamiliar destination. For the safety and useability benefits identified above, a turn-by-turn navigation system is recommended for a future Adelaide bike share program.

Recommendation:

- Investigate emerging and existing turn-by-turn navigation technology and integrate it as a hardware requirement in a future bike share program for Adelaide.

3.1.6. Lighting

It is mandatory to use bike lights when riding a bicycle at night in South Australia. Bike share providers typically provide full time front and rear lights on their bicycles and this is recommended for Adelaide. In addition to standard lighting, some systems (e.g. London) have chosen to install a laser system that places an image of a bicycle symbol on the pavement (e.g. Blaze), in an effort to increase levels of awareness from motorists regarding the presence of a bicycle. Tests conducted by the Transport Research Laboratory in the UK found that the use of such lights reduces the risk of collision with a motor vehicle.

Recommendation:

- Investigate the experience of London and other bike share programs to determine the most effective lighting system to increase safety levels and include such technology within the hardware requirements of a future bike share program in Adelaide.

3.2. Pricing structure

There are a wide variety of pricing structures for bike share, as identified in Table 10 of the Stage One Report (Appendix Two). China, which has the largest number of bicycles and cities with bike share, generally do not charge for any trips under 60 minutes. In most European and North American systems, a daily fee of between $4 - $10 is charged for casual users (which includes an unlimited number of trips within a 24 hour period, providing none exceed 30 minutes). Users can also buy an annual pass, for between $70 - $150, which also allows unlimited trips under 30 minutes.

Recommendation:

- No fee for standard use of a future Adelaide bike share program, at least in the first year of operation. The reasons for this recommendation are as follows:

    1. The greatest risk of a future bike share program for Adelaide is low usage. A free system will encourage more people to try bike share, a proportion of which would not have, if a standard fee structure were applied.

2. The current bike share program (*Adelaide Free Bikes)* has no cost and this makes it difficult to introduce a new system that involves charging users.
3. A free, albeit limited public transport service exists within the central Adelaide area, overlapping the main catchment of a future bike share program. If the bike share program included a fee, potential users may feel compelled to use the free public transport system as a better value option. Experience from the free city tram in Melbourne shows that the availability of free public transport depresses bike share use (which is not free in Melbourne).
4. The expected usage levels of an Adelaide bike share program are unlikely to exceed two trips per day per bike (which, compared to many international systems is low). With each trip likely to be completed in less than 20 minutes, this means that each bicycle will sit idle for approx. 95% of the day (similar to the average motor vehicle). Thus, the revenue from each bike is not expected to be substantial if a charge was included. Therefore it is reasonable to forgo this modest revenue in exchange for the benefits of higher usage.
5. Bicycle use generates an economic return to government, through improved health, cleaner air, and lower congestion. The health benefit alone is estimated at $1.12 per km cycled (Mulley, Tyson, McCue, Rissel, & Munro, 2013). By encouraging greater cycling, a free program increases the benefit to government through a reduction in the costs of treating sedentary lifestyle diseases (e.g. diabetes, obesity).

Finally, it should be noted that under the *free* model, users will still be required to provide their credit card details as part of the sign up process. This will act as a security deposit, as well as enable a fee to be charged for trips exceeding 30 minutes. This policy is recommended to help ensure bicycles are put back into the system as soon as possible, ready for others to use. International and domestic experience suggests local users are sensitive to this charge (90% of these users end trip within 30 minutes), whereas tourists are more likely to absorb the fee and take trips beyond half an hour.

3.3. Integration with public transport

Best practice bike share programs are increasingly planning their systems to operate as a new addition to their public transport system. Many of the bike share programs operating in China are run by the public transport authority, and users typically use bike share as a *last mile* solution to get to and from a public transport node. Even for systems that have not had any specific public transport integration as part of their initial design, bike share use is very often highest around public transport nodes and users report that they frequently use bike share in conjunction with public transport (Lansell, 2011). Research from Brisbane suggests that allowing holders of a public transport smartcard to gain automatic access to bike share is one of the most powerful mechanisms of reducing barriers to signing up to bike share (Fishman et al., 2012a).

Recommendations

- Any future bike share program should be operated in partnership with the public transport authority.
- The location of docking station should be determined in part by the degree to which it enhances integration with the public transport system.
- Holders of a credit card linked public transport smartcard be granted access to the bike share system, including automatic unlocking of bicycles (no need to carry a separate card/fob).

3.4. Sign up, marketing and promotion

3.4.1. Sign up

A successful bike share program must focus on *spontaneity* and *convenience*, in order to provide a compelling value proposition to prospective users. The sign up process in particular must be designed to facilitate spontaneous use, as many bike share trips are too short to warrant advanced planning. Research from Brisbane found that the requirement to call an office, during office hours only impacted negatively on use. This was compounded initially by requiring prospective users to listen to lengthy legal disclaimer notice that in some circumstances exceeded 24 minutes in duration – all for a ride that would in most cases last less than 15 minutes.

Recommendations:

- Ensure marketing highlights the ease with which holders of a credit card linked public transport smartcard are able to access bike share instantaneously.
- Enable Smartphone (NFC) touch sign up and include this function within marketing material.
- Enable credit card swipe sign up at docking station kiosks.

The goal of these two measures is to allow prospective users to be riding within 2 minutes of approaching a docking station. The ubiquity of the Smartphone now allows users to download an App, enter credit card details and unlock a bicycle. For those without a smartphone, a docking station kiosk can be used to allow spontaneous sign up.

3.4.2. Marketing and promotion

Marketing and promotion can have an important impact on bike share usage levels. Research from Brisbane and elsewhere has found that marketing focused on the convenience benefits afforded by bike share are most critical in gaining new users. Promotion prior to launch can also be an important method of increasing interest in bike share. In the lead up to the launch of the *Citi Bike* program in New York City, a large number of '*come and try*' events were held, including the closing off of some streets to motorised traffic in order to provide a safe environment for people to learn how to use the new system. Pricing incentives to maximise interest in bike share has also been used successfully.

Recommendations:

- Engage a branding agency to work with a suitably qualified bike share consultant to develop a marketing and promotion strategy in the six – 12 months leading up to the launch of the bike share program. The central theme of the campaign should be focused on *time* and *financial savings* as well as the lifestyle benefits of cycling. Developing a defined list of target markets and a customised campaign to these markets should be developed.
- Recognise that the most powerful marketing message is actually seeing *someone* riding a bike share bike. Tailor activities to ensure usage is high from the earliest stage. The first month is critical. Avoid launching April to September due to colder weather and shorter days.
- Use social media to promote bike share, including incentives for people to share their experience with their social network.
- Engage several high profile Adelaide identities to be Ambassadors of the bike share program, including personalities drawn from industry/enterprise, sports, scientific and arts communities.

3.5. Safety

The most powerful barrier preventing people from cycling in Australian cities is fear of collision with motorised traffic (Fishman, Washington, & Haworth, 2012b; Garrard, 2011). A major barrier preventing greater use of the bike share programs in Brisbane and Melbourne is a lack of supportive infrastructure, as described in the Stage One Report (Appendix Two). The current level of bicycle infrastructure in Adelaide fails to adequately support a future bike share program. The following recommendations are made to increase the level of perceived and actual safety of people cycling in Adelaide, which supports both a future bike share program, as well as regular cyclists (both current and future).

Recommendations:

- Create a network of protected bicycle routes on main roads in inner Adelaide.
- Connect Adelaide's cycling network with major destinations.
- Reduce the speed limit to 30km/h in inner Adelaide on routes without sufficient width for bicycle lanes/paths.
- Identify opportunities to reallocate road space for protected bicycle lanes in instances where an overall increase in safety is expected.
- Commission a study into the overall population health impact of amending mandatory helmet legislation, to include an exemption for

bike share users.[2] Such a study would include examination of the impact of an exemption in relation to riding levels, head injuries, and changes to physical activity levels. As with other bike share schemes operating in a voluntary helmet environment, the operator will still be required to encourage helmet use.

The implementation of the above recommendations, in addition to increasing usage levels of a future bike share program, will also support the City of Adelaide and the South Australian government's target to double cycling participation by 2020. The State will be more likely to meet its ambitious target of reducing road fatalities and serious injuries by 30% by 2020 via the implementation of the above recommendations.

3.6. Summary of factors influencing bike share in Adelaide

The assessment of the potential for bike share to succeed in Adelaide is dependent on a wide variety of factors. The discussion of the barriers and facilitators to bike share use shown in the Stage One Report (Appendix Two) has been distilled in this section, and expanded upon, to include consideration of the recommendations made immediately above.

Central to any assessment of the capacity for Adelaide to support a successful bike share program is the degree to which it provides compelling value proposition to potential users. This in turn is dependent on bike share's ability to offer a convenient, time competitive alternative to existing modes, at least for a small proportion of trip types. Just as public transport planners have been encouraged to *'think like a passenger'*, it is helpful for bike share planners to *'think like a rider'*. What compelling value proposition do people have to use bike share in Adelaide? Is it faster than competing travel options? Is it more pleasant to use? Is it cheaper than other forms of transport? Are docking stations located close to where people live, work and shop? Does it feel safe to use? Is sign up easy and fast? Can users integrate bike share with public transport easily? Designing a system with these questions in mind is crucial to the success of a future bike share program.

Figure 6 provides an illustration distilling the barriers and facilitators to a bike share program in Adelaide. The barriers (in black, on the left), relate to the factors that make car use the most common mode of transport in Adelaide. The facilitators (in white, on the right) should be seen as *potential* facilitators, as they are generally not part of present conditions, and would require specific policy to enact them. These factors are considered pre-conditions, necessary to create a fertile environment for bike share. A brief discussion of these barriers and facilitators is provided, followed by an overall recommendation as to whether it is feasible for Adelaide to support a successful bike share program.

---

[2] This recommendation is not in favour of changes to mandatory helmet legislation, but rather an empirical study into its impact, and the impact of creating a waiver for bike share users. Only after the completion of such a study would it be possible to recommend any changes in current helmet legislation.

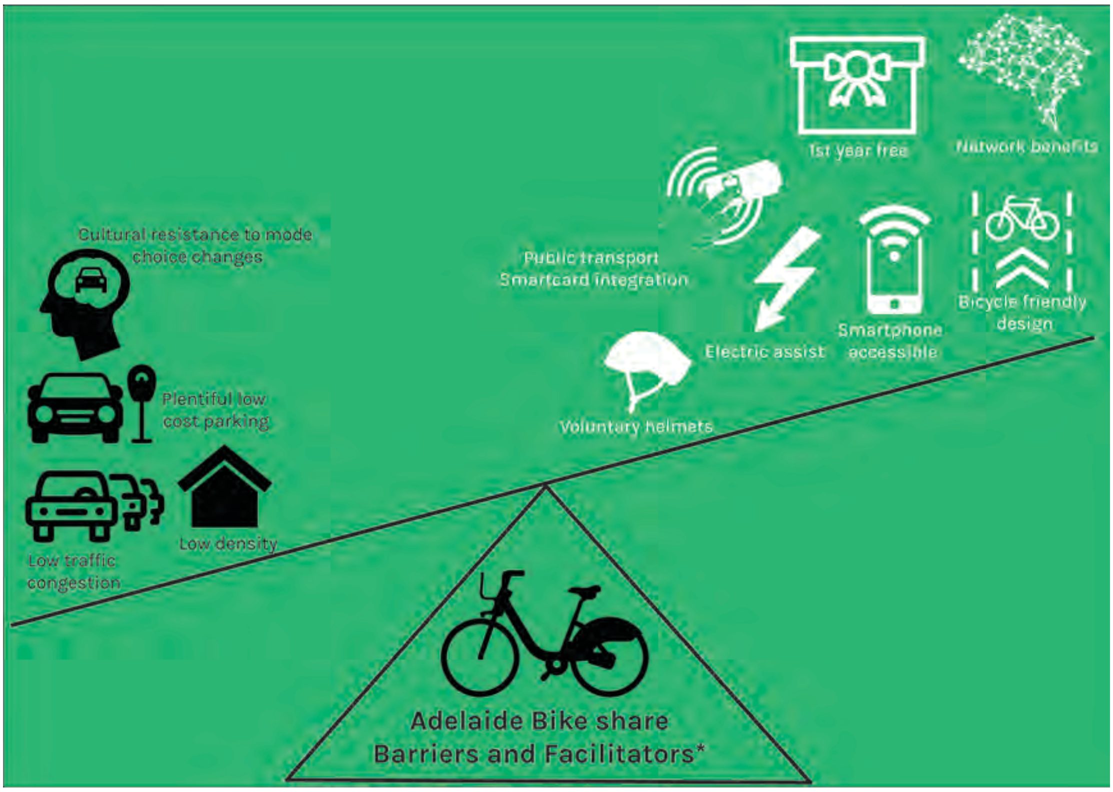


Figure 6 Barriers and facilitators to bike share use in Adelaide

NB: *The facilitators are not currently present but reflect design recommendations made in this report. The degree to which they act as facilitators is dependent on their adoption. Many of these factors represent substantial changes from current conditions and require the involvement of state government (e.g. changes to mandatory helmet legislation and enhanced conditions for safe cycling).

3.6.1. Barriers to bike share

Adelaide's low-density development is a major barrier to bike share and there are no cities of a similar density to Adelaide that have high levels of bike share use (e.g. above four trips per day per bike). Low density works against bike share in at least three ways. Firstly, it increases average trip distance, lowering the competiveness of active modes. Secondly, low-density housing reduces the *'latent demand'* for cycling, because there are fewer constraints to owning and storing a private bicycle. In contrast, Paris and London, with a housing stock that makes bike storage difficult, those with only a modest interest in cycling will be less likely to own a bicycle. Thus, when bike share became available in Paris and London, there was a wider pool of the population with a moderate interest in cycling who did not own a bike. This was a fertile target market for bike share, such that around one quarter of all bicycles travelling in Paris are estimated to be bike share bikes. Finally, and perhaps most importantly, in a low-density city, there are less people living and working in close proximity to each docking station. For instance, the City of Paris (bordered by the Boulevard Peripherique) has a population of over 2.2m yet is the same size geographically as inner Adelaide with a population of only 380,500.[3] Thus for every 100 people that may live close to a docking station in a future Adelaide bike share program, there are 800 living within the same proximity for the Paris bike share program. It is therefore important to recognise that Adelaide's low density means it is unlikely to experience usage levels close to those of Paris, regardless of the quality of bicycles or other system design characteristics a future Adelaide bike share program may employ.

The relatively low levels of traffic congestion in Adelaide, and ease of car parking also presents a significant barrier to bike share. In a study of why people in Brisbane do not use bike share, the *convenience of car use* emerged as among the most powerful barriers (Fishman, Washington, Haworth, et al., 2014).

Finally, a cultural resistance to alternative modes of travel may exist in Adelaide. Adelaide, like other Australian cities, has a very high level of car use, and this has been present for several decades. For a large proportion of the Adelaide population, the car features as a central component of their day-to-day experience. The social and economic investment in car based lifestyles (e.g. where people live, work and housing type) can be very difficult to change, and there will be a significant proportion of the population that will resist the possibility of using bike share, even in cases in which it offers a time or economically competitive alternative. Amplifying this resistance to alternatives to car use is the fact that many people have developed a strong emotional attachment to the feelings of independence and privacy when inside their car (Kent, 2014).

The barriers presented above are unlikely to change over the coming decades and whilst they will undoubtedly supress bike share usage, there are important steps Adelaide are able to take to mitigate against them, as described below.

3.6.2. Bike share facilitators

As introduced above, the facilitators to bike share in Adelaide, symbolised in Figure 6, should be seen as *potential* factors supporting bike share use in Adelaide. They do not currently form part of the transport environment in Adelaide, but rather, present the recommended preconditions for a successful bike share program. The suite of policies identified in Figure 6 and described briefly below have been designed to address the key factors identified as contributing to the weak usage levels from the Brisbane and Melbourne bike share programs (discussed in the Stage One Report in Appendix Two).

Mandatory helmet legislation reduces bike share use significantly and the potential to create a voluntary helmet requirement for bike share users is a policy option worthy of further investigation. As noted previously, bike share users are significantly less like to be involved in a serious injury than

[3] This includes the residential populations of the following LGAs: Adelaide, Charles Sturt, Prospect, Walkerville, Norwood Payneham and St Peters, West Torrens, Holdfast Bay, Unley and Burnside.

a private bike rider (Fishman & Schepers, 2016). Moreover, bike share users in cities without mandatory helmet laws are four times less likely to wear helmets than private bike riders (Fischer et al., 2012). The study recommended in Section 3.5 is required to make an evidence based decision regarding possible changes to current legislation relating to helmets. Although it is not possible to estimate with any certainty the impact a waiver might have on usage, based on previous studies (Alta Bike Share, 2011; Alta Planning + Design, 2012; Fischer et al., 2012; Fishman, 2014, 2015), it is reasonable to expect voluntary helmet requirements may increase usage by between 50% and 200% (i.e. if Adelaide bike share was to achieve a usage of one trip per day per bike, this would rise to between 1.5 and 3 trips under voluntary requirements). Tel Aviv and Mexico City both repealed their mandatory helmet laws to make way for bike share (Sadik-Khan & Solomonow, 2016).

Electric assist bicycles, as noted earlier, will help to increase the attractiveness of bike share, and is particularly well suited to a low density in which temperatures regularly exceed 25 degrees Celsius. The assistance offered to the rider should be cut off at between 20 – 22km/h rather than the current legal limit of 25km/h to reduce the risk of injury to the rider, should further investigation find a strong case for waiving mandatory helmet requirements described earlier.

Integration with public transport, including both the position of the docking stations as well as seamless interoperability between existing public transport smartcards and a future bike share program will help to capture users who may not have otherwise considered bike share as an option. Moreover, offering bike share as a free service, at least during its first year will assist in boosting usage during the crucial introductory period. Bike share systems that are slow to attract ridership often suffer from depressed usage levels, even when the value proposition to users is improved, as people have become accustomed to seeing the bikes sit unused. The proposed bike share system for Adelaide also includes instantaneous sign up via Smartphone, helping people make spontaneous use of the program.

As with any other mode of transport, bike share systems must be large enough to form a useful network/catchment for potential users. The system proposed for Adelaide, detailed in Section 4 below, is much larger than the Melbourne system relative to the size of population and geographical coverage of the city. Whilst the Stage 1 deployment that will be described in Section 4 covers a relatively modest proportion of Adelaide, its density of docking stations will offer a convenient alternative for trips originating on the periphery of the Parklands with destinations around central Adelaide.

Finally, the bicycle infrastructure network in inner Adelaide will need to undergo an extensive expansion to support a successful bike share program. Moreover, speed limits will need to be reduced, to as low as 30km/h on streets without dedicated bicycle infrastructure to mitigate against the major reason people choose not to cycle in Adelaide – fear of collision with motorised traffic. Whilst many of these recommendations may appear bold, experience from Australian and international bike share programs suggest they are necessary in order for Adelaide to have a well-used bike share program.

3.7. Feasibility of bike share in Adelaide

The analysis conducted for this report suggests that Adelaide does not currently hold the necessary conditions to support a well-used bike share program. However, implementation of the policy and system design recommendations made earlier in Section 3 will provide Adelaide with the necessary pre-conditions to support a successful bike share program. As outlined in Section 8, it is likely a four-year period will be required to creating fertile grounds for bike share in Adelaide. The remainder of this report describes the proposed catchment, cost estimates, ridership, governance and funding options, implementation timetable and concluding recommendations for further action.

4. Potential catchment

The design of a bike share catchment (the area in which the docking stations are located) is critical to its future success. Bike share catchments that are too small fail to provide the network benefits required to be seen as useful. The cost of bike share docking stations, combined with limited government and commercial operator budgets require docking stations to be located in the areas that provide optimal usage. Typically, bike share operators place their docking stations in the central area of a city, as these areas typically have higher densities, better bicycle infrastructure, shorter trips and other attributes suggestive of higher bike share usage.

Adelaide's characteristics have been considered, and included in a customised *Bike Share Propensity Index* which has been developed to create a data-driven method of designing a catchment for a future Adelaide bike share program.

4.1. Bike Share Propensity Index

4.1.1. Methodology

A range of data has been assembled to prepare the *Bike Share Propensity Index.* These data relate to known determinants of bike share membership in Australia, as described in Fishman, Washington, Haworth, & Watson (2015). The datasets that have been used to act as the basis for the *Bike Share Propensity Index* are drawn from Adelaide data collected in the 2011 Census, including:

1. Residential Population Density, measured as *people per hectare*
2. Central Business District Employment Density, measured as *number of people working per hectare.* This data was provided by the City of Adelaide.
3. Density of young people, measured as *number of people aged 18 – 34 years of age per hectare.*
4. City based employment, measured as the *number of employed people across Adelaide with employment destinations within the City of Adelaide*, by residential SA2.[4]
5. Low motor vehicle ownership, measured as the *number of households with one or zero motor vehicles per hectare.*
6. Bicycle use - origin, measured as the proportion of workers who used the bicycle for at least one stage of their trip to work, by residential SA2.
7. Bicycle use – destination, measured as the proportion of workers who used the bicycle for at least one stage of their trip to work, by destination SA2.

---

[4] An SA2 is a Statistical Area Level 2, as defined by the Australian Bureau of Statistics. See http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/88F6A0EDEB8879C0CA257801000C64D9

The seven datasets identified above have been mapped, showing their variation across Adelaide. These maps, illustrating the disaggregated data are shown in Appendix One and show the data at the level at which they are published, namely SA2 for Journey to Work data (attributes 2, 4, 6 and 7 above), SA1[5] for general demographic information (attributes 1, 3 and 5), and Survey Block for employment numbers provided by the City of Adelaide's Employment and Land Use Survey (attribute 2).

The *Bike Share Propensity Index* shows the variation in the relative propensity to use bike share at the highest possible level of detail. The 2,256 individual geographic areas mapped in Figure 8 are a mix of Survey Blocks for the city of Adelaide and SA1s for the suburbs around the City. Geographic areas that rank in the bottom quintile (Q1) receive a score of 0.2 for that attribute, while those in the top quintile receive 1.0, as shown in Table 1. The mapped values are aggregates of the seven attributes' scores.

Geographic areas ranked lowest to highest	Quintile	Index Score
0 - 451	1	0.2
452 - 902	2	0.4
903 – 1354	3	0.6
1355 – 1805	4	0.8
1806 - 2256	5	1.0

Table 1 Ranking system for geographic areas and Index categories

Appendix One provides the scale used for each attribute included in the *Bike Share Propensity Index.*

It should be noted that not all factors influencing bike share use have been included in the *Bike Share Propensity Index*. The factors known to be omitted from the Index include hotel room density, public transport hubs, major sporting and shopping destinations, convention centres, entertainment venues and bike infrastructure. These factors can be used to inform precise siting of docking stations.

4.2. Adelaide's bike share catchment

In an effort to rationalise the size of a potential bike share catchment area for Adelaide, areas displaying relatively high propensity to use bike share have been distilled. In this way docking stations are only placed in parts of Adelaide that have a combination of characteristics predictive of bike

[5] SA1 (Statistical Area Level 1) is the smallest unit used in the Census. See http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/7CAFD05E79EB6F81CA257801000C64CD?opendocument

share use (e.g. relatively low motor vehicle ownership, and high current riding levels).

Initially the areas of Adelaide that received a high score on the *Bike Share Propensity Index* were calculated, in terms of area (km^2). These are shown in Appendix One. When applying industry standard docking station densities (one docking station every 300m, or about a four minute walk between each), the number of bikes and subsequent costs were unjustifiably high.

Figure 7 illustrates the outcome of the *Bike Share Propensity Index*, with darker regions indicating higher likelihood of bike share use. It is important to note Figure 7 (and 8) shows *relative* propensity for bike share use. Thus, the darkest regions are only indicative of high levels of bike share use relative to the other areas of Adelaide. No comparison can be made with other cities. The areas displaying the strongest attributes for bike share include central Adelaide, Unley, and the corridors immediately east and west of the central city area. A corridor extending southwest, towards Glenelg has also been identified.

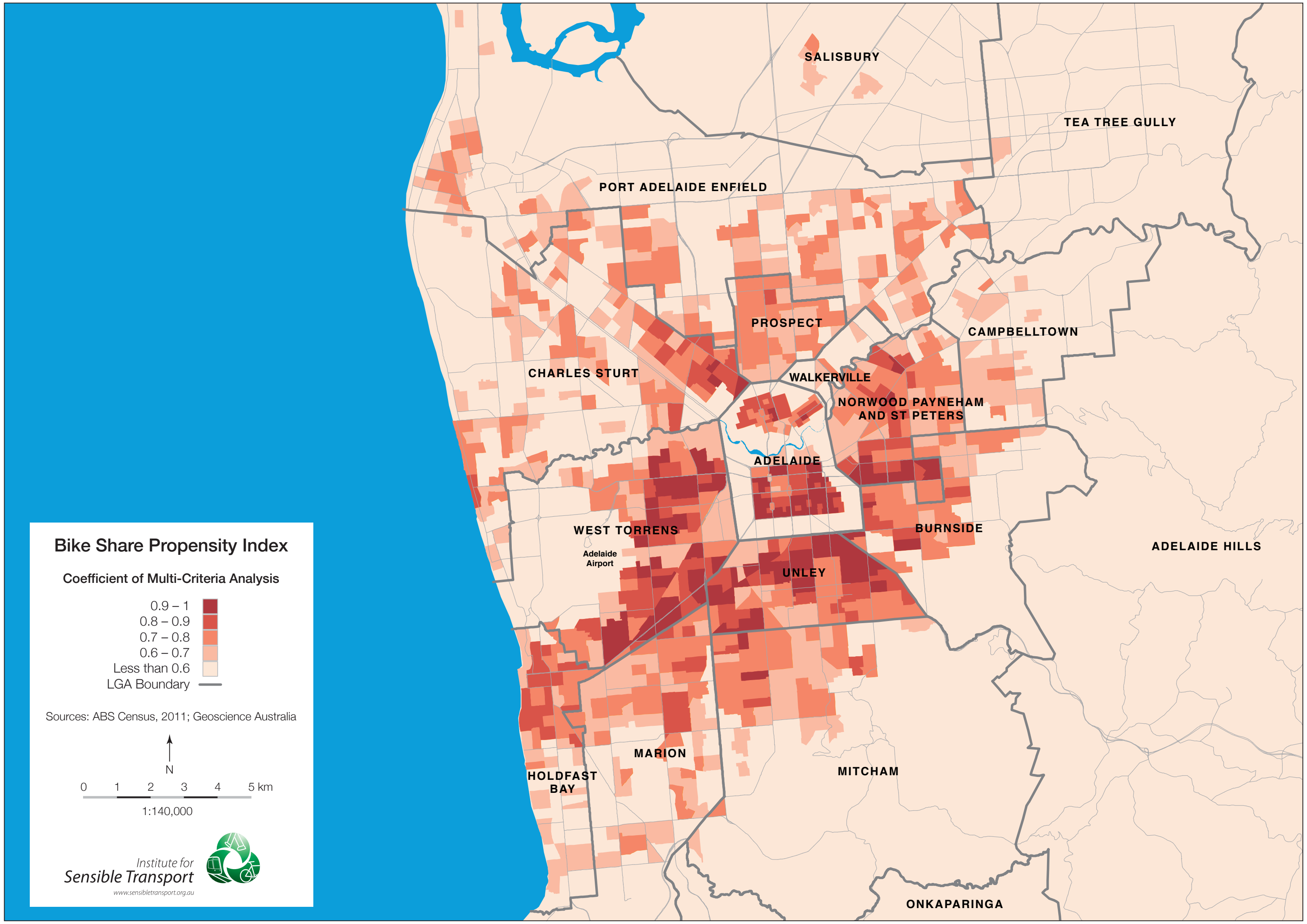


Figure 7 Bike Share Propensity Index Map for Adelaide

The areas of Adelaide displaying a relatively high score on the *Bike Share Propensity Index* (e.g. above 0.7) encompass an area of 98km^2. The cost of providing bike share docking stations across an area this large was considered far too high when using the internationally recognised density of docking stations (11 per km^2). Initial calculations suggest a bike share system covering this area would require 1,080 docking stations, with approx. 10,000 bicycles, which would be beyond a suitable scale for Adelaide, based on its population and available budget. This calculation simply illustrates the inherent limitation of transport provision in a low-density urban area.

A more pragmatic, modest and financially appropriate alternative has been adopted for the present study, involving two stages, as outlined below.

4.3. Stage 1

The first stage of an Adelaide bike share program includes 162 docking stations, with a docking station density of 11 per km^2, which is based on best practice design principles (City & County of Honolulu, 2014; Institute for Transportation & Development Policy, 2013). Stage 1 would see the bike share catchment covering all of the City of Adelaide, as well as outer edge of the Parklands. A small number of docking stations have been transferred from around the rail yards on the south west border of the city (which showed a low bike share propensity), into West Torrens, given the higher *Bike Share Propensity Index* ratings in West Torrens. The Stage 1 catchment and docking station locations are shown in Figure 8.

Conceptually, the objective underpinning the docking station catchment shown in Figure 8 has been to offer bike share in the locations showing the strongest prospect for use. This has resulted in a tight knit catchment, which ensures prospective users are never more than approximately 150m from a docking station, and the distance between one docking station and the next is generally never more than 300m. This becomes particularly important when one docking station is empty; users simply walk to the next closest facility. Moreover, a bike share user seeking to dock their bike at the end of a trip may find the docking station 100% occupied. A tightly knit catchment of docking stations reduces the time and inconvenience cost of such a situation, which is inevitable in a well used system.

Strategically, the catchment offers the best balance between system cost and usability. In addition to offering an attractive alternative to short car trips in the central Adelaide area, it also increases the connection with Adelaide's Parklands. It enables users to undertake both utilitarian and recreational trips that encompass a Parklands experience, helping more people connect with this unique open space asset encircling central Adelaide.

Finally, it is important to note that the docking station locations shown in Figure 8 have been chosen for illustrative purposes and precise locations will need refinement should Adelaide choose to establish a bike share program.

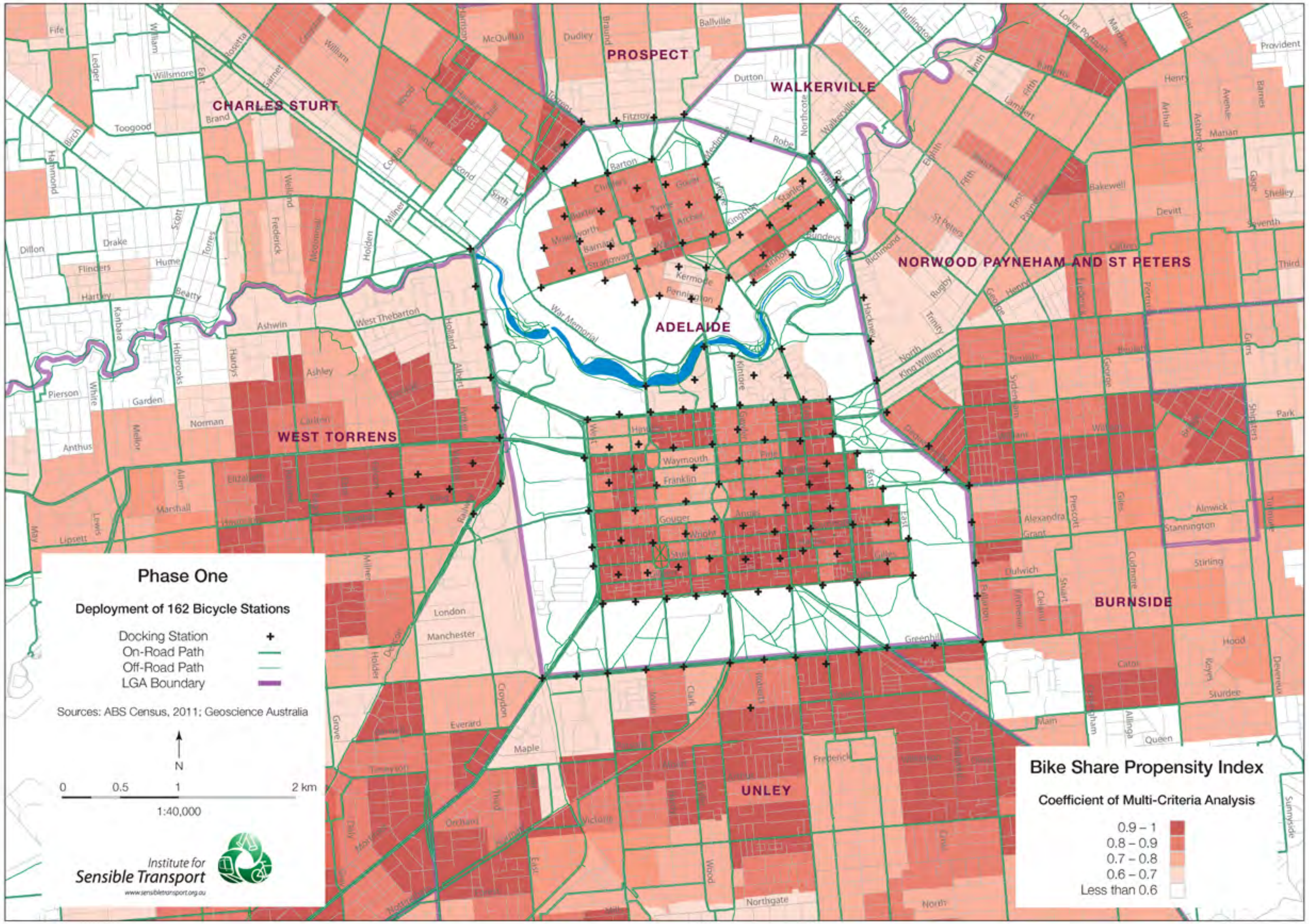


Figure 8 Stage One docking station catchment[6]

---

6 A separate map, only showing areas of Adelaide that received a *Bike Share Propensity Index* score of 0.9 or above is shown in Figure 20, Appendix One.

4.4. Stage 2

A second, substantially larger bike share expansion is proposed (see Figure 9), to assist in making bike share a viable option for a larger proportion of the Adelaide population. The proposed catchment for Stage 2 continues to be informed by the results of the *Bike Share Propensity Index*, in which docking station deployment is based on higher levels of expected bike share use. The Stage 2 catchment includes 603 docking stations and uses the same docking station density as for Stage 1 (11 per km^2). The roll out of Stage 2 should only be determined once a detailed evaluation of the Stage 1 bike share program has been completed between one and three years after Stage 1 is implemented.

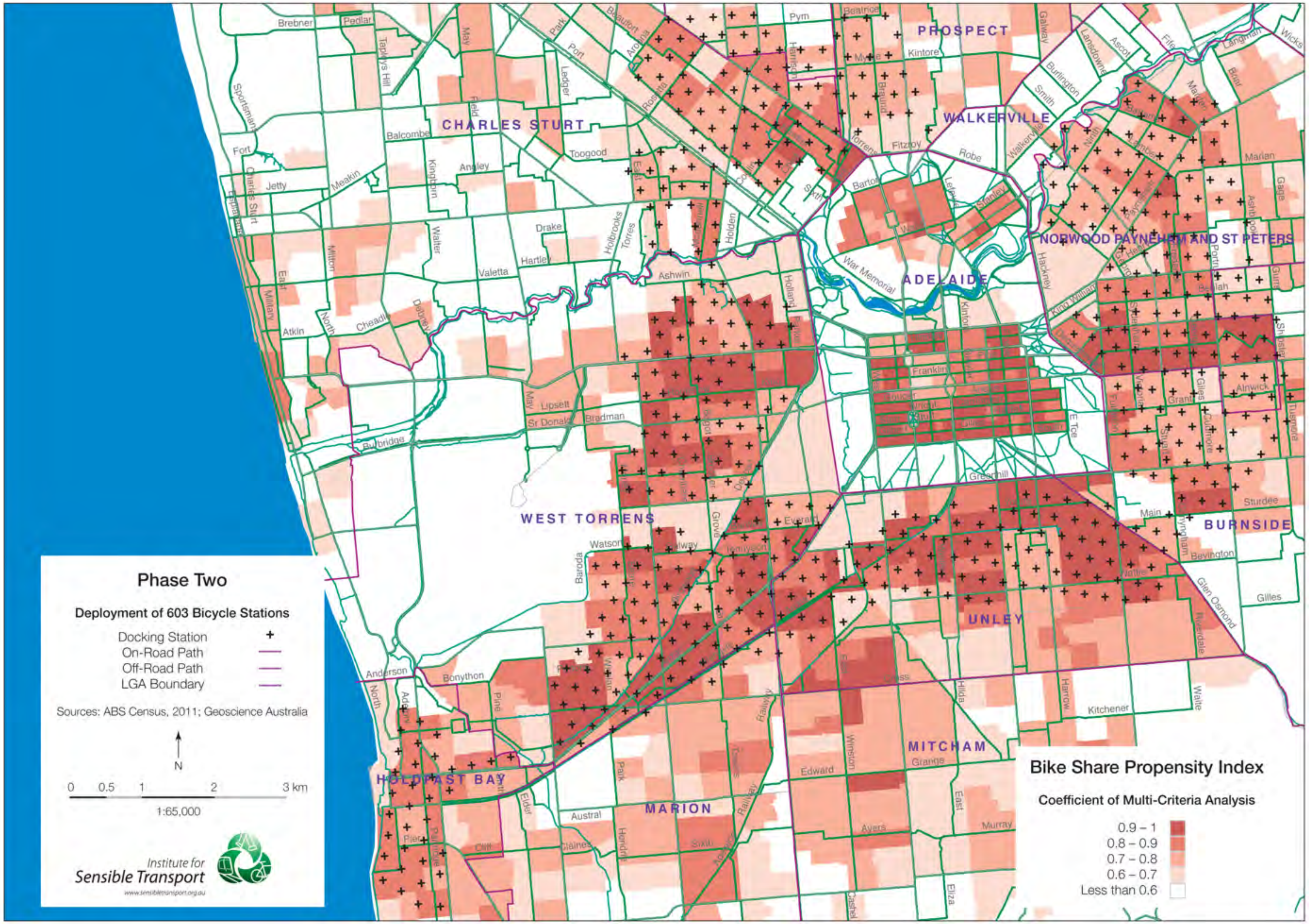


Figure 9 Stage 2 docking station catchment

5. Estimated costs

Forecasting the capital costs of bike share can be difficult, as it is typical for commercial providers to withhold detailed costs until submitting a formal response to *Requests for Quotation*. Nevertheless, it is possible, using publically available data and direct communication with hardware suppliers to provide some cost estimates for a future Adelaide bike share program.

The costs of providing a bike share system can be separated in Capital Expenditure and Operating Expenditure. This section is intended to provide some high level cost estimates for a bike share system consistent with the attributes identified in Section 3.

5.1. Pre-launch start up costs

Preparatory activities required in the development of a bike share program are not insubstantial. New York City for instance required at least four years of planning prior to the launch of *Citi Bike*. The initial phase, which can begin after the completion of the feasibility-testing phase (e.g. this project as well as subsequent research activities identified in Section 9) is likely to include a number of investments, including:

- Staff salaries
- Office
- IT services and website development
- Community consultation
- Market research, branding and graphic design development
- Sponsorship search and negotiation
- Insurance and legal costs
- Technical design of catchment location and docking station siting
- Request for Proposal development.

5.2.Capital Expenditure Estimates

Bike share capital expenditure consists primarily of the bikes themselves, and their associated docking infrastructure. Bike share capital costs vary depending on the technology, quality of the hardware, docking infrastructure requirements and shipping distance to remote markets.

The industry standard is to provide two docking points for each bicycle. It is difficult to compare the prices from different suppliers, as some include their technological components within the docking station (e.g. the systems operating in Melbourne and Brisbane), whereas other providers include the technology within the bicycles themselves (e.g. the systems operating in Phoenix, and Monash University). To account for these differences, a standard price estimate has been used in Table 2 that offers an estimate *per bike*, which includes the necessary associated docking infrastructure. Other upfront costs include the establishment of the software, to track usage, security and payment methods.

5.3. Operational Expenditure Estimates

The costs involved in operating and maintaining a bike share program are not insubstantial. They include fleet redistribution, servicing and replacement of bike hardware, as well as customer service/call centre costs. There are also software licencing fees, which are generally monthly payments to connect the bicycles to the 'cloud', enabling GPS tracking and other remote features.

5.1. Summary of costs

A small number of bike share suppliers offering hardware and software consistent with the recommended requirements outlined in Section 3 have been contacted for this report. These suppliers have provided some indicative costs to assist the City of Adelaide in their efforts to assess the feasibility of bike share. Some recalculation has been required to provide a consistent format across each of the suppliers and no responsibility is taken for possible discrepancies between the costs listed in Table 2 and the costs provided by the suppliers. These costs are summarised in Table 2. Each of the suppliers included in Table 2 are established commercial operators, with systems currently in operation across a number of countries. GoBike, based in Denmark supplies the bike share system currently operating in Copenhagen. Bewegen is based in Canada and supplies bicycles used in the Birmingham, Alabama bike share program. Their CEO, Alain Ayotte was instrumental in the development of many of the bike share systems in North America. PBSC, also based in Canada, supplies the bicycles used in dozens of cities, including London, Melbourne, and Washington, D.C. SoBi (SocialBicycles) is a NYC-based, relatively new supplier that specialise in dockless systems. The Institute for Sensible Transport does not endorse any of these suppliers, nor does it suggest options for potential suppliers to a future Adelaide bike share program be restricted to these companies.

Costs	Suppliers			
	GoBike (E-assist)[7]	Bewegen (E-assist)	PBSC^	SoBi*
Cost per bike (inc docking stations)	$8,575	$6,392	$7,030	$3,670
Annual operating cost, per bike	$4,440	$2,000	$2,543	$2,355
Per bike cost (hardware + 1 year operating)	$13,015	$8,392	$9,573	$6,024
Number of bikes in Stage 1[8]	1,620	1,620	1,620	1,620
Stage 1 CapEx	$13,891,500	$10,355,040	$11,388,600	$5,942,980
Stage 1 CapEx + first year OpEx	$21,084,300	$13,595,040	$15,508,260	$9,759,508

Table 2 Summary of approximate bike share costs

NB: All costs indicative only. Costs are in Australian dollars, are subject to change and do not include shipping. Costs in Table 2 do not include initial planning, research and organisational costs incurred prior to launch.

^Not electric assist. Based on figures shown in Honolulu bike share feasibility study (City & County of Honolulu, 2014).

*SoBi's does not require IT based docks, however an option within their system is to add payment kiosks, maps and ad panels to docking stations. The prices in this table include one in five docking stations to have these facilities. A connection fee for these payment kiosks are include in SoBi's operating costs. The SoBi costs are for non-electric assist bikes.

[7] GoBike charge an additional $15,000 as a one-time technology set up fee.
[8] These bikes to be distributed across 162 docking stations.

6. Estimated ridership

The level of forecast ridership is a crucial element in any decision regarding bike share options for Adelaide. Forecasting ridership has proven difficult in Australia, with both systems attracting significantly less usage than anticipated. In Melbourne, ridership forecasts were around 10 times higher than actual figures in its first year of operation. The factors associated with low ridership in Brisbane and Melbourne were explored in the Stage One Report (Appendix Two). Given the large range of unknown factors associated with an as yet non-existent Adelaide bike share program, it is not possible to make ridership forecasts with certainty. Nevertheless, with Australia's two bike share programs now operating for over five years, ridership data from these programs can be used as a basis upon which to derive estimated usage for an Adelaide bike share program. The Melbourne and Brisbane bike share programs began their first year of operation with around 0.5 and 0.3 trips per day per bike respectively and although this has increased as the programs have matured, neither consistently achieves more than one trip per day per bike. Ridership figures for Brisbane and Melbourne are provided in the Stage One Report (Appendix Two).

Whilst the ridership data from Brisbane and Melbourne are useful, it is important to identify that the recommended design of a future Adelaide bike share program (identified in Section 3) addresses many of the recognised shortcomings of the Brisbane and Melbourne bike share programs. The key elements in which the bike share design features described in Section 3 offer an advantage over the existing Australian bike share programs are listed below:

1. Electric assist bicycles
2. Public transport smartcard integration
3. Smartphone unlocking of bicycles using NFC technology
4. Larger network, higher density catchment design
5. Improved marketing and promotion
6. Enhancing organisational and contract structure that better incentivizes the operator to maximise usage levels
7. Free basic fare structure (at least for first year)
8. Safer bicycle infrastructure network
9. Voluntary helmet regulation.

Whilst the nine elements identified above are all known to increase bike share usage, there are some Adelaide specific factors that may also work to dampen usage, which have been identified in Figure 6 above. These include lower employment and population density, relative ease of car use (congestion and parking availability and price). The suburb with the highest Journey to Work bike mode share in Adelaide (Unley) is only half that of the equivalent suburb in Melbourne (6% vs 12%).

Using both the positive and negative factors identified above, the following estimates are made for bike share usage levels in Adelaide, assuming each of the 9 elements highlighted above are employed.

Figure 10 provides an indication of Adelaide's forecast ridership, on a trips per day, per bike basis, compared to several other bike share cities. Adelaide's forecasts are based on Melbourne's February usage levels with a two fold base increase due to the impact of the nine elements highlighted above. In addition, March has included a 30% multiplier to account for the large number of festivals taking place in Adelaide at this time. A 10% reduction has also been applied to the months of May through to August, due to lower temperatures and hours of daylight. Finally, it must be noted that as no empirical data has been collected from the Adelaide population, the data contained in Figure 10 can only be used as a high level estimate.

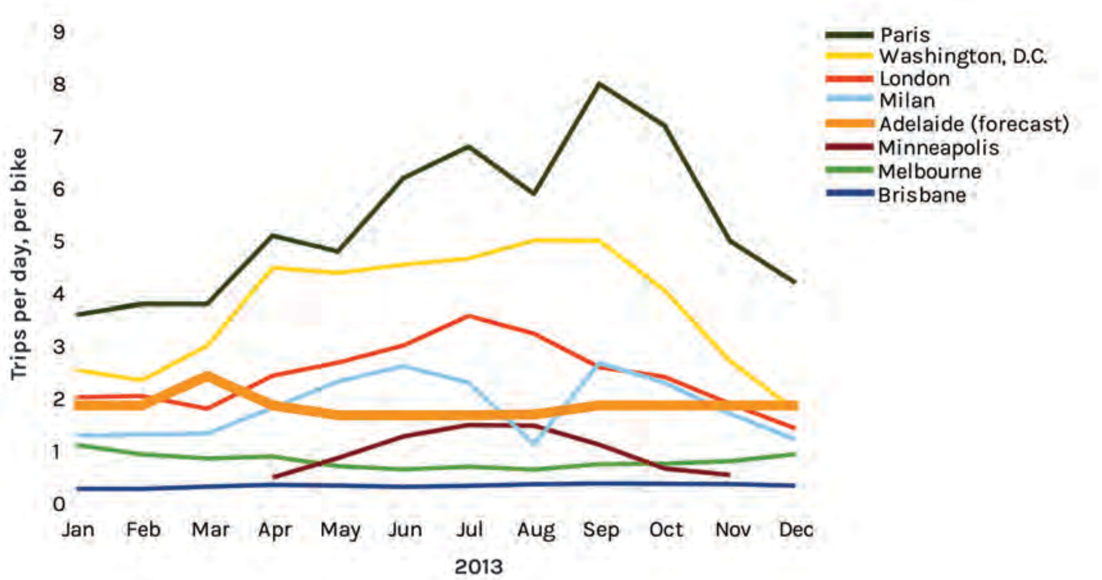


Figure 10 Adelaide's forecast ridership, trips per day per bike
NB: Other cities based on 2013 usage data as reported in Fishman (2015).

7. Governance and funding model

There are a variety of operating and funding models employed to provide bike share, ranging from fully publically owned, to entirely commercial programs. The main differences between the models currently in operation are summarised below.

1. **Government owned, with private sector operator**. The Melbourne Bike Share program employs this model, with the Victorian State Government owning and financing the program, which is operated by the Royal Automobile Club of Victoria (RACV), which then subcontract *Motivate* (formerly Alta Bike Share) to manage the bikes (e.g. servicing, replacement and re-distribution).
2. **Government owned and operated**. This model replicates the manner in which most city rail agencies are structured in Australia and elsewhere, whereby the government own the hardware, operating system and are responsible for all day-to-day and strategic requirements. Whilst there are no North American examples of this model known to the author, it is commonplace for Chinese bike share programs to be operated in this way.
3. **Non Government Organisation (NGO) owned.** This model is common in North America and involves an NGO being formed (or pre-existing) to own the system, and either manages and operates the bike share program itself, or contracts this out to a bike share operator. Funding is primarily from government, with additional revenue streams through commercial sponsorship and rider fees/charges. The responsibility for all day-to-day activities associated with running the bike share program usually reside with the contractor operator, and the NGO take administrative responsibilities for non-day-to-day tasks. A Board of Directors is usually formed to make strategic decisions and can be composed of private sector sponsors as well as government representatives.
4. **Commercially owned and operated.** CitiBike in New York City employ this model. The commercial operator is typically responsible for securing a sponsor/fundraising and also rely on rider fees as a form of revenue generation to help cover costs. The government has less control over system design and expansion, as well as access to data, unless written into the contract. Whilst reliance on public funds is lessened in this model, it is not uncommon for government to subsidise the system, either with direct funding, or through in kind support. For CityCycle in Brisbane, as well as many of the bike share programs in Europe, a street advertiser, such as JCDecaux acts as the commercial owner and operator, in return for outdoor advertising contracts, often with a life of one or two decades (20 years in Brisbane's case).

7.1. Recommended Governance and Funding Model

An NGO owned bike share system set up and funded by government is recommended for Adelaide. The scale of the system will require a multi-level government partnership that at a minimum must include local and state government. It is common for US bike share programs to have their capital costs met by the Federal Government, and this should be pursued, given both the funding required, and the strategic alignment between bike share and the Commonwealth's urban priorities. The Commonwealth's renewed interest in urban policy and innovation, including the recently announced *'city deals'* program of infrastructure funding should be seen as a potential mechanism for establishing a bike share program for Adelaide. Strategic alignment with preventive health programs run by the Commonwealth and State governments should also be seen as an opportunity for funding.

The funds required to *operate* an Adelaide bike share program are most appropriately met through a combination of State government financing, as well as local government contributions, based on the number of docking stations located in each municipality. Large organisations situated slightly outside the established catchment should also be invited to contribute the funds necessary to finance a docking station outside their facility.

7.2. Revenue

Bike share revenue is generated from two key sources; 1) commercial sponsorship and 2) user fees/charges.

7.2.1. Commercial sponsorship

It is too early to determine the likely revenue generated from sponsorship of a future Adelaide bike share program. The amount of revenue can generally be expected to be a function of the size of the potential market an advertiser's product or service is exposed to. For instance, New York City's bike share program enjoys high levels of public exposure, owing to the size and profile of the city. This has allowed Citi Bike to attract $US41 over five years from CitiBank, as well as an addition $US6 from MasterCard. For a city of Adelaide's size, sponsorship levels similar to what Minnesota Nice Ride (located in Minneapolis St Paul) receives is more appropriate. The author of this report was not able to determine the level of sponsorship received by Minnesota Nice Ride, but may provide an approx. indication of what Adelaide might expect to generate in sponsorship revenue.

Once detailed program design features have been developed, a prospectus should be produced. This document and associated website will allow prospective commercial and government sponsors to assess the benefits of involvement and levels of contribution, from naming rights sponsor, through to the sponsoring of individual docking stations. This process should not be undertaken without the involvement of a branding agency and bike share consultant, as both these disciplines are likely to produce a prospectus capable of yielding higher levels of sponsorship.

The mostly appropriate naming rights/principal sponsor is likely to be one with a particular affiliation with both Adelaide, and a connection with at least one of the elements bike share relates to (e.g. sustainability, health, fun, transport, cost effectiveness, convenience). Some examples are provided below (not exhaustive):

- *Commonwealth and/or State Department of Health:* Health is the largest beneficiary from increased population levels of cycling and is recognised as an effective preventative behaviour reducing sedentary lifestyle disease. The relationship between cycling and healthy living makes for a potentially strong partnership between health departments and bike share. Many corporate sponsors of bike share in North America are health companies.
- *Internode*: Adelaide born technology firm. The high tech features of the recommended Adelaide bike share hardware and software complements this well known ISP.
- *Coopers Brewery*: Adelaide based brewer. Potential synergy related to bike share's ability to provide a relaxed, fun form of mobility. The *individuality* promoted by both the brewer and bike share is a further overlap.
- *Statewide Super:* South Australian super fund. Prudent financial planning and cost effective, sustainable mobility is a potential overlap.
- *SA Power Network*: There is an obvious synergy between a major electricity company, and a bike share program that offers electric assist bicycles.
- *Santos:* As the largest company by revenue in South Australia, there may be some appetite on Santos's part to promote its interest in sustainable, renewable energy via support for a bike share program.

7.3. User fees

As highlighted in Section 3, it is recommended that for the first year of operation, no usage fees should apply. However, for trips above 30 minutes in duration, an escalating fee should apply, which is standard in OECD based bike share programs. A typical scale would be $2 for an additional 30 minutes, $4 for the next 30 minutes and $8 for every additional 30 minutes. The goal to provide a set of price signals that reduce the likelihood of people holding onto the bikes for longer than is necessary (e.g. taking it inside their workplace or home). Additional analysis is required to determine potential fee revenue derived from these trips. Section 8.3 in the Stage One Report (see Appendix Two) highlighted the standard fees and revenue received across a number of bike share programs.

8. Implementation timeline

This report has identified that a number of major policies require implementation before the necessary preconditions for an Adelaide bike share program are met. It is likely that the process of meeting these pre-conditions will take in the order of four years, meaning a future bike share program for Adelaide is unlikely before 2020.

As highlighted in the Stage 1 Report, a lack of supportive bicycle infrastructure was one reason the Brisbane and Melbourne bike share schemes failed to achieve substantial ridership. It is therefore necessary to make a significant investment in the bicycle infrastructure network prior to launching a bike share program in Adelaide. This must include protected bicycle infrastructure, which has been shown to overcome the real and perceived risk associated with urban cycling.

There are a number of 'triggers' – actions that are considered necessary before a bike share program in Adelaide offers reasonable prospects of success. These triggers are described briefly below, and are encapsulated within Figure 13, which provides a summary of the proposed timeline to launch.

- Trigger 1: Outcome of market analysis: Data collection and analysis of likely target markets for an Adelaide bike share program, including commuters, tourists and local visitors to central Adelaide. Data collection to include focus groups, online and intercept surveys. The objective of this trigger is to more precisely determine the local constraints and opportunities to a bike share system for Adelaide.

- Trigger 2: Outcome of investigation into impacts of legislative changes to helmet requirements. Should the outcome of this investigation find that a waiver to mandatory helmet legislation is not in the public interest, bike share may no longer be feasible in Adelaide (in terms of benefits compared to costs). Bike share with mandatory helmet legislation would mean the costs will rise slightly (for helmet provision) whilst the benefits would reduce substantially (due to less usage).

- Trigger 3: Commitment to build network of protected bikeways to provide continuous, safe bike routes across central Adelaide, throughout proposed catchment of bike share program.

- Trigger 4: Financing. Sufficient financing of both capital and operating expenditure over the life of the program (10 – 20 years) is required and if this cannot be secured, plans for bike share may have to be abandoned.

The above four triggers are considered essential pre-conditions before an Adelaide bike share program could be launched with reasonable prospects of success. Should these triggers be successfully achieved, the following implementation timetable is proposed. Some of these initial tasks must be undertaken to respond to the triggers outlined above.

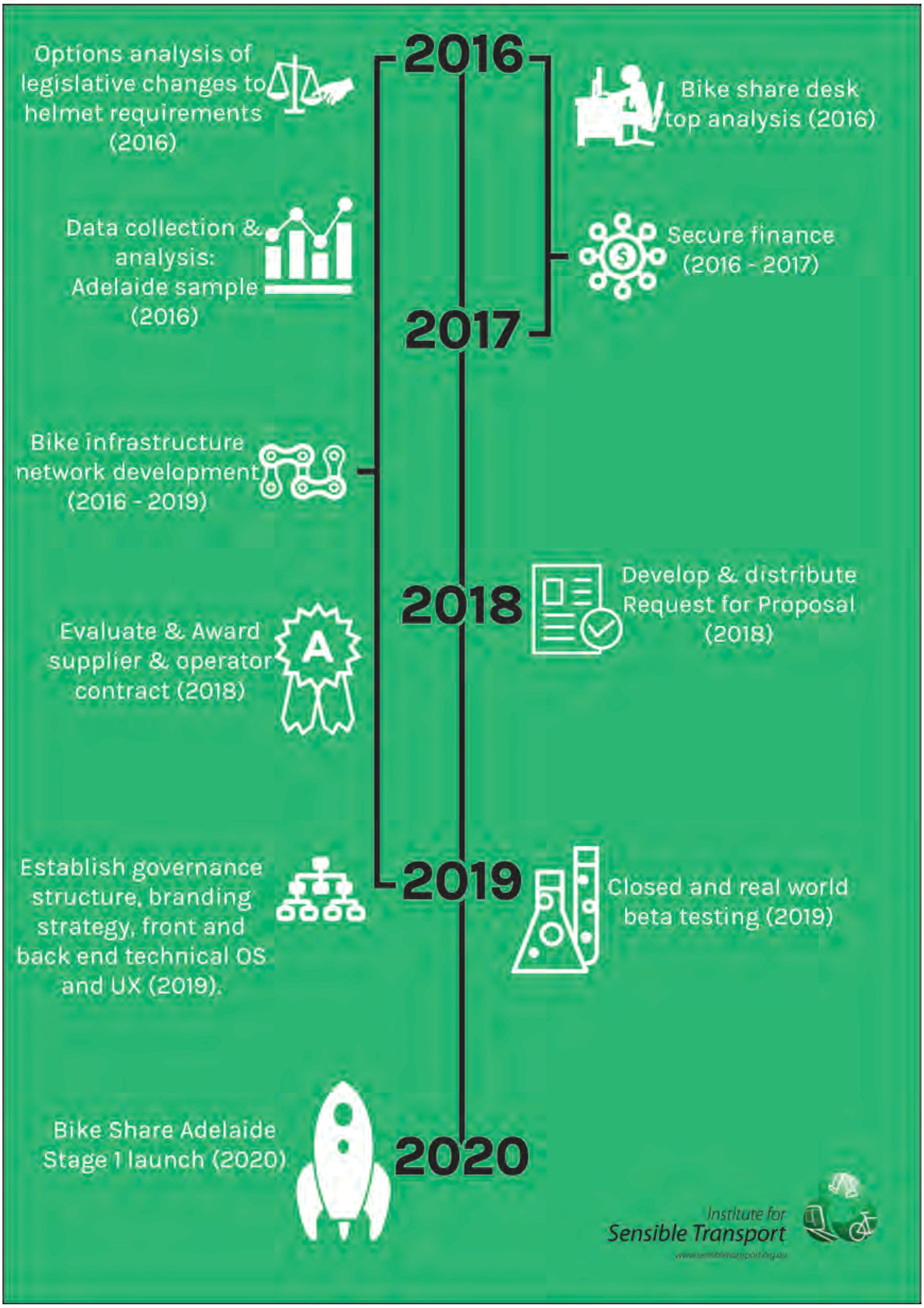


Figure 11 Implementation timeline

9. Conclusion and summary of recommended options

This report has provided an assessment of options for a future Adelaide bike share program. The assessment has found that Adelaide does not currently have the necessary conditions to support a successful bike share program. There are a number of pre-conditions that require implementation before Adelaide is likely to support a well used bike share program. Establishing a bike share program before these pre-conditions are met is likely to result in an underused system. As identified in Section 6, these pre-conditions include:

1. Electric assist bicycles.
2. Public transport smartcard integration.
3. Smartphone unlocking of bicycles using NFC technology.
4. Higher density catchment design than other Australian bike share systems.
5. Comprehensive marketing and branding strategy
6. Enhancing organisational and contract structure that better incentivizes the operator to maximise usage levels
7. Free basic fare structure (at least for first year).
8. Safer bicycle infrastructure network and lower motor vehicle speeds.
9. Voluntary helmet regulation.[9]

Implementing a bike share program that satisfies the pre-conditions identified above will provide Adelaide with the best possible prospect of success. However, there are limits to the impact these actions can have on ridership, as they do not eliminate the negative impact on usage associated with a low-density city and a transport system still heavily in favour of car use. Thus, this assessment of bike share options for Adelaide has found that although it is unlikely Adelaide will achieve the high usage levels of some bike share cities, bike share should be seen as a positive step Adelaide can take to begin the transition to a more sustainable transport system. The choice to use bike share must be seen as a complex decision making process that involves an assessment of *all* potential modes of transport. Ultimately the ability of a future bike share program to provide a compelling value proposition to potential riders will determine its popularity.

9.1. Recommendations

This report has provided Adelaide with a recommended set of design options for a future bike share program. Should the recommendations

[9] As highlighted earlier, this is subject to the outcome of the recommended investigation and determined by the overall impact on population health.

made earlier in this report (Section 3 and 8) be accepted, the following sequential set of actions are proposed.

9.1.1. Research and public consultation

- Market data collection and analysis: Conduct focus groups to identify key barriers and facilitators to bike share, based on the Adelaide context, with people who live, work or study in inner Adelaide, including current cyclists and non-cyclists, as well as visitors.
- Conduct online and intercept surveys with target markets, to inform program design (e.g. bike hardware capabilities, pricing structure) as well as ridership forecasts.
- Undertake a benefit cost analysis for bike share, over the life of the program, including health, environmental, visitor experience and transport benefits, against capital and operational costs.
- Investigate the current bicycle infrastructure network in central Adelaide, for its ability to support a safe riding environment for a future bike share program, including a gap analysis and recommended actions.

9.1.2. Management and operational structure

- Conduct an analysis of best practice bike share management and operational structures
- Assess local capacity to manage and operate bike share program in Adelaide
- Develop preferred management and operational structure for bike share in Adelaide.

9.1.3. Sponsorship

- Conduct analysis of sponsorship opportunities and revenue forecasts.
- Develop, in conjunction with a branding agency and bike share consultant, a digital and hardcopy prospectus to attract potential program and station sponsors.

9.1.4. Develop Request for Proposals (RFP) document

- Using the results of the above activities, develop a detailed RFP document that includes desired specifications in relation to:
    - Minimum bicycle hardware requirements
    - Catchment size
    - Number of bicycles
    - Technology (both customer interface and backend) and data sharing policies, usage analytics interface
    - Fee structure and payment options
    - Proposed marketing strategy and target markets
    - Operations structure and capabilities.

10. References

Allchin, C. (2013). *Adelaide Fine Grain: A Strategy for Strengthening the Fine Grain of the Adelaide City Centre*. Retrieved from: http://www.adelaidecitycouncil.com/assets/documents/Ad_Fine_Grain_Final.pdf

Alta Bike Share. (2011). *Melbourne Bike Share Survey*. Melbourne.

Alta Planning + Design. (2012). *King County Bike Share Business Plan*. Retrieved from: http://pugetsoundbikeshare.org/wp-content/uploads/2012/07/KCBS_Business_Plan_FINAL.pdf

Arlington County. (2015). *Arlington County Fiscal Year 2015 Summary Report on Capital Bikeshare*. Retrieved from: http://www.bikearlington.com/pages/bikesharing/reports-and-analysis/arlington-fy-2015-capital-bikeshare-report/

City & County of Honolulu. (2014). *Honolulu Bikeshare Organizational Study*. Retrieved from:

City of Adelaide. (2016). *City of Adelaide 2016 - 2020 Stategic Plan*. Retrieved from: http://yoursay.adelaidecitycouncil.com/strategic-plan

Department of Environment Water and Natural Resources. (2016). Carbon Neutral Adelaide. Retrieved from http://www.environment.sa.gov.au/Science/Science_research/climate-change/climate-change-initiatives-in-south-australia/sa-climate-change-strategy/carbon-neutral-adelaide

Fischer, C. M., Sanchez, C. E., Pittman, M., Milzman, D., Volz, K. A., Huang, H., . . . Sanchez, L. D. (2012). Prevalence of Bicycle Helmet Use by Users of Public Bikeshare Programs. *Annals of emergency medicine, 60*(2), 228-231. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0196064412002880?showall=true

Fishman, E. (2014). *Bikeshare: barriers, facilitators and impacts on car use*. (PhD Thesis by Publication), Queensland University of Technology, Brisbane.

Fishman, E. (2015). Bikeshare: A Review of Recent Literature. *TRANSPORT REVIEWS*, 1-22. doi:10.1080/01441647.2015.1033036

Fishman, E. (2016). Cycling as transport. *TRANSPORT REVIEWS, 36*(1), 1-8. doi:10.1080/01441647.2015.1114271

Fishman, E., & Schepers, P. (2016). Global bike share: What the data tells us about road safety. *Journal of Safety Research, 56*, 41-45.

Fishman, E., Washington, S., & Haworth, N. (2012a). Barriers and Facilitators to Public Bicycle Scheme Use: A Qualitative Approach. *Transportation Research Part F-Traffic Psychology and Behaviour, 15*(6), 686-698. Retrieved from http://www.sciencedirect.com/science/article/pii/S136984781200073 3

Fishman, E., Washington, S., & Haworth, N. (2012b). Understanding the fear of bicycle riding in Australia. *Journal of the Australasian College of Road Safety, 23*(3), 19-27. Retrieved from

http://www.sensibletransport.org.au/sites/sensibletransport.org.au/files/ACRSjournalVol23No3Aug12webV2.pdf
Fishman, E., Washington, S., & Haworth, N. (2014). Bike Share's Impact on Car Use: Evidence from the United States, Great Britain, and Australia. *Transportation Research Part D: Transport & Environment, 31*, 7. doi:10.1016/j.trd.2014.05.013
Fishman, E., Washington, S., Haworth, N., & Mazzei, A. (2014). Barriers to bikesharing: an analysis from Melbourne and Brisbane. *Journal of Transport Geography*. Retrieved from http://dx.doi.org/10.1016/j.jtrangeo.2014.08.005
Fishman, E., Washington, S., Haworth, N., & Watson, A. (2015). Factors influencing bike share membership: an analysis of Melbourne and Brisbane. *Transportation Research Part A, 71*, 17-30. doi:doi:10.1016/j.tra.2014.10.021
Garrard, J. (2011). *Make it feel safe and they will come: addressing the actual and perceived risks of cycling*. Paper presented at the Asia Pacific Cycle Congress., Brisbane. . http://www.scribd.com/fullscreen/80977058?access_key=key-22zzmxaqdhn59lglz9u2
Goodman, A., Green, J., & Woodcock, J. (2013). The role of bicycle sharing systems in normalising the image of cycling: An observational study of London cyclists. *Journal of Transport & Health, 1*(1), 5-8. doi:doi:10.1016/j.jth.2013.07.001
Graves, J. M., Pless, B., Moore, L., Nathens, A. B., Hunte, G., & Rivara, F. P. (2014). Public Bicycle Share Programs and Head Injuries. *American Journal of Public Health*, e1-e6. doi:10.2105/AJPH.2014.302012
Hoffmann, C., Kandt, J., Smith, D., & Graff, A. (2015). *Toward New Urban Mobility: The case of London and Berlin*. Retrieved from London: https://files.lsecities.net/files/2015/09/New-Urban-Mobility-London-and-Berlin.pdf
Institute for Transportation & Development Policy. (2013). *The Bike-sharing Planning Guide*. Retrieved from New York City: https://www.itdp.org/the-bike-share-planning-guide-2/
Kent, J. L. (2014). Driving to save time or saving time to drive? The enduring appeal of the private car. *Transportation Research Part A: Policy and Practice, 65*(0), 103-115. doi:http://dx.doi.org/10.1016/j.tra.2014.04.009
Lansell, K. (2011). *Melbourne Bike Share and Public Transport Integration*. (Master of Urban Planning Minor thesis), University of Melbourne, Melbourne.
Meddin, R., & DeMaio, P. (2016). The Bike-sharing World the Last Week of December 2015. Retrieved from http://bike-sharing.blogspot.com.au/2015/12/the-bike-sharing-world-last-week-of.html
Mulley, C., Tyson, R., McCue, P., Rissel, C., & Munro, C. (2013). Valuing active travel: Including the health benefits of sustainable transport in transportation appraisal frameworks. *Research in Transportation Business and Management, 7*, 27-34. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84878578191&partnerID=40&md5=6134074500afef09a0dba1608fc4fea5

Parkes, S. D., Marsden, G., Shaheen, S. A., & Cohen, A. P. (2013). Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. *Journal of Transport Geography, 31*, 94-103.
Sadik-Khan, J., & Solomonow, S. (2016). *Streetfight: Handbook for an Urban Revolution*. New York City: Viking.
Shaheen, S., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia. *Transportation Research Record: Journal of the Transportation Research Board, 2143*, 159-167. doi:10.3141/2143-20

11. Appendices

11.1. Appendix 1: Bike Share Propensity Index Data

See next page.

Measure	Scale for Index quintile				
	Q1	Q2	Q3	Q4	Q5
People per hectare	0 – 13.945	14.011 – 20.931	20.941 – 24.873	24.876 – 29.000	29.002 – 90.234
Number of people working per hectare	0–1.483	1.567 – 3.416	3.416 – 6.127	6.127 – 8.531	8.531 – 198.023
Number of people aged 18 – 34 years of age per hectare.	0 – 2.728	2.734 – 4.423	4.423 – 5.855	5.860 – 7.799	7.804 – 61.982
Number of employed people across Adelaide with employment destinations within the City of Adelaide, by number in SA2	0-874	874-1088	1088-1545	1545-1912	1912-2926
Number of households with one or zero motor vehicles per hectare.	0 – 1.973	1.973 – 3.534	3.534 – 4.968	4.968 – 6.788	6.788 – 32.325
Proportion of workers who used the bicycle for at least one stage of their trip to work, by residential SA2	0 – .009	0.009 – .016	0.016 – 0.021	0.021 – 0.033	0.033 – 0.050
Proportion of workers who used the bicycle for at least one stage of their trip to work, by destination SA2	0 – 0.004	0.004 – 0.010	0.010 – 0.015	0.015 – 0.0236	0.0236 – 0.0340

Table 3 Bike share Propensity Index Variables and Quintiles

Bike Share Propensity Index Rating				
	>0.6	**>0.7**	**>0.8**	**>0.9**
Area (km2)	158.22	98.17	37.27	15.68
Docking stations per km2 (approx. one every 300m)	11	11	11	11
Number of docking stations	1,740	1080	405	172
Number of bikes	17,404	10,800	4,100	1,725

Table 4 Bike Share Propensity Index Estimates of Bike Share Size

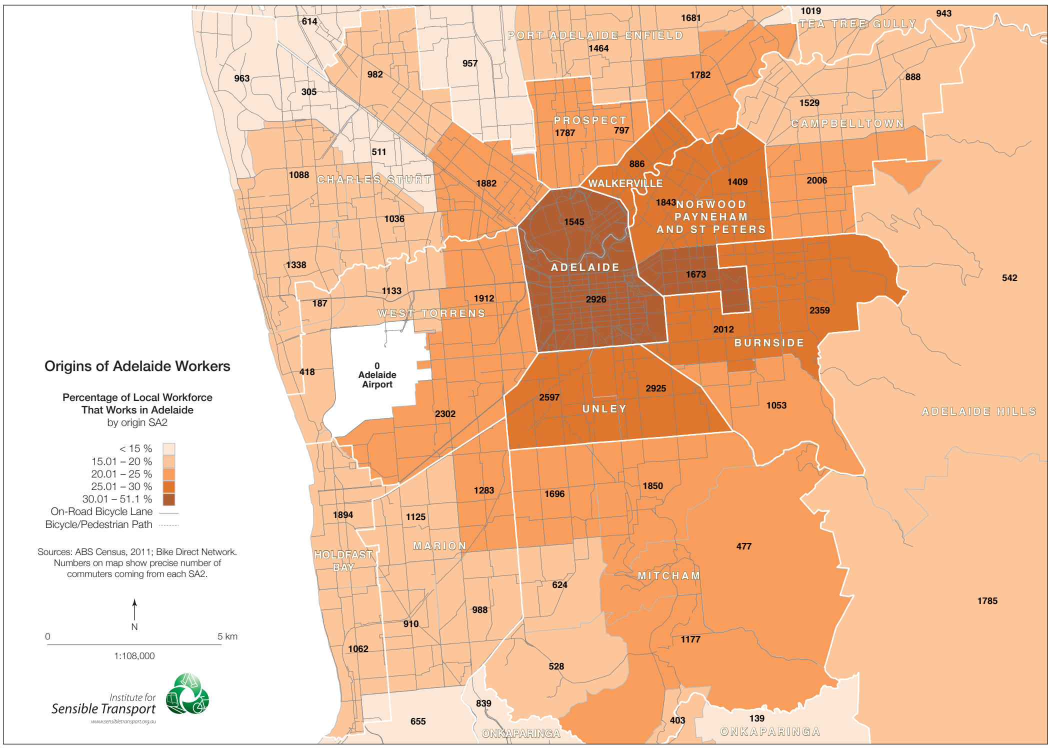


Figure 12 Origin of City of Adelaide workers

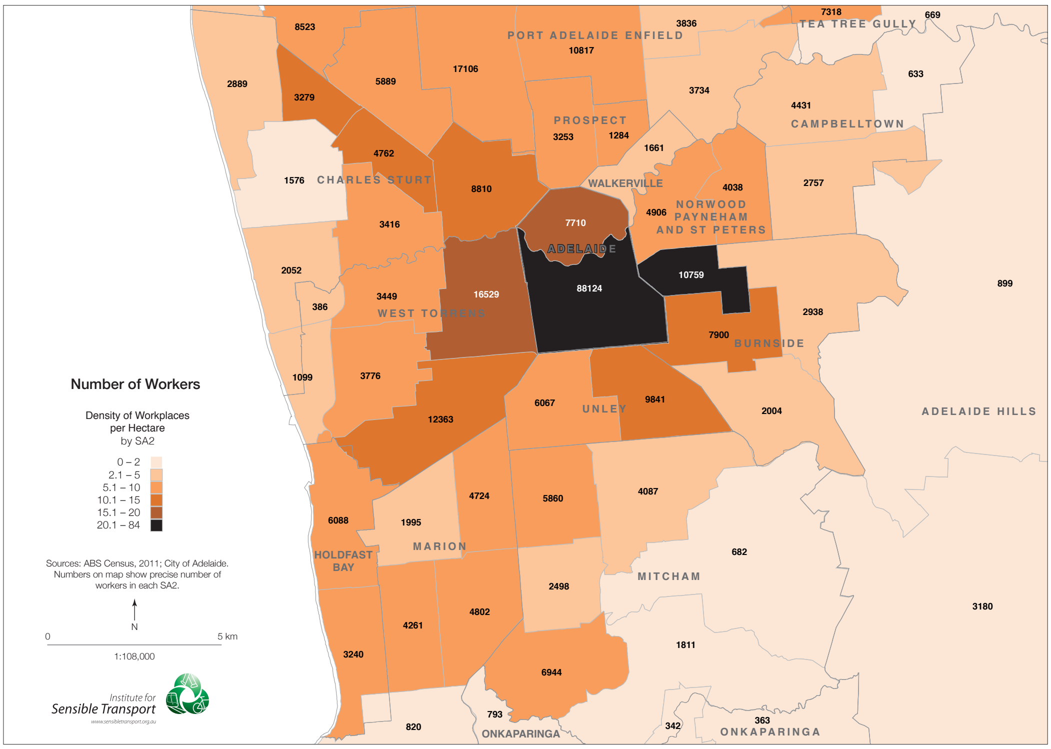


Figure 13 Job Density

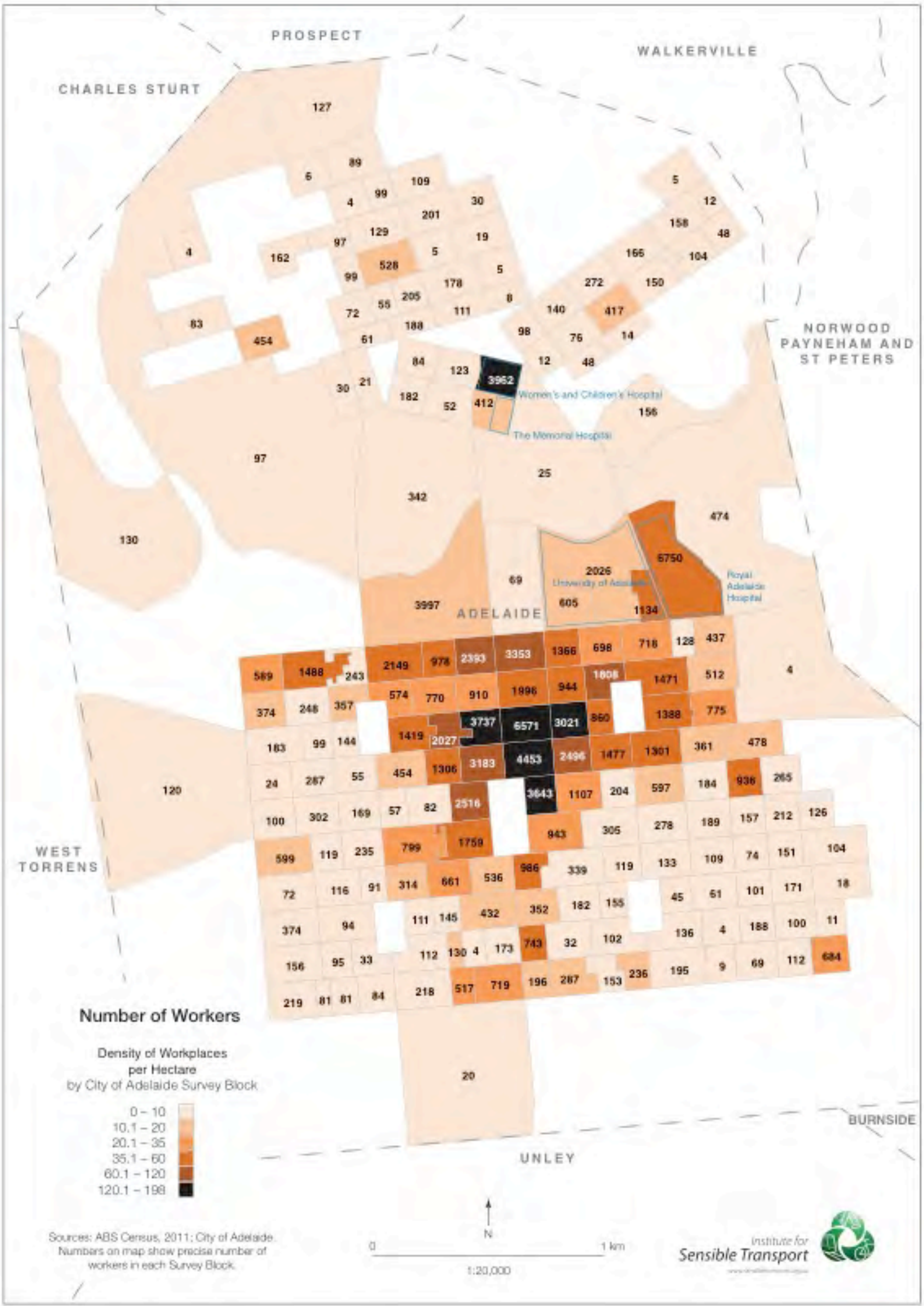


Figure 14 CBD Job Density

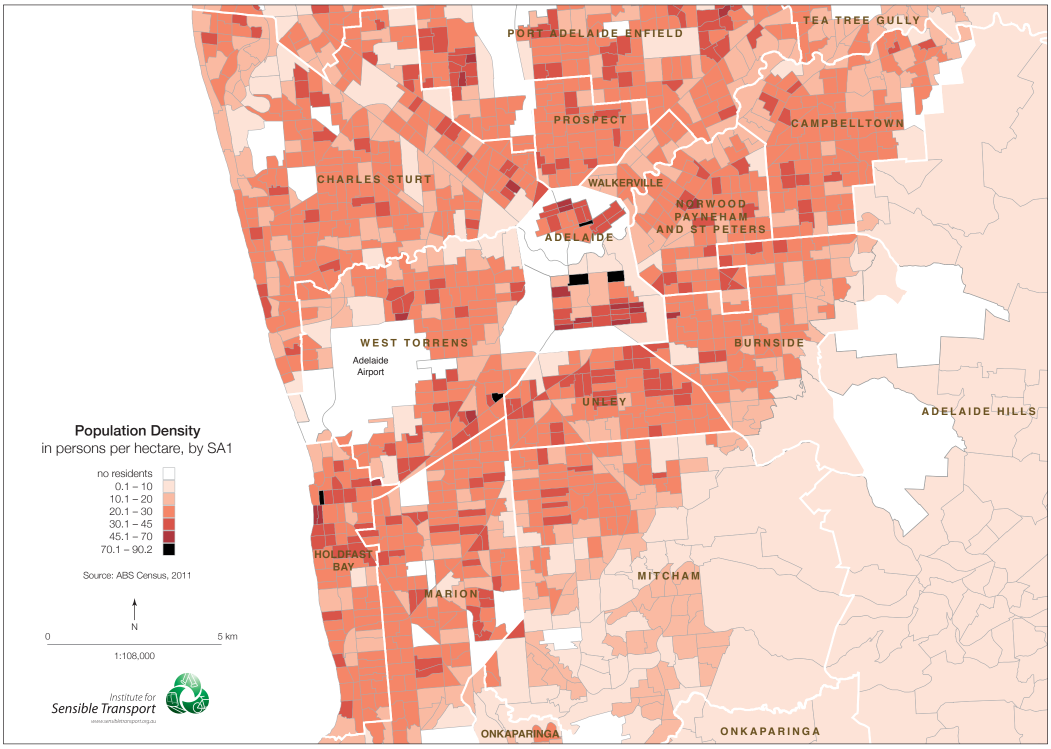


Figure 15 Residential Density

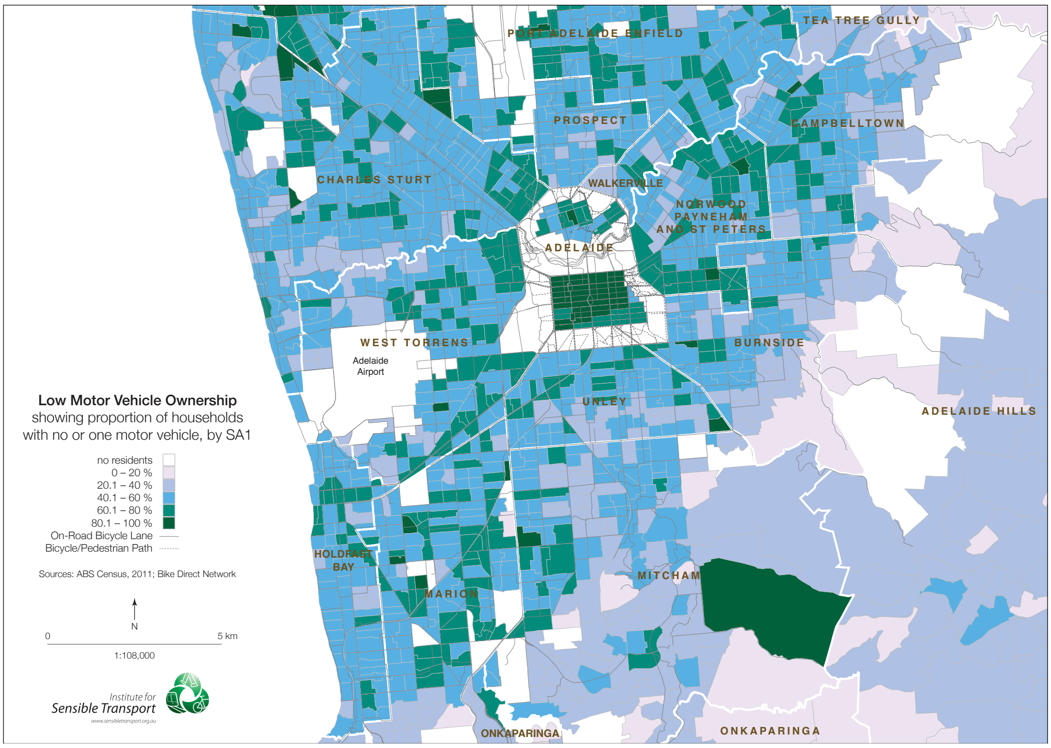


Figure 16 Low Car Ownership Households

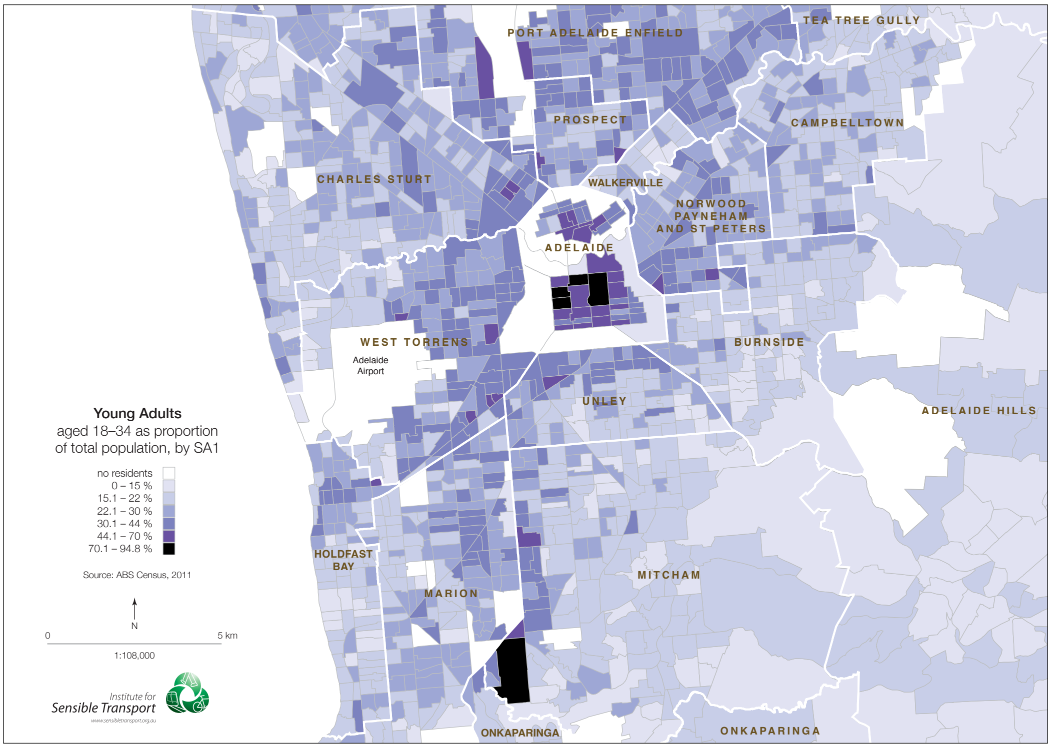


Figure 17 Young Adult Population

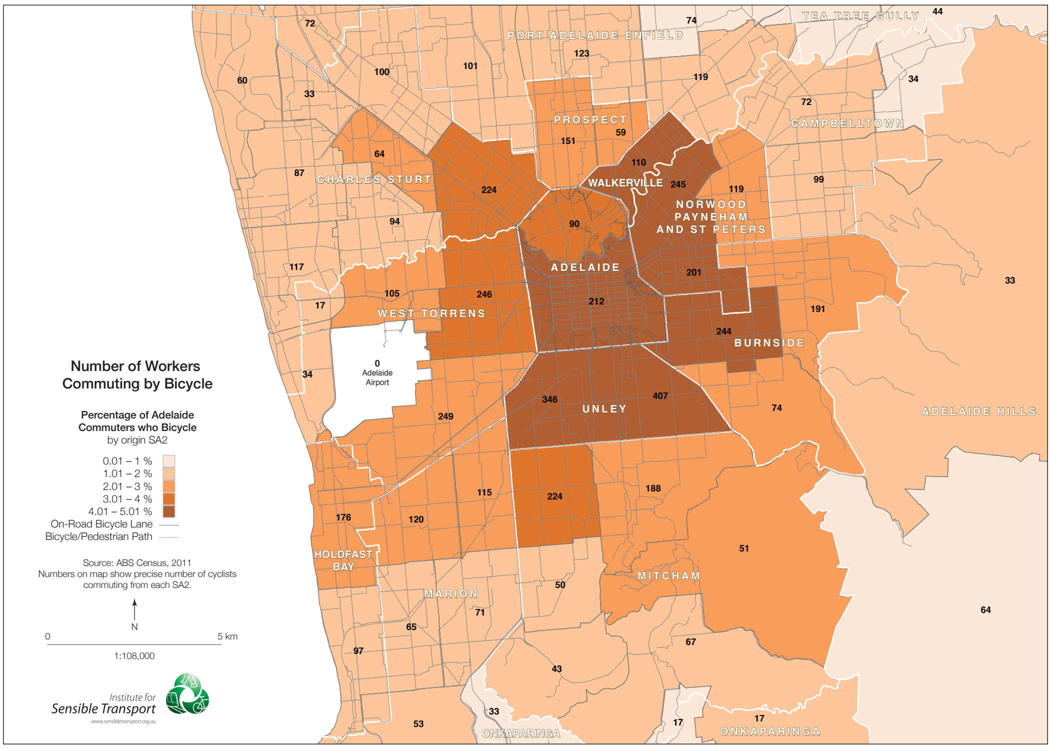


Figure 18 Bicycle Journey to Work, by Origin

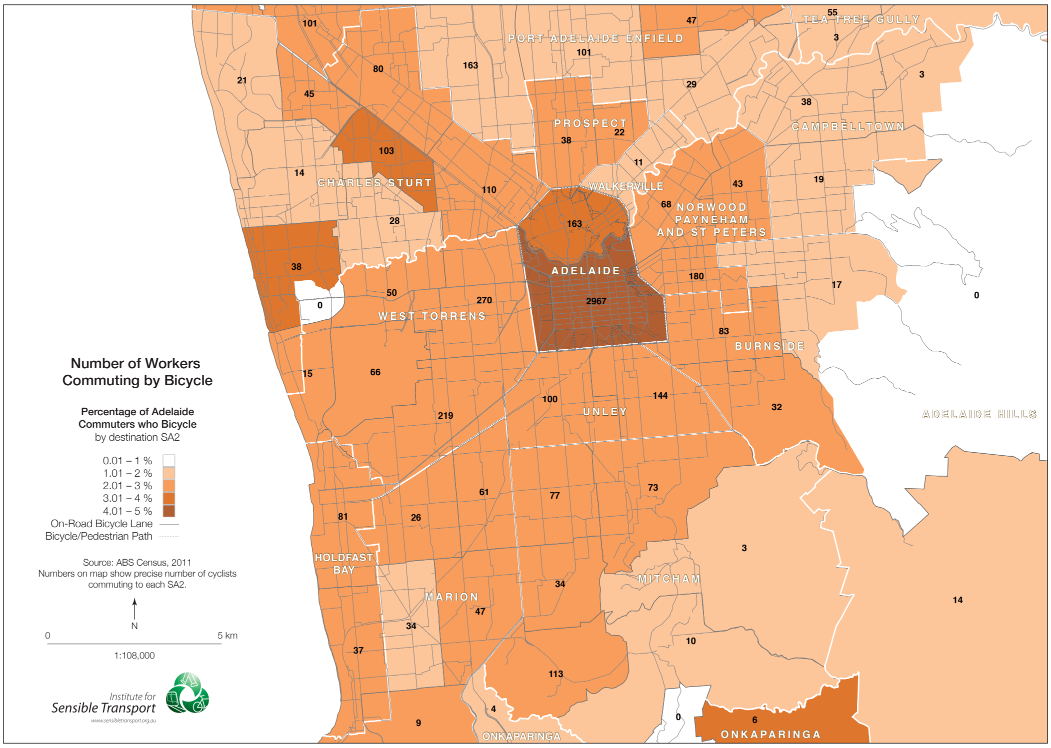


Figure 19 Journey to Work, by Destination

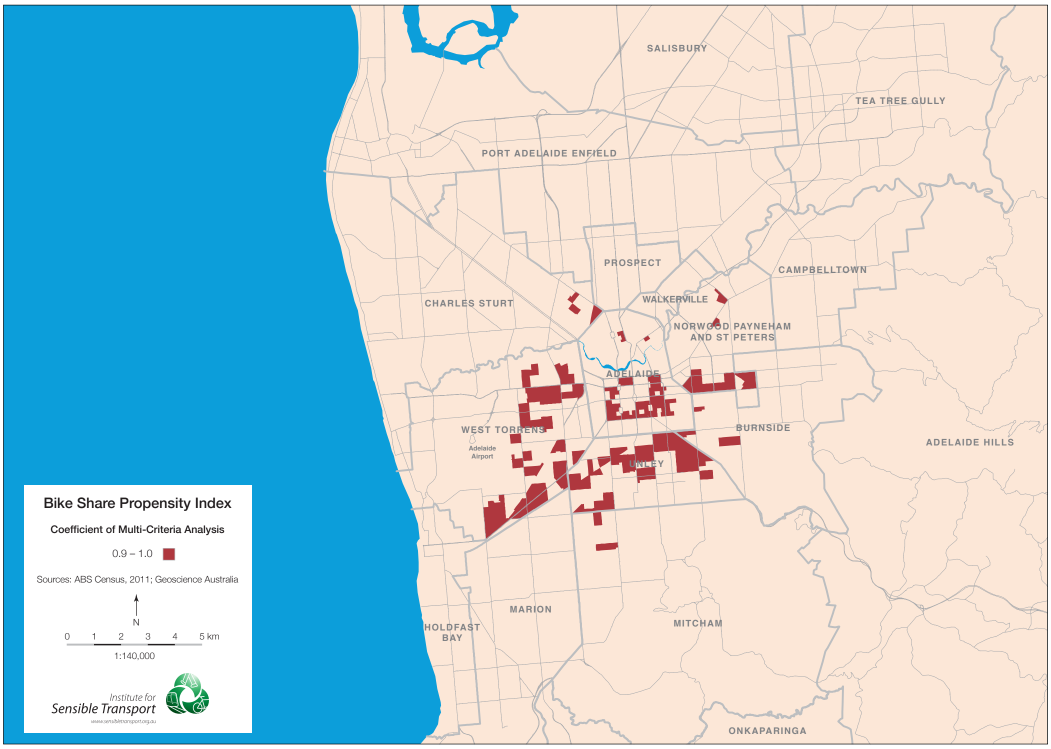


Figure 20 Areas with Highest Bike Share Propensity Index rating

11.2. Appendix 2: Stage One Report: Review of Bike Share Literature

See next page.

Bike Share - Options for Adelaide

Stage One: Review

Prepared for the City of Adelaide by
the Institute for Sensible Transport

February 2016

Institute for
Sensible Transport
www.sensibletransport.org.au

This page has been left intentionally blank

CONTENTS

FIGURES

TABLES

About this report

This report (Stage One) is the first of three sequential reports that will assess the feasibility and options for a modern bike share program in Adelaide. The Institute for Sensible Transport has been commissioned to undertake this work by the City of Adelaide. The central objective of this Stage One report is to review the existing literature on bike share, encompassing a wide range of essential data related to costs, benefits, technologies, usage factors, and other issues that may impact on any future program in Adelaide. This report will be followed by two subsequent stages; Stage Two involves a stakeholder workshop with key Adelaide Metro Councils and Government representatives, which will explore bike share possibilities for Adelaide. Stage Three will present an options analysis for a bike share program in Adelaide, centred on best practice principles.

Background

Adelaide City Council has financed the *Adelaide Free Bikes* program since 2005. *Adelaide Free Bikes* includes 200 bicycles, which can be rented at 19 hire nodes. Users are limited to the opening hours of the node, as these are staffed locations (e.g. libraries). The program does have strong support, but given developments in bike share internationally, there is a need to investigate the feasibility of a more technologically advanced program.

1. A brief history of bike share

The *White Bikes* program was launched in Amsterdam in 1965 and consisted of little more than five to 10 bicycles, hand painted white, and left on the street for people to use freely (Schimmelpennink, 2014). The total absence of any security mechanisms led to theft and vandalism, and the rapid demise of the program (DeMaio, 2009). Bike share, as a concept, experienced little growth after the failure of the *White Bikes* program, until technological advancements emerged designed to reduce the threat of misuse.

Figure 1 White Bike program in Amsterdam, mid 1960s
Image provided by Luud Schimmelpennink

1.1. Generations of Bike Share

Some researchers have categorised the evolution of bike share systems into four 'generations' (Parkes, Marsden, Shaheen, & Cohen, 2013). *White Bikes* described above is known as a *first-generation* bike share 'system', characterised by no payment or security functions. *Second-generation* programs involved a coin deposit system (similar to trolleys at a supermarket or airport). The first large-scale second-generation program launched in Copenhagen in 1995, but the anonymity exposed the system to theft (DeMaio, 2009). The problems experienced by these first two generations of bike share led to the development of *third-generation* systems, which are characterised by dedicated docking stations (in which bicycles are picked up and returned), as well as automated credit card payment and other technologies to allow the tracking of the bicycles (Shaheen, Cohen, & Martin, 2013). It is these elements, in combination with growing public policy interest in cycling (Pucher & Buehler, 2012), that have enabled the rapid growth of bike share programs globally (Shaheen & Guzman, 2011). The features of *fourth-generation* systems are not quite so clear, but are said to potentially include dockless systems, easier installation, power assistance and transit smartcard integration (Parkes et al., 2013).

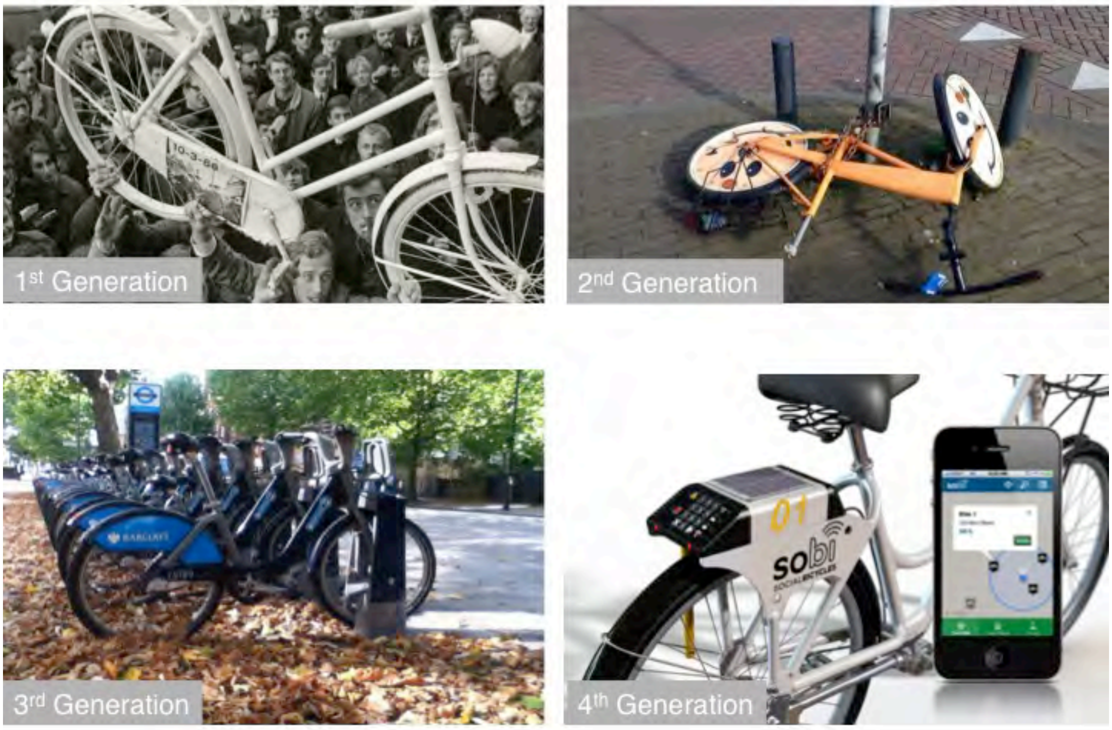


Figure 2 Generations of bike share

1.2. Global bike share growth

In the past decade, the number of cities operating a bike share program has increased from 13 in 2004 to around 980 cities as of 2015 (3rd generation or above). As shown in Figure 3, the global growth in bike share began around 2005 - 2007. The global bike share fleet is estimated at 1,258,500 bicycles, of which over half are in China (Meddin & DeMaio, 2016). China also has more than double the number of bike share systems than the next closest country. As of early 2015, there were an estimated 237 cities in China with bike share, compared to 114 in Italy and 113 in Spain. The USA, a relative latecomer to bike share, has 54 cities offering bike share in early 2015 (Meddin, 2015).

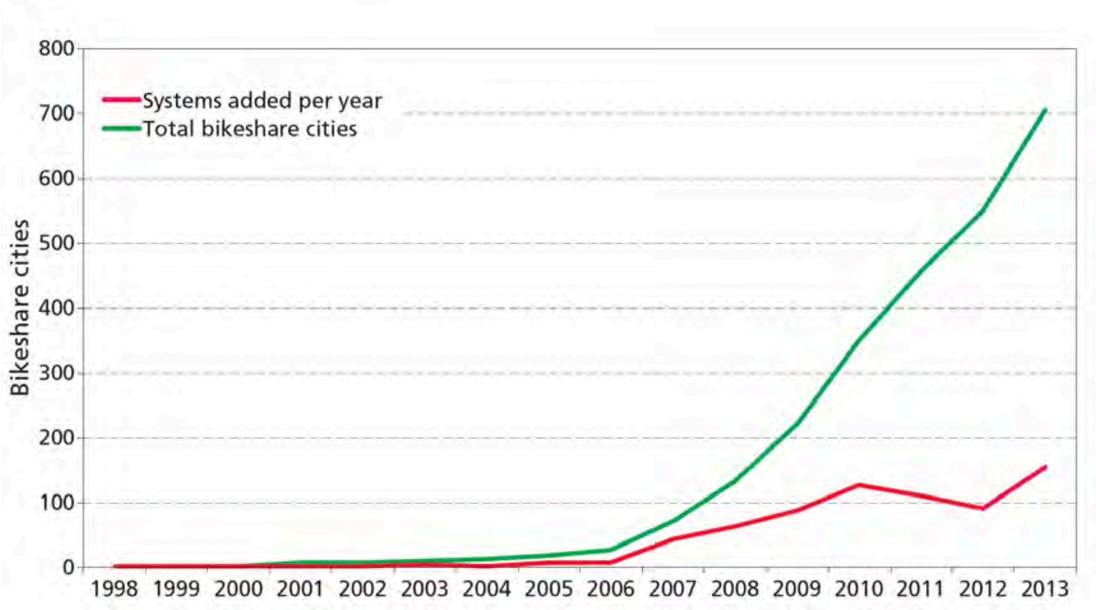


Figure 3 Growth of bike share 1998 – 2013
Source: Meddin (2014)

In 2010, Oliver O'Brien began visualising bike share activity in different cities, making this available via the website http://oobrien.com/bikesharemap/. This became the most efficient method of examining the number of bikes available and the number of bikes in use. Interestingly, an analysis of these data reveals that the number of bikes available is often considerably lower than what bike share operators report. Figure 4 uses data collected via the aforementioned bike share map for selected cities, showing the maximum number of observed bicycles. The two Australian bike share programs, in Brisbane and Melbourne are shown in Figure 4, with 1,832 and 545 bicycles respectively. European systems tend to be larger than North American systems and some have suggested that this may be due to a tendency for European systems to be totally or largely funded through advertising, as well as cycling participation being higher in most European countries (Parkes et al., 2013).

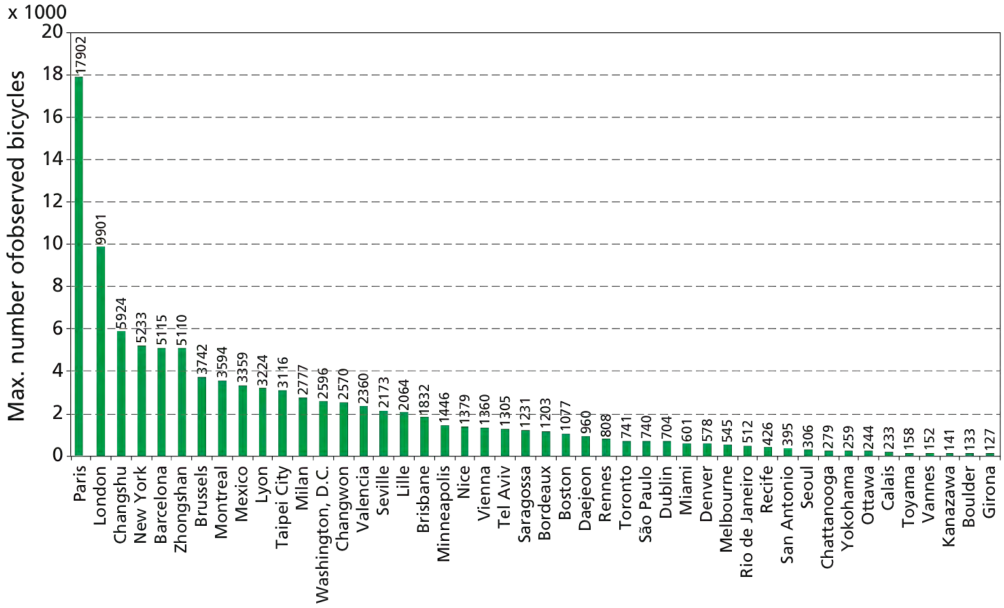


Figure 4 Bike share system size

NB: Not all cities with bike share are included. Changshu figure is October 2012 and Changwon and Ottawa figures are October 2013.
Source: O'Brien (2014)

1.3. Bike share in the context of transport systems

Fundamentally, transport systems consist of three elements; 1) vehicles, 2) rights of way, and 3) terminal capacity (Shoup, 2005). Each mode of transport typically requires each of these elements (with the exception of walking). Maritime transport, for example requires ships (the vehicle), shipping lanes (rights of way) and ports (terminal capacity). For bicycling, the vehicles are bicycles, the rights of way are streets and bicycle paths, and terminal capacity are bicycle racks or similar devices to lock bicycles. Bike share programs address two of these three elements, namely, they provide the vehicle and the terminal capacity. Failing to provide sufficient *rights of way* (e.g. separated bicycle lanes) can act as a barrier to bike share use, as described in Section 4 and 5. Importantly, bike share is increasingly seen as a *last mile* solution (Shaheen, Guzman, & Zhang, 2010), helping to improve access to and from public transport (Parkes et al., 2013). As will be shown in Section 8, the operational cost recovery for bike share compares favourably to other forms of public transport.

2. Bike share usage

Bike share usage can vary dramatically between bike share programs in different cities, but they generally exhibit a similar daily usage profile. Weekday usage peaks between 7 am–9 am and 4 pm–6 pm, while weekend usage is strongest in the middle of the day (e.g. see Pfrommer, Warrington, Schildbach, & Morari, 2013), as might be expected. In comparing system usage between different cities, it has become standard to use the metric *trips per day per bike*, as this controls for variation in the number of bikes in a system. Figure 5 illustrates *trips per day per bike* for several prominent bike share programs for which the author was able to obtain the necessary data. It shows considerable differences in usage, both with the same system at different times of the year, as well as between systems.

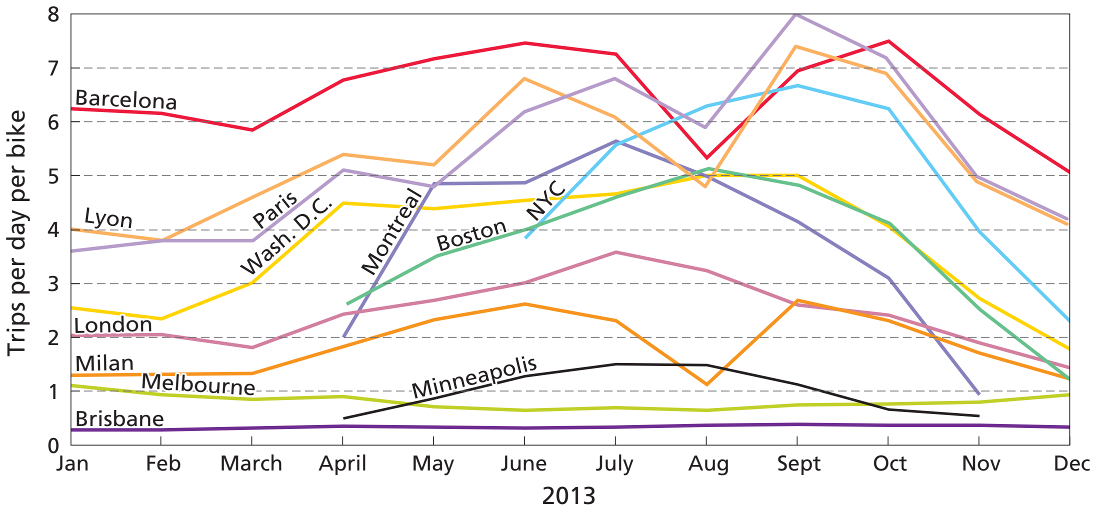


Figure 5 Bike share usage, trips per day, per bike, 2013
Source: Fishman (2015)

Bike share programs are busier in the warmer months, which generally confirms the relationship between weather and propensity to cycle found in research on private bike riding (Ahmed, Rose, & Jacob, 2010). Of the cities included in Figure 5, Barcelona is the most heavily used across the year, with New York City's *Citi Bike* achieving a remarkable four trips per day per bike in its first full month (May 2013), and almost doubling by September. Paris has the highest peak, reaching eight trips per day per bike in September. Washington, D.C., consistently reached four to five trips per day per bike in summer, and even in their sometimes icy winters have at least twice the usage of Australian bike share programs during their busiest months (January/February). Melbourne and Brisbane have around 0.8 and 0.3 trips per day per bike respectively. The low usage level of Australian bike share programs will be examined in Section 4 and 5.

Unlike private bicycle riding, it is relatively easy to determine the trip duration of bike share journeys, as each trip is generally time stamped at the point a bicycle is removed from a docking station and again when it is returned. A study on bike share trip duration, using data from Melbourne, Brisbane, Washington, D.C., Minnesota and London found they fell within a tight band of between 16 and 22 minutes (Fishman, Washington, & Haworth, 2014). Other researchers have found casual users typically take longer trips than annual members (Buck et al., 2013) and duration has also been shown to vary seasonally, with longer trips during warmer months (Zaltz Austwick, O'Brien, Strano, & Viana, 2013).

3. Demographics of bike share users

The demographics of bike share users have become a common focus of attention for bike share operators and researchers. The issues examined include the gender and income profiles of bike share users, relative to the underlying population averages. Moreover, the ethnicity and education status of bike share members has also been an important question for researchers and city governments.

Much of this research has revealed common trends; users tend to be of higher average income (e.g. see Fishman, Washington, Haworth, & Watson, 2015; Lewis, 2011; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014), and education status (e.g. see Fishman, Washington, Haworth, & Mazzei, 2014; LDA Consulting, 2013; Shaheen et al., 2013) and engaged in full-time or part-time work (Woodcock et al., 2014). In Melbourne for instance, bike share members were substantially more likely to earn in excess of $104,000 per annum than the general population of Melbourne.

Buck et al. (2013) carried out one of the few studies that set out to specifically examine demographic differences between bike share users and other cyclists. The authors collected data on *Capital Bikeshare* users (short- and long-term subscribers) as well as regular cyclists in the same geographic area (Washington, D.C.). The authors found that in comparison to regular bicycle riders, bike share users were more likely to be female, younger and own fewer cars and bicycles. *Capital Bikeshare* users were likely to have lower mean household incomes compared to regular cyclists (US$81,920 compared to US$93,180). Interestingly, however, and something not reported in the Buck et al. study, median household income for the general population in the Washington, D.C. area is US$64,267 (United States Census Bureau, 2013). This suggests both bike share users and general bicycle riders have higher incomes than the general Washington, D.C. population, though it is possible response bias contributes to this difference. A study by Goodman and Cheshire (2014) found that users of the London bike share program were disproportionately wealthy when the program began in 2010. As the program matured, however, the proportion of users from deprived areas increased from 6% to 12% between 2010 and 2013. The increase in usage fees in January 2013 however, has, according to Goodman and Cheshire (2014) resulted in a reduction in the level of *casual* use from those residing in the most economically deprived areas of London.

The ethnicity of bike share users has been documented in some North American programs as well as in London. The results show some substantial differences between bike share users and the general population. For instance, only 3% of *Capital Bikeshare* members are African-American, compared to 8% for general bicycle riders in the D.C. area (Buck et al., 2013), despite African-Americans making up some 50% of the Washington, D.C. population (United States Census Bureau, 2013). Members of London's bike share program have been found to differ demographically from the general London population. Some 88% of respondents to a Transport for London bike share survey identified as being white (Transport for London, 2014), compared to 55% for the general London population

(Office of National Statistics, 2014). Many bike share programs do not cover the full residential area of the city, and this may offer an explanation for the demographic biases of bike share users.

In terms of bicycle ownership, Buck et al. (2013) found only 29% of *Capital Bikeshare* members owned a bicycle, compared to 94% for general bicycle riders. A study using snowball sampling in Montreal, Canada, found those owning a bike were less frequent users of bike share (Bachand-Marleau, Lee, & El-Geneidy, 2012). Interestingly, the same study found those possessing a driver's licence had 1.5 times greater odds of using bike share.

Several studies have identified a relationship between gender and bike share usage. One US commentator has suggested bike share does not have the same level of gender disparity as general cycling in North America (Goodyear, 2013), although no report details were offered allowing the reader to verify the numbers provided in the online piece. In countries with low levels of general cycling, such as the UK, the USA and Australia, between 65% and 90% of cycling trips are by men (Pucher & Buehler, 2012), while in strong cycling countries such as the Netherlands, women cycle more than men (Fishman, Böcker, & Helbich, 2015). Unsurprisingly therefore, bike share programs in countries with low cycling usage have lower levels of female participation. For instance, less than 20% of trips by registered users of the London bike share program are by women (Goodman & Cheshire, 2014), though this proportion rises slightly when looking at casual users. Interestingly, female participation rises substantially for trips that start or finish in a park, possibly suggesting a desire among females to avoid motorised traffic routes in London and a recreational rather than commuting trip purpose. Previous research has found that women have a stronger preference for traffic free riding (Johnson, Charlton, & Oxley, 2010). A study of Australia's bike share members has found that women account for 23% and 40% of annual members in Melbourne and Brisbane, respectively, but it is not clear what accounts for the discrepancy between the two (Fishman, Washington, Haworth, et al., 2014). Nevertheless, the proportion of female *CityCycle* (Brisbane) members is greater than for private bike riding in Australia (Pucher, Greaves, & Garrard, 2010). Dublin's bike share gender split is 22% female (Murphy & Usher, 2015). Census data for Adelaide confirms that national relationship with cycling and gender, with males more like to ride to work than females.

In summary, bike share users are on average disproportionately of higher education and income, more likely to be male and white. The gender disparity does appear to be smaller, however, than for private bike riding.

4. Determinants of bike share use

4.1. User preferences

The motivations and preferences for using bike share is an area of interest to researchers, policy-makers as well as bike share program operators. An understanding of user preferences is also of vital interest to Adelaide, as any future program must be cognisant of the factors that encourage and inhibit usage. This is considered to be especially important given the low usage rates seen in Melbourne and Brisbane's experience with bike share.

As many bike share programs require those signing up for a monthly or annual membership to provide an email address, operators have been able to gauge the views of members with relative ease, via emailed online surveys. This section provides a review of literature regarding the results of these activities.

Convenience is the major perceived benefit identified by bike share users (Fishman, 2015). *Capital Bikeshare* in Washington, D.C. conduct regular surveys of their members. In 2013 some 11,100 members (50% of total membership) were emailed a survey (response rate 34%). The main benefit identified by respondents was enhanced convenience provided by bike share (LDA Consulting, 2013). Specifically, some 69% of respondents noted get around more easily, faster, shorter as *'very important'* in their motivation for bike share use. This finding is consistent with earlier studies of this program (LDA Consulting, 2012), as well as similar surveys of bike share users in London (Transport for London, 2014), and a multi-system North American survey (Shaheen et al., 2013). Research on Australia's two bike share programs (*Melbourne Bike Share* and *CityCycle*) also found that *convenience* is the main motivating factor (Fishman, Washington, Haworth, et al., 2014). Figure 6 provides an illustration of motivating factors for bike share sign up, as provided by existing *CityCycle* and *Melbourne Bike Share* annual members (surveys completed in October 2012).

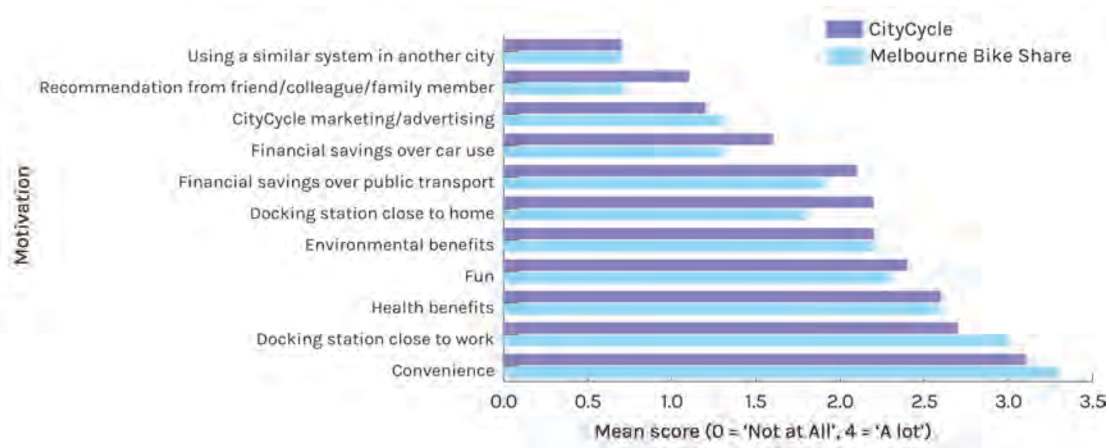


Figure 6 What motivated you to become a CityCycle/Melbourne Bike Share member?

Source: Fishman, Washington, Haworth, et al. (2014)

As noted earlier, *convenience* is the predominant motivation, with proximity between work and closest docking station identified as the second strongest motivator (which could also be argued falls under the *convenience* theme). Other research has shown the importance of docking station proximity to *home*. For instance, Bachand-Marleau, Lee, and El-Geneidy (2012) found Montreal respondents living within 500 metres of a docking station were 3.2 times more likely to have used bike share. One possible explanation for why this did not emerge from the Australian research is that the docking station catchment is overwhelmingly located in employment rather than residential districts (Fishman, Washington, Haworth, et al., 2014).

Saving money has also been found to be a motivating factor for members of some bike share programs (though a weak motivation in Figure 6). For low income members of *Capital Bikeshare*, over 70% of respondents note saving money on transport is an important sign-up motivation (LDA Consulting, 2013). In a related finding from a London study, bike share members who were residents of poorer areas had higher trip rates than members of more affluent suburbs (Ogilvie & Goodman, 2012). One possible reason why financial savings did not feature as a strong motivation for Australian bike share members may be because they had a vastly higher income than the general population (E. Fishman, S. Washington, N. Haworth, et al., 2015). The docking station locations of Australian bike share programs are also overwhelming located in areas with higher household incomes.

4.1.1. User frequency

One of the somewhat surprising findings from investigations on bike share program user frequency is that, on the whole, members are not particularly frequent bike share users. In London, almost half (49%) of members responding to a Transport for London survey reported *not* having used the service once in the past month (Transport for London, 2014). In Washington, D.C., some 21% female *Capital Bikeshare* members reported no rides in a typical month, compared to 13% for men (Buck et al., 2013). In an Australian study, almost half (46%) of annual members recorded no trips in the previous month and only 14% use the system everyday (Fishman, Washington, Haworth, et al., 2014). Results on user frequency, for the purposes of commuting, for Australia's two bike share programs are shown in Figure 7.

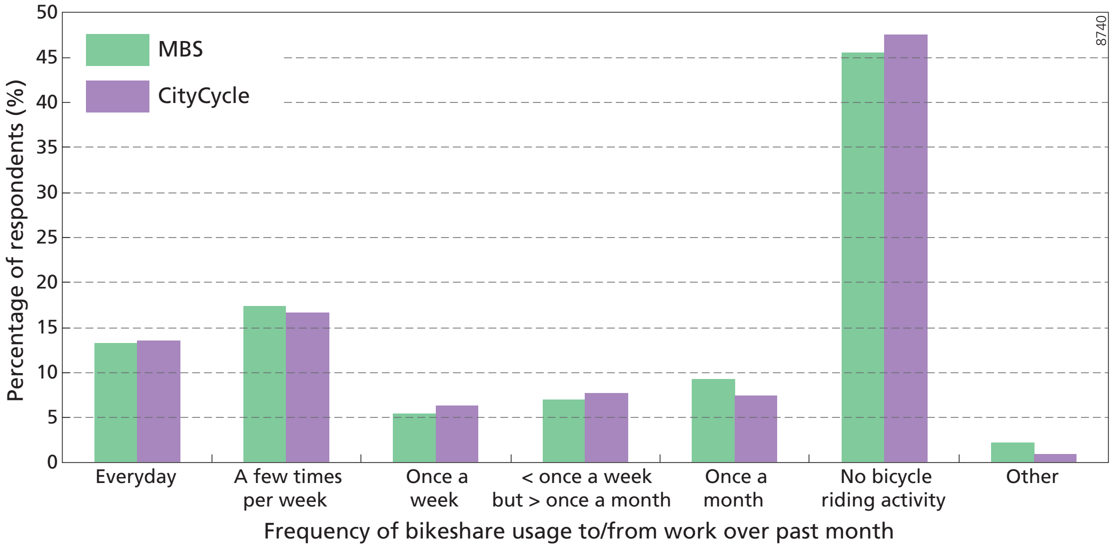


Figure 7 Frequency of bike share commuting over past month
Source: Fishman, Washington, Haworth, et al. (2014)

Based on the above data, it appears that many bike share subscribers may view bike share as an occasional adjunct to their primary and secondary transport modes. In focus group discussions with bike share members, a commonly reported motivation for signing up was a desire to show support for the government decision to initiate a bike share program (Fishman, Washington, & Haworth, 2012a) and this may help explain why around half of members report no usage in the previous month. One might also expect that this may be the case should Adelaide choose to establish a contemporary bike share program, i.e. those supportive of government efforts to encourage cycling in Adelaide sign up as members, even if they do not become regular users.

4.1.2. Trip purpose

The most common trip purpose for bike share appears to be somewhat dependent on the type of user. For instance, a survey of *Capital Bikeshare* users in Washington, D.C. reveals that the last trip for *long-term* members was work related for 43% of the sample, whereas this drops to 2% for *short-term* users (Buck et al., 2013). Similarly, in London, 52% of respondents of an annual member survey report that their last trip was commuting to/from work, with no other trip purpose accounting for more than 10% (Transport for London, 2014). The day the survey was taken is not identified and this may influence results, as a weekend survey distribution is likely to show higher levels of social trips. In Brisbane, 65% of *CityCycle* casual users report that their main trip purpose for their last *CityCycle* journey was *'leisure or sightseeing'*, whereas for long-term subscribers, only 14% recorded this as the purpose of their last trip. Long-term users are much more likely to report using *CityCycle* for work trips (Roy Morgan Research, 2013).

Among the most detailed description of bike share trip purpose, LDA Consulting (2013) identified that trip purpose can vary by residential location, age, gender, ethnicity and whether the member has a car available for their use. Women were found to be more likely to report making errands by bike share, whereas men were more likely to report commute trips by bike share (LDA Consulting, 2013).

4.1.3. Voluntary helmet use and bike share

A consistent theme emerging from the literature on bike share and helmets is that in jurisdictions in which helmet use is voluntary, bike share users are less likely to wear a helmet than a private bike rider in the same city. For instance, an observational study has found US bike share riders are four times *less* likely to wear a helmet than private bike riders in the same cities, controlling for age and gender (Fischer et al., 2012). In London, 16% of bike share riders wear helmets, compared to 64% for those on private bikes (Goodman, Green, & Woodcock, 2013). A recent study in New York City found some 85% *Citi Bike* users do not wear a helmet (Basch, Zagnit, Rajan, Ethan, & Basch, 2014) and 45% of *Capital Bikeshare* surveyed members report *never* wearing a helmet (LDA Consulting, 2013).

Interestingly, helmet use appears to vary considerably depending on whether the bike share user is a long-term or short-term subscriber. For instance, in a study by Buck et al. (2013), 94% of short-term subscribers did not wear a helmet, compared to 63% for long-term subscribers. An explanation for this difference might be that short-term subscribers may be more likely to take spontaneous trips, in which they did not have a helmet with them. Previous research has revealed a reluctance to carry a helmet on the chance they will use bike share spontaneously at some point during the day (Fishman et al., 2012a).

4.1.4. Geospatial analysis of bike share usage – Melbourne

Melbourne bike share operators provided the author of this report with detailed information on bike share usage. As with other 3rd generation bike share programs, each trip on *Melbourne Bike Share* is automatically logged, with the use of Radio Frequency ID tags on each bicycle. Every trip that took place on *Melbourne Bike Share* in November 2012 has been included in this analysis, which includes 13,713 individual trips. Figure 8 highlights the relationship between stations (i.e. dominant travel between one station and another). Any two stations recording more than 50 trips between them have been represented with a blue line. The width of the line corresponds with the number of trips occurring between the two stations (see Legend). Public transit accessibility has also been included, using the established Public Transport Accessibility Levels (PTAL) methodology (Transport for London, 2010). The PTAL is divided into 6 levels (1 - 6), with 6 representing high accessibility (shown as dark areas in Figure 8).[1]

[1] Public Transport Accessibility Levels (PTALs) are a measure of the accessibility of a point

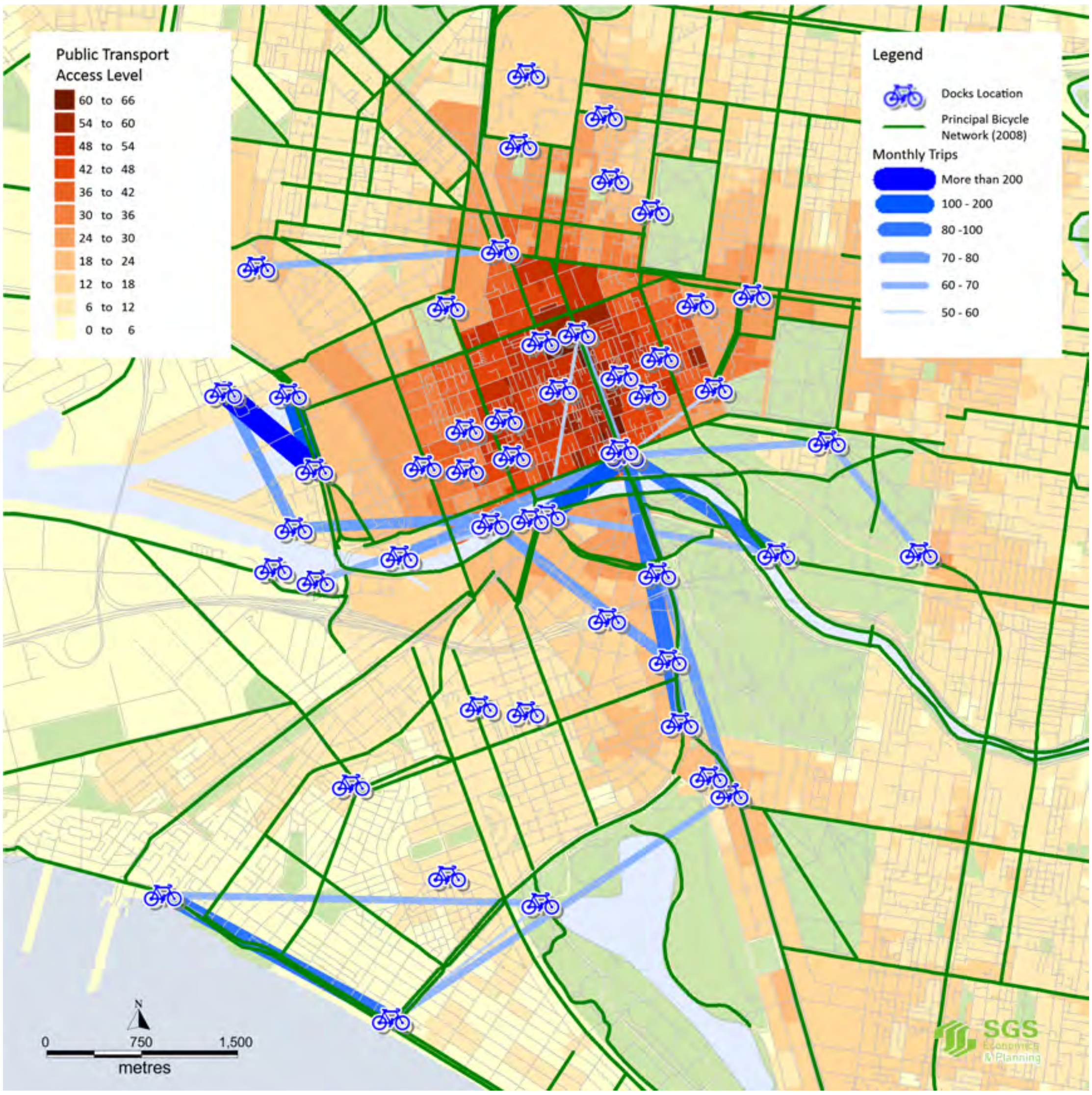


Figure 8 Major relationships between docking stations, Melbourne Bike Share, November 2012

Source: Fishman, Washington, Haworth, et al. (2014)

Many of the strongest trip patterns shown in Figure 8 occur between stations located in areas of relatively weak public transport accessibility. This may be explained by the journey time competitiveness of bike share in these areas. Travel time is a key determinant of mode choice (Sener, Eluru, & Bhat, 2009), and it is likely the increased utility afforded by bike share in areas of lower public transport accessibility may help explain the relationships illustrated in Figure 8. This is consistent with research conducted in Helsinki that found the greatest travel time savings associated with bike share and public transport can be found in areas in which the public transport network is less developed (Jäppinen, Toivonen, & Salonen, 2013).

The implication of the above finding for Adelaide is that the design of any future bike share program should be cognisant of public transport accessibility, in order to provide a network of docking stations capable of complementing public transport, and helping to reduce door-to-door travel times. A focus on the potential for bike share to offer the user with a distinct competitive advantage is an important consideration in the design of a bike share catchment.

4.2. Determinants of bike share use in Australia

Given the substantially lower usage levels of bike share systems in Australia, an examination of the factors associated with bike share usage in Brisbane and Melbourne is warranted. The purpose of such an examination is to assist Adelaide as it investigates possible options for the design of a bike share program.

In 2012 a study was conducted on members of the Brisbane and Melbourne bike share programs, to understand the factors influencing their decision to join, and gain insights into how they use the system. Given the low usage level, particularly of the *CityCycle* program, the researchers also used a control of Brisbane residents with no known relationship to bike share, known as the *InSPiRS Panel* (E. Fishman, S. Washington, N. Haworth, et al., 2015). Sample numbers and response rates are identified in Table 1. The low sample number for non-members has been addressed through weighting.

	Melbourne Bike Share	*CityCycle*	InSPiRS Panel
Sample sent invitation email	921	2,490[2]	436
Successfully received emails	914	2,357	311
Fully completed surveys received	372	443	60
Response rate	40.7%	18.8%	19.3%

Table 1 Sample size and response rates

Source: Fishman, Washington, Haworth, & Watson (2015)

The surveys were launched in mid November 2012 and were open for two weeks. Sample groups were sent a reminder email after one week, with the exception of the *CityCycle* group, as the bike share operator has a policy of not sending more than one email per month to members. This lack of reminder email for the *CityCycle* group is suspected as the reason for their lower response rate compared to the *Melbourne Bike Share* sample. The survey questions employed significant branching and logic, to customise the questions based on responses to previous questions.

4.2.1. Results

An examination of the survey results revealed similarities between bike share member groups and differences between these members and the *InSPiRS Panel* (non-members). Bike share members differed from the *InSPiRS Panel* in that they are significantly younger, more likely to know the

[2] Of these, 1,926 were to annual members.

distance between their home and work to their closest docking station, have pre tax incomes above $104,000 per annum and have friends or family who are bike share members. Moreover, bike share members were considerably more likely to have ridden a bicycle in the month prior to undertaking the survey. Bike share members are shown in Table 2 to be disproportionately male, and this is generally consistent with previous research, as mentioned above, showing higher cycling levels among males in Australia (Pucher et al., 2010). A little over three quarters of *Melbourne Bike Share* respondents were male, compared to just over 60% for *CityCycle* respondents. A Chi-Square test showed that there were statistically significant gender differences between the sample of bike share members and non-members.

Table 2 presents the key results between the three sample groups. The most frequent age range from the Census is somewhat younger than bike share groups, and considerably younger than the *InSPiRS Panel*. This may reflect the fact that respondents to this study were required to be 18 years or older. When removing those under 18 years from the Census data, the distribution of age ranges show considerable similarity between bike share groups. Bike share members are more heavily represented within the 25 – 44 age band. By contrast, the *InSPiRS Panel* shows a larger proportion within the 50 – 64 age brackets.

Variable		Melbourne Bike Share	CityCycle	InSPiRS Panel	Greater Melbourne	Greater Brisbane
Most frequent age range		30 - 34 (16.9%)	30 – 34 (16.6.%)	55 - 59 (19.8%)	25-29 (7.9%)	25-29 (7.6%)
Male		N = 285 (76.6%)	N = 265 (59.8%)	N = 25 (41.7%)	49.2%	49.3%
Female		N = 87 (23.4%)	N = 178 (40.2%)	N = 35 (58.3%)	50.8%	50.7%
Mean distance between home & work		10.7km (SD 9.5)	8.6km (SD 7.7)	13.2km (SD 10.4)	10km[*]	15.3km[#]
Percentage living within 500m of a docking station		44%	54.1%	5%^	NA	NA
Percentage working within 500m of a docking station		83.9%	83.6%	15%^	NA	NA
Annual income range	**Less than $41,599**	7.6%	14.9%	21.7%	56.8%	55.4%
	$41,600 - $77,999	20.0%	28.0%	48.3%	22.6%	24.0%
	$78,000 - $103,999	19.2%	22.3%	15.0%	6.4%	7.0%
	$104,000 or more	43.0%	26.9%	5.0%	6.5%	6.3%
	No response	10.3%	7.9%	10.0%	7.6%	7.2%
Car ownership		76.6%	80.4%	100%	NA	NA
Free car park at work		19.9%	26%	63.3%	NA	NA
Mean number of family/friends who are bikeshare members		0.59 (SD 0.87)	0.95 (SD 1.10)	0.05 (SD 0.28)	NA	NA
Most frequently reported bicycle riding activity in past month		16+ trips (35.8%)	16+ trips (33%)	No bicycle riding activity (75%)	NA	NA

Table 2 Bike share user characteristics compared to non-members

∞Australian Bureau of Statistics (2012)

^Approximately 50% of InSPiRS members responded Don't know in relation to the distance between their home and work and closest docking station

[#] ABS 2006 Census, for South East Queensland (cited in Doonan, 2010)

[*] ABS 2011 Census, reporting median distance (cited in Department of Transport Planning and Local Infrastructure, 2013)

The highest level of education varied considerably between sample groups, and these groups differed substantially from Greater Melbourne and Greater Brisbane Census data. As shown in Figure 9, bike share members achieved higher education levels than both the *InSPiRS Panel* members and the general population in both cities. For instance, some 81% and 77% of *Melbourne Bike Share* and *CityCycle* members respectively have Bachelor's Degree or higher, compared to 50% for *InSPiRS Panel* members and 22% and 18% for Greater Melbourne and Greater Brisbane. Previous research has found similar results with respect to the educational attainment of bike share users (Shaheen et al., 2012).

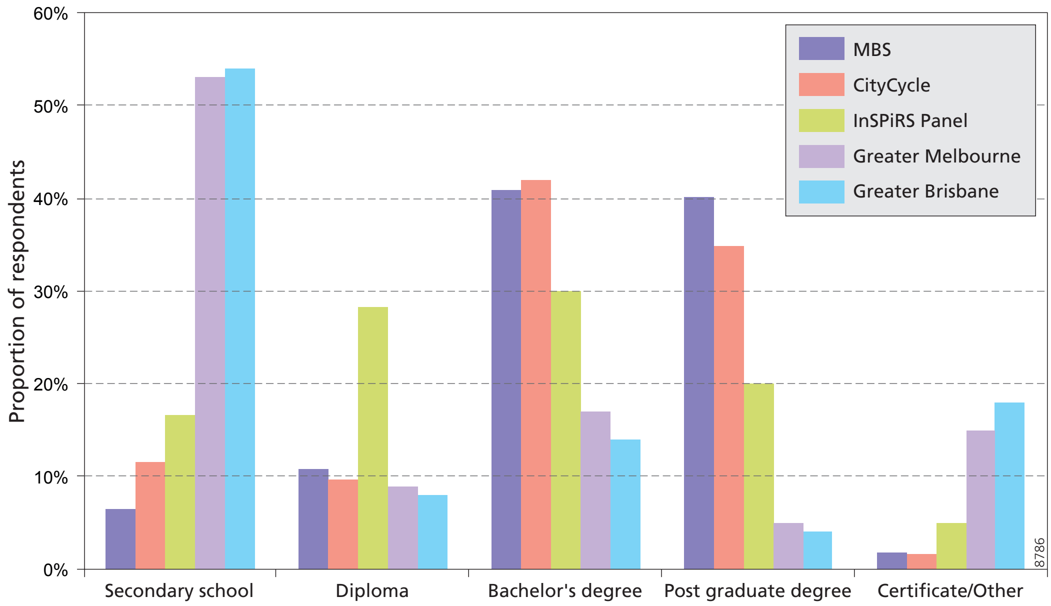


Figure 9 Highest level of educational attainment
Source: Fishman, Washington, Haworth et al. (2015)

In addition to the aforementioned demographic contrasts, a number of other differences that may influence bike share membership were apparent. Work place bicycle end of trip facilities (such as showers and lockers) were more likely to be available at workplaces of bike share members than the *InSPiRS Panel* sample (72% and 71% for *Melbourne Bike Share* and *CityCycle*, compared to 52% for *InSPiRS Panel* members). Bike share members were also more likely to have a friend or family member who were bike share members (41% and 56% for *Melbourne Bike Share* and *CityCycle* members respectively, compared to just 3% for *InSPiRS Panel* members).

Respondents were asked their main mode of transport for their most recent journey to work. The results indicate that around one fifth of bike share members used bike share as their main mode, with a similar proportion travelling on a private bike. By contrast, Census data reveal that private bike travel constitutes the main mode in less than 2% of trips in both Greater Melbourne and Greater Brisbane (and similar for Adelaide). No *InSPiRS Panel* members nominated either public or private bikes as their main mode to work on the day the survey was undertaken. Full results are shown in Figure 10.

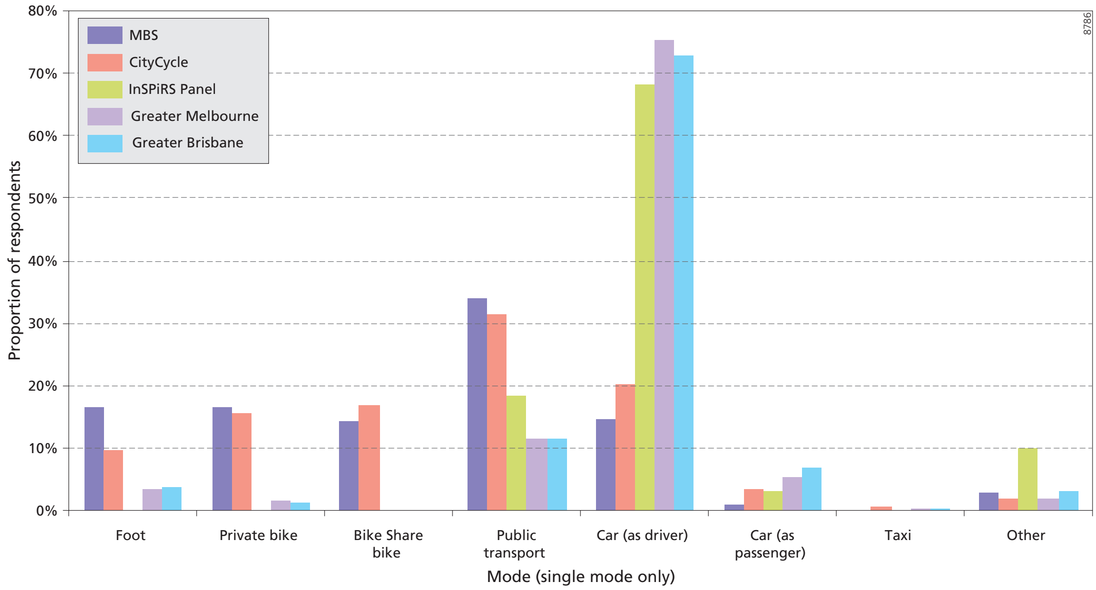


Figure 10 Mode of most recent journey to work

Source: Fishman, Washington, Haworth et al. (2015)

Safety concerns are a well-known barrier to bicycle riding, in the UK (Horton, Rosen, & Cox, 2007), the US (Gardner, 2002) and Australia (Queensland Parliamentary Committee, 2013). Survey respondents were shown images of three bicycle riding environments (separated on-street bike lane, painted bike lane and no bike infrastructure) and asked to rate how safe they would feel riding in these environments. Figure 11 presents the results for a separated bike lane.

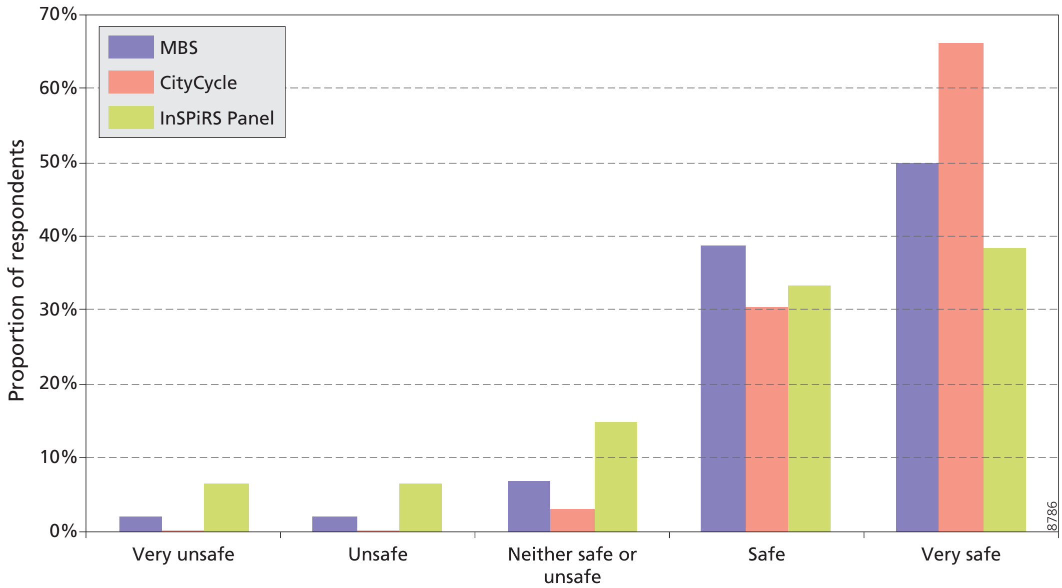


Figure 11 How safe do you feel riding on a separated lane/path?

Source: Fishman, Washington, Haworth et al. (2015)

The results indicate the majority, across all sample groups would feel *safe* or *very safe* riding on separated bicycle infrastructure, which is consistent with previous research (Wardman, Tight, & Page, 2007). By contrast, when presented with no bicycle infrastructure, an overwhelming proportion of respondents, across all groups, reported feeling *very unsafe* or *unsafe*, as illustrated in Figure 12 below. Whilst the level of bicycle infrastructure has improved in Melbourne and Brisbane over recent years, substantial areas within the *Melbourne Bike Share* and *CityCycle* catchment have no bicycle infrastructure and the infrastructure that does exist is frequently disconnected, with the exception of waterway paths. These data may have implications for Adelaide, which also lacks a coherent system of high quality bicycle infrastructure that provides continuous routes between origins and destinations. These findings underline the importance of the three components of transport systems referred to earlier, from the work of Shoup (2005), particularly in relation to *rights of way*. What is clear from the international and domestic research on bike share is that programs perform poorly without high levels of connected, coherent bicycle infrastructure, including segregation on heavily trafficked streets.

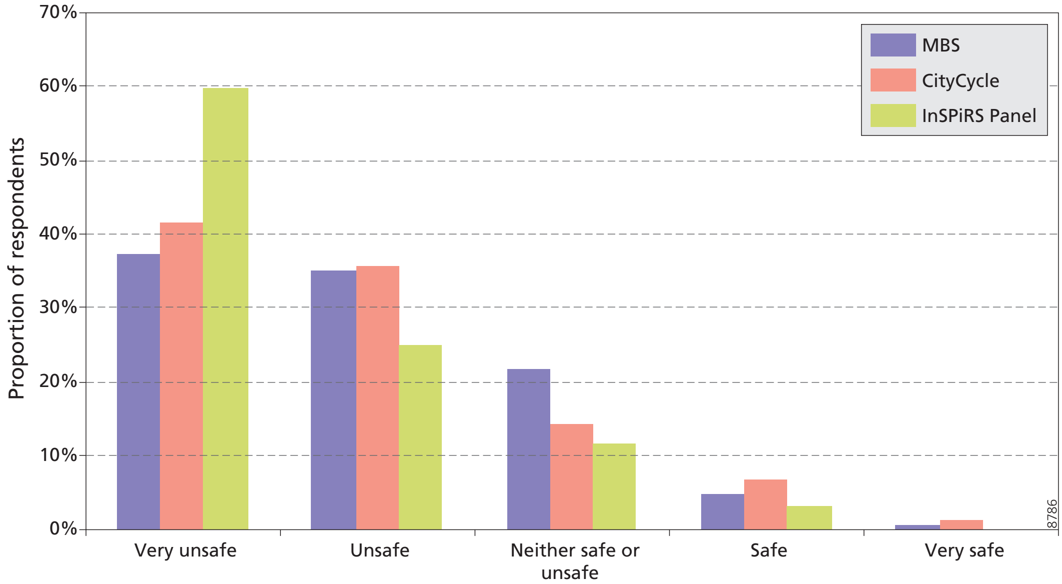


Figure 12 How safe do you feel when riding on road with no bike lane?

Source: Fishman, Washington, Haworth et al. (2015)

4.2.2. Logistic regression model

A wide range of variables were tested for inclusion in the model to predict bike share membership. The variables that provided the optimum predictive capability of bike share membership were included in the model and are presented in Table 3. The Pseudo R^2 is 0.30, suggesting that significant factors that influence membership are omitted from the model or that unknown factors influence membership.

Variables included in the model	Level/Referent	z-statistic	Coefficient	Sig.	Odds ratio	Odds Ratio 95%CI
Impact of mandatory helmet legislation on riding (0 = does not reduce riding, 1 = reduces riding)	Does not reduce riding	5.85	3.20	<0.001	24.5	8.4 – 71.6
Riding activity in the past month (0 = No riding, 1 = Riding)	No riding	32.33	1.75	0.020	5.8	1.3 – 25.3
Convenience as an encouraging factor for private bike riding (1 = Not at all, 5 = A lot)	Not at all	2.29	0.65	0.022	1.9#	1.09 – 3.33
Age (0 = 35 years and over, 1 = 18 - 34)	35 years and over	2.0	1.2	0.047	3.3	1.02 – 10.83
Income (1 = $10,400 or less, 10 = $104,000 or more)	<$10,400	2.51	0.27	0.012	1.3#	1.06 – 1.61
Work within 250m of docking station (0 = No, 1 = Yes)	No	7.18	3.40	<0.001	29.9	11.81 – 75.49
Constant		-8.76	-13.86	<0.001	9.56e-07	4.30e-08 – 0.0000212

Table 3 Logistic regression analysis

#This value is cumulative, meaning that for each higher increment, the odds of being a bikeshare member increases by the OR

Source: Fishman, Washington, Haworth et al. (2015)

Respondents were asked whether the legal requirement to wear a bike helmet affects how often they ride.[3] Responding that compulsory helmet requirements reduce riding frequency was found to *increase* their odds of being a bikeshare member (Odds Ratio 24.5). This is a somewhat peculiar result, given that those who feel mandatory helmet legislation reduces their riding frequency were also found to be *more* likely to report having ridden in the previous month. It is suspected that this variable may be *endogenous*. Indeed this variable may be reflecting scheme members' *opinion* on mandatory helmet use rather than that same person's proclivity to use bike share. Finally, the confidence interval for this variable is large, which lowers our confidence in this estimate.

Riding activity in the previous month was found to be a reliable predictor of bike share membership. Riding at least once in the previous month was associated with a 5.8 fold increase in the odds of being a bike share member compared to those who reported no bike riding in the month prior to undertaking the survey. This is generally consistent with previous research, which has found those who ride a private bike are more likely to be bike share members. It is further supported by the notion that there are, in broad terms, two categories of barrier to bike share usage. The first relates to barriers to riding in general (such as safety perceptions or distance). The second concerns bike share specific barriers (such as lack of close proximity to docking stations). By definition, regular bike riders have not found the first set of barriers insurmountable and therefore find fewer barriers to the use of bike share. It is this reasoning that may be useful for cities seeking to establish a bike share program. Catchment design may focus on areas of the city in which riding levels are relatively high. For Adelaide, Unley may offer a good example, as it has relatively high rates of commuter cycling (around 4.5%, compared to around 1.2% for the Greater Adelaide region), yet clearly substantial potential for growth exists (over 95% of Unley residents did not cycle on Census day). Bike share, especially as part of a wider package of policies supportive of cycling may help realise this growth.

The level of convenience respondents associated with private bike riding was found to be a significant predictor of bike share membership. Respondents were asked to what degree convenience acts as an encouragement to private bike riding, using a 1 – 5 scale from *'Not at all'* to *'A lot'*. Each increment towards *'A lot'* increased the odds of bikeshare membership 1.9 fold. This corresponds with research on motivation for *public* bike riding, with consultant reports on the *Melbourne Bike Share* program, peer-reviewed research on the *CityCycle* scheme (Fishman et al., 2012a) and North American research (Shaheen, Martin, Cohen, & Finson, 2012).

---

[3] Actual question: *The legal requirement to wear a bicycle helmet* a) Does not affect how often I ride, b) Somewhat reduces how often I ride or c) Significantly reduces how often I ride. Option b and c were collapsed.

Those aged 18 – 34 had 3.3 fold greater odds of being a bike share member than all other age groups. Previous research cited earlier show bike share members are typically younger than the general adult population. Income (pre-tax) was found to be a significant predictor of bike share membership. Each higher increment along a 10-point scale (less than $10,400 to $104,000 +) was associated with a 1.3 fold increase in the odds of being a bike share member.

One of the most powerful determinants of bike share membership is the distance between their home and their closest docking station. Respondents who indicated they work within 250m of a docking station had 29.9 fold greater odds of being a bike share member. The confidence interval for this variable was large however, which reduces our confidence in this estimate. As shown in Table 2, bike share members were considerably more likely to work rather than live within 500m of a docking station. This finding may be influenced by the configuration of the bike share docking station catchments and this is especially so for Melbourne. The *Melbourne Bike Share* program is particularly small relative to the size of the city (less than 600 bikes and a Greater Melbourne population of approximately four million). The docking stations are largely in the central employment district, rather than residential neighbourhoods. Therefore, the finding that distance between docking station and work was more powerful than the distance between home and docking station may be influenced by the current catchment configuration. Should Adelaide seek to introduce a bike share program is may be helpful to consider the merits of designing a catchment that connects where people live to where they work (i.e. including residential zones within the catchment), as well as integration with public transport nodes.

4.2.3. Application of logistic regression model

The logistic regression results are used to predict how changing variable values alter the odds of bike share membership. When variable values are held at their means, the probability of bike share membership is at or close to 0 – which broadly reflects the current usage of bike share in both Melbourne and Brisbane, in which only a very small proportion of the population are members. Nevertheless, as illustrated in some of the hypothetical scenarios below, it is possible to predict a relatively high probability of being a bike share member through the manipulation of key variables. The variable *Convenience as an encouraging factor for private bike riding*, in which respondents were asked to rate the level to which this statement is true (1 = Not at all, 5 = A lot) has been used as the horizontal axis in Figure 13, extrapolating the means, from 1 through to 5.

Income $104K+, work <250m docking describes a scenario in which incomes are set at their highest level and the distance between place of work and closest docking station is within 250m. In the second scenario, *Work <250m docking*, the settings are the same as the previous scenario, with the exception of the income variable, which has been left at the mean. The third scenario in Figure 13 holds values at their mean, with the exception of *riding in the previous month*, which has been changed to '*yes*'. The fourth scenario in

Figure 13 is identical to the previous scenario, with one crucial addition; the distance between work and the closest docking station is now *within 250m*. There is a considerable difference in the probability of bike share membership between these two scenarios, shown in Figure 13 and is indicative of the importance of proximity between workplace and docking station. The model/scenarios shown in Figure 13 may be useful for Adelaide as it provides an illustration of the influence of different variables on the probability of membership. As a system is designed, consideration of different attributes, in terms of their impact on membership levels, will help underpin the decision making process.

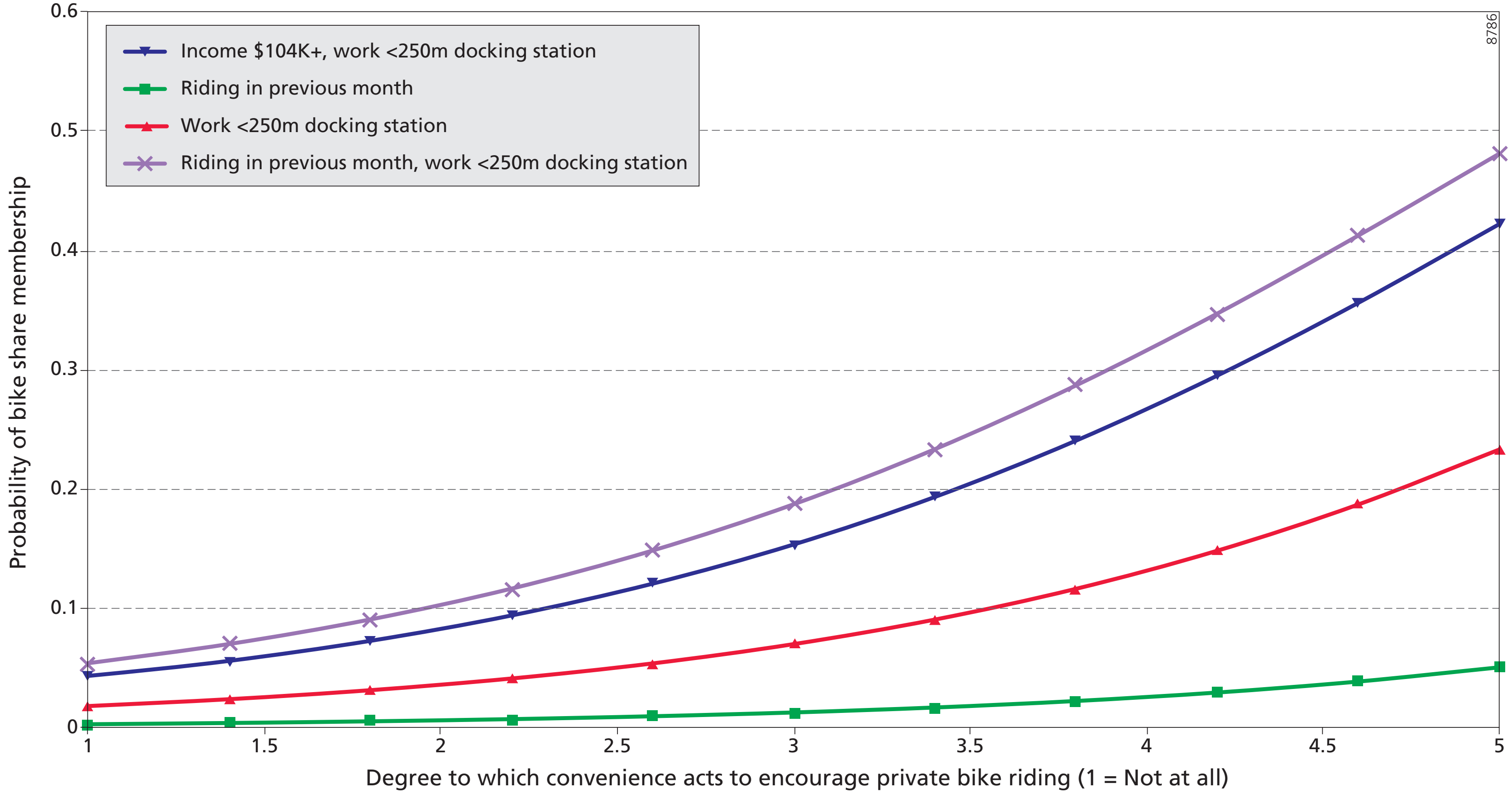


Figure 13 Probability of bike share membership under different scenarios, with convenience extended through its range of means

Source: Fishman, Washington, Haworth et al. (2015)

Figure 14 below uses the variable of *annual income* on the horizontal axis, to predict bike share membership, with five scenarios shown.

Highest scenario + no riding previous month differs from previous scenarios in that the means for each variable have not been selected by default. In this scenario, the means have intentionally been adjusted to the values most typical of a bike share member. Should this procedure be carried out for all variables, the probability of being a bike share member rises to 1. For illustrative purposes, this scenario has adjusted the riding activity variable to equal 0 (no riding in previous month), with probabilities rising from 0.09 at the lowest income bracket ($10,400 or less) to 0.52 at the highest income level ($104,000 +). *Highest scenario + riding previous month* can be understood based on the explanation of the previous scenario. Bike share membership probabilities rise from 0.36 to 0.86 from the lowest to highest income level. The difference between these two scenarios demonstrates the influence riding during the previous month has on increasing bike share membership probabilities.

Mandatory helmets reduce riding, convenience encourages riding, aged 18 – 34 illustrates a scenario in which the mandatory helmets variable has been adjusted to reduce riding and convenience has been adjusted to be a powerful motivator for riding a private bike (5 on a scale of 1 – 5). Moreover, the age category has been adjusted to include only those aged 18 – 34. The lowest income levels in this scenario shows a probability of bike share membership of 0.01, rising to 0.06 for the highest income bracket. The final scenario *No riding previous month, mandatory helmets reduce riding, aged 18 – 34* is similar to the previous scenario, however *convenience* has been replaced with no riding during the previous month. This case provides the lowest probability of membership for the scenarios shown in Figure 14, reaching a maximum probability of 0.01 at the highest income bracket.

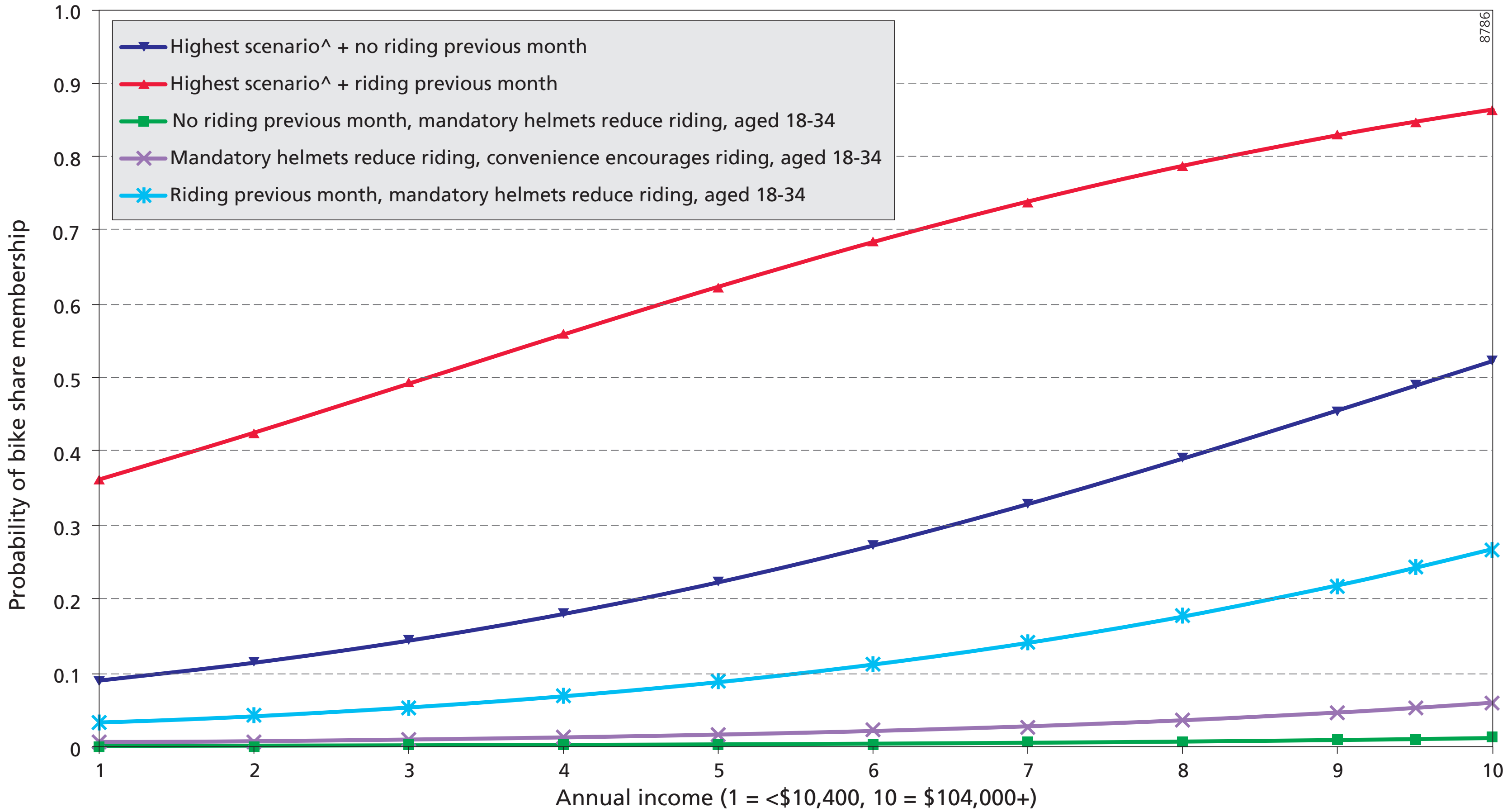


Figure 14 Probability of bike share membership under different scenarios, with income extended through its range of means

^This scenario includes being aged between 18 and 34, working within 250m of a docking station, convenience acting as a strong motivator for private bike riding, and mandatory helmets reducing bike riding.

Source: Fishman, Washington, Haworth et al. (2015)

4.2.4. Summary

This section has analysed the results of online surveys with bike share members and non-members to understand the factors influencing membership. The findings of this study provide Adelaide with an improved ability to understand how bike share may be designed to maximise usage levels, which is perhaps the greatest risk an Australian city faces when assessing bike share possibilities.

Consistent with previously reviewed material, *convenience* emerged as an important predictor of membership. Adelaide policy makers interested in maximising the performance of any future bike share program may wish to consider how the program competes with existing transport options, in terms of the *value proposition* it offers residents and visitors. The distance to the closest docking station for instance is something that was shown to have a very powerful impact of propensity to use bike share. Moreover, planning a bike share system capable of providing the *network benefits* that provide a compelling proposition to citizens is central to its success. Positioning docking stations around areas with relatively high levels of cycling, high-density residential and commercial development as well as those areas with large number of those aged under 35 may provide a fruitful method of boosting ridership. Areas of Adelaide in which car parking is heavily restricted, costly or unavailable may also prove to be areas with a higher likelihood of bike share use.

The differences in safety perceptions between bike share members and non-members when presented with different levels of infrastructure provision provide insights for government agencies with infrastructure responsibilities. Non-bike share members show lower levels of perceived safety in all bike-riding environments. This suggests an expansion of the bicycle infrastructure network, particularly separated bicycle lanes, may be useful in optimising the performance of any bike share program for Adelaide. Those on private bicycles will of course use these lanes as well, helping to improve their benefit cost ratio.

Finally, the results of this study related to helmet issues are complicated and it is difficult to draw clear conclusions. Whilst it is clear from a wide variety of previous research that mandatory helmet legislation (MHL) reduces bike share usage, further research may help increase our understanding of this issue and what measures may be taken to mitigate the negative impact MHL has on bike share usage.

5. Barriers to Bike Share

As is clear from the material reviewed earlier in this report, Australian bike share programs have had lower usage levels when compared to those operating in other countries. It has also been highlighted that the barriers to bike share in Australia warrant close examination, to help ensure cities seeking to introduce a new bike share program do not suffer from the low usage shown in Melbourne and Brisbane. There is a paucity of research examining barriers to bike share, in large part because of the difficulty associated with collecting responses from those without a known connection to bike share. The following section documents the key findings from the limited research gauging the views of those without a known involvement with bike share.

5.1. Convenience and safety

Driving is more convenient, docking stations are not close enough to my house & work and *I don't want to carry a helmet with me* all emerged as the most powerful barriers to bike share among those that have not become members, in a Brisbane based sample (Fishman, Washington, Haworth, et al., 2014). *Safety concerns* whilst riding in traffic also received among the highest mean scores and is consistent with the findings of previous research (Webster & Cunningham, 2012). Figure 15 provides the results to the question *'If you were considering joining CityCycle, to what extent would these factors discourage you?'.*

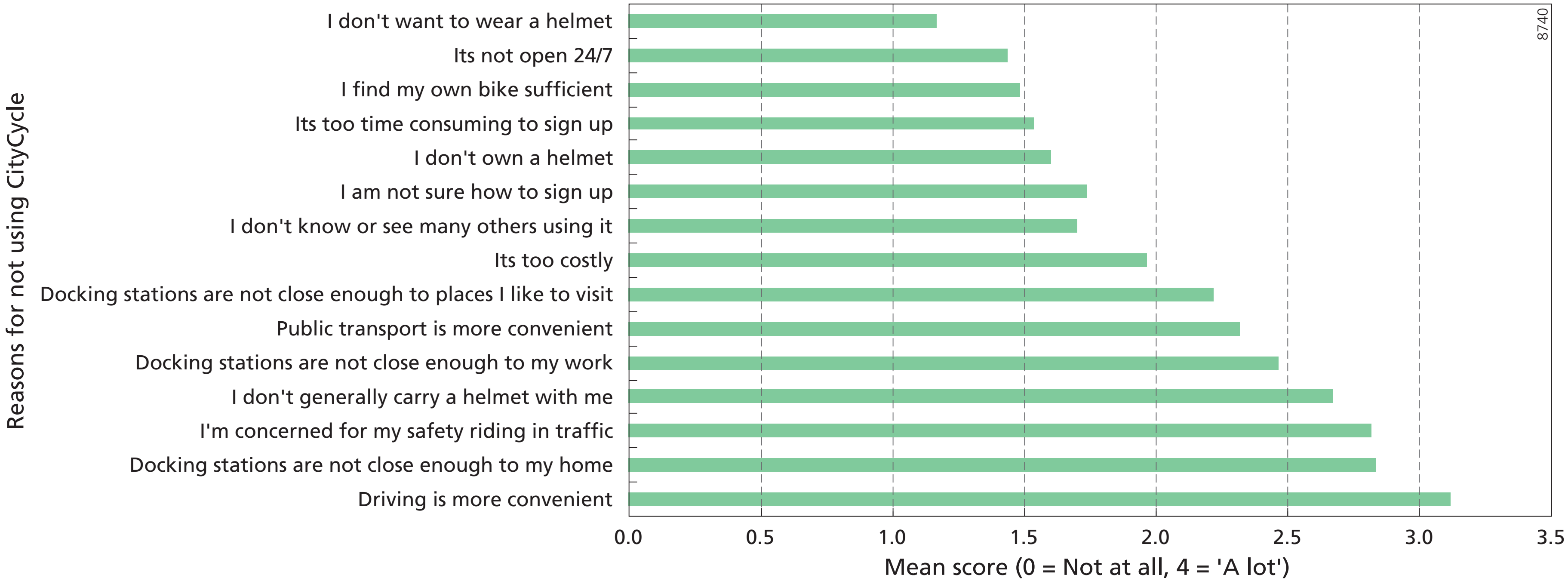


Figure 15 If you were considering joining CityCycle, to what extent would these factors discourage you?

Source: Fishman, Washington, Haworth, et al. (2014)

The same sample group was also asked what would *encourage* them to consider becoming a bike share member. Factors related to *safety* and *convenience* emerged as the strongest encouragement factors. *More bike lanes and paths* and *automatically open to GoCard*[4] *holders* receiving the strongest mean scores.

Interestingly, the third strongest factor was *nothing; I am not interested in using CityCycle, no matter what*. Relaxing mandatory helmet laws, which is frequently cited as a key reason for the lower usage of Australian bike share programs, received the lowest rating of all possible factors offered in the survey question. To some extent this may simply reflect the fact that these respondents were overwhelmingly non-bike riders. For those that do not ride a bike, there may be other factors more important than mandatory helmet legislation that prevents them from riding. Previously cited research found a lack of immediate access to helmets to be a critical barrier to bike share in countries in which they are mandatory (Fishman et al., 2012a). Helmet issues will be discussed further in Section 5.2.

[4] GoCard is the SmartCard public transport ticketing used in Brisbane.

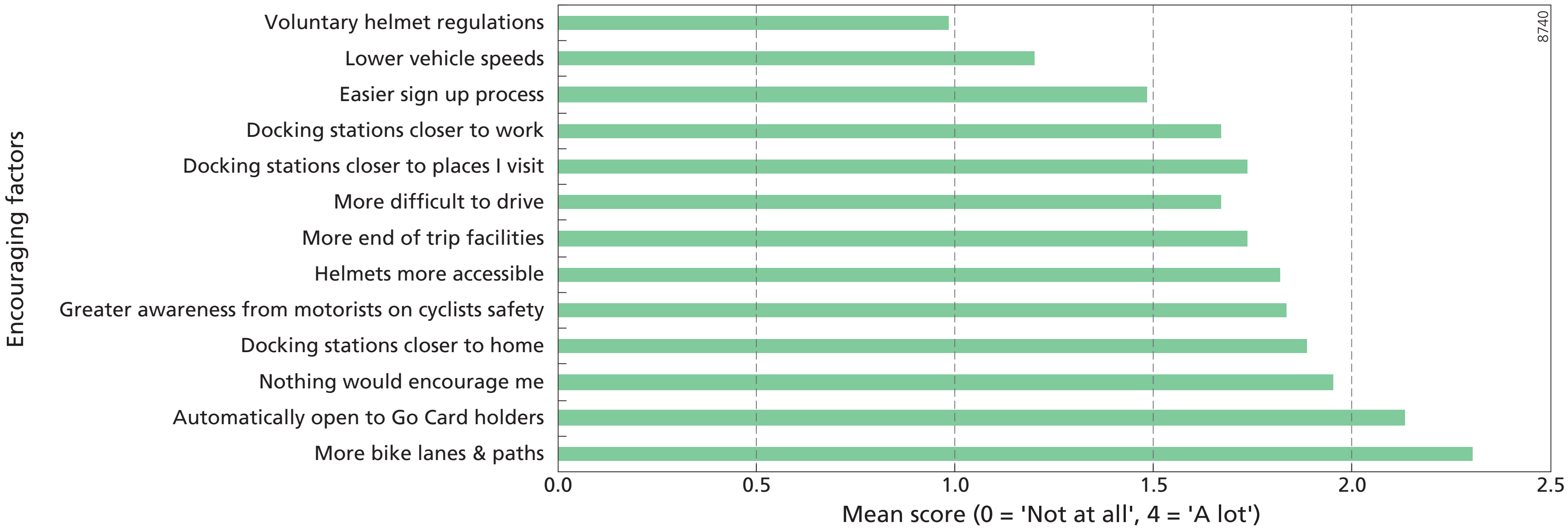


Figure 16 To what extent would these factors encourage you to become a CityCycle member?

Source: Fishman, Washington, Haworth, et al. (2014)

5.2.Mandatory Helmet Legislation

Helmets have emerged as a contentious issue for bike share (Basch, Ethan, Rajan, Samayoa-Kozlowsky, & Basch, 2013). In jurisdictions in which helmet use is mandated by law, such as Melbourne and Brisbane, helmets have prominently featured in bike share commentary (Fishman, 2012; Queensland Parliamentary Committee, 2013), and have been implicated in the significantly lower usage levels than other cities (Fishman, Washington, & Haworth, 2013; Oliver O'Brien, Cheshire, & Batty, 2014; Queensland Parliamentary Committee, 2013; Rissel, 2011; Traffix Group, 2012). Indeed Tel Aviv and Mexico City repealed their mandatory helmet law, as a pre-emptive move to boost usage levels (Flegenheimer, 2013a). It is interesting to note, however, that in the results illustrated in Figure 16, drawn from a sample with very low levels of cycling participation (of any kind), helmets did not feature as a major barrier to bike share. A distillation of the limited literature on this issue appears to suggest that for those who do not ride a bike, there are other, more important barriers to riding than mandatory helmet legislation, as highlighted previously.

For those that ride regularly, the requirement to carry a helmet has been shown to have a negative effect on bike share (Alta Bike Share, 2012; Alta Planning + Design, 2012; Fishman, 2014; Traffix Group, 2012). This is supported by what might be considered a naturalistic experiment (though the bike share operators did not call it as such), in which freely available helmets were placed on *CityCycle* bikes, and a significant increase in casual usage was recorded (Fishman et al., 2013), although this period coincided with the introduction of a more favourable pricing structure, it suggests increasing immediate access to helmets at the point of departure may help reduce the barrier presented by mandatory helmet legislation. This finding has direct implications for any Australian city seeking establish a bike share program. The City of Sydney has sought to request a relaxation of helmet requirements, in order to pave the way for a future bike share program in Sydney.

Six months after the launch of *Melbourne Bike Share,* the operators of the system conducted a market research exercise, motivated in part by lower than expected usage (Alta Bike Share, 2011). The survey was completed online by self-selected Internet users, and in the field by people walking in close proximity to a docking station. Just under 500 people were surveyed in each method and 31% of respondents had used *Melbourne Bike Share*. It is important to recognise that these survey methods limit the generalizability of the results, as the sample only includes people who have visited the *Melbourne Bike Share* website or walked past specific docking stations. Nevertheless, the survey revealed some interesting findings with regard to the barriers and motivators to using the scheme, as illustrated in Figure 17. In the period immediately following the launch of the *Melbourne Bike Share* program, little attempt had been made to offer helmets to prospective riders, and the impact of this is shown in Figure 17, with a lack of helmet availability being highest rating barrier, followed by not wanting to wear a helmet.

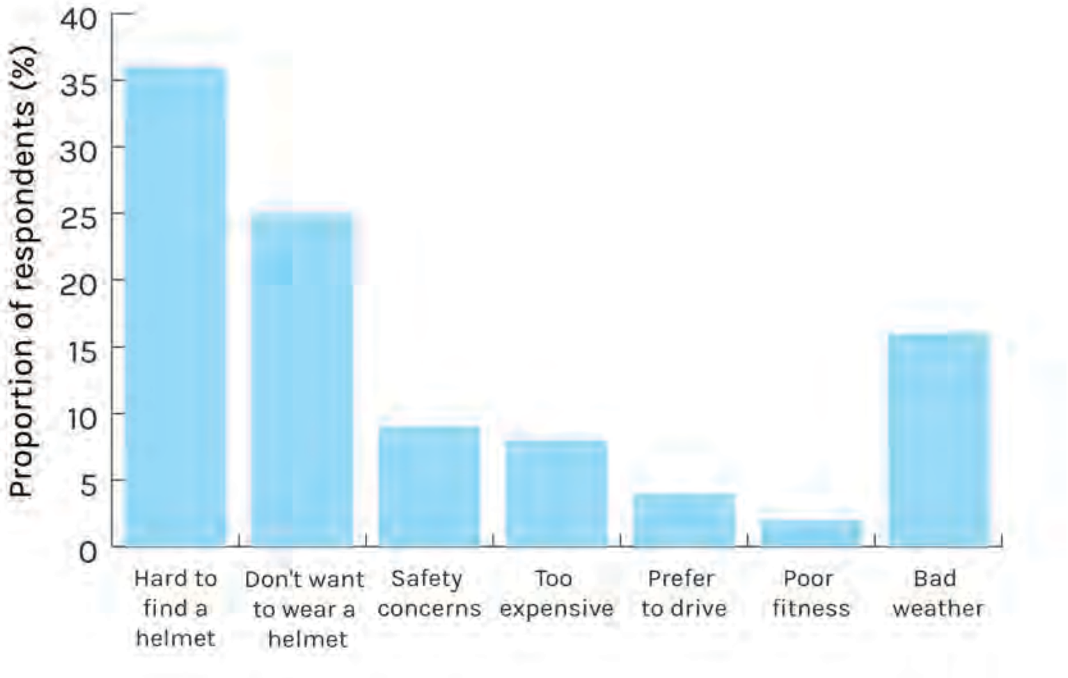


Figure 17 Barriers to using Melbourne Bike Share
Source: Alta Bike Share (2011)

In a customer satisfaction survey of *CityCycle* subscribers, one in three subscribers reported not wishing to re-subscribe (Roy Morgan Research, 2013), compared to 11% for London bike share members (Transport for London, 2014). When *CityCycle* subscribers were asked why they will not be renewing their subscription, 11% cited mandatory helmet laws as the main reason and a further 9% called for the removal of the helmet laws (Roy Morgan Research, 2013). Members of *Melbourne Bike Share* and *CityCycle* both reported using bike share less due to mandatory helmet legislation (Fishman & Schepers, 2014). Indeed the lower than expected usage of *CityCycle* prompted a Queensland Parliamentary Committee to recommend:

> a 24 month trial which exempts cyclists aged 16 years and over from the mandatory helmet road use when riding in parks, on footpaths, and shared/cycle paths and on roads with a speed limit of 60km/h or less. (Queensland Parliamentary Committee, 2013, p. xvii)

As of January 2016, the Queensland Government had not chosen to accept this recommendation.

Australia is not the only jurisdiction with mandatory helmet legislation (MHL). Seattle, Washington offers another example of a city with a bike share program (known as *Pronto*) and mandatory helmet legislation. *Pronto* has been in operation since 2014 and free helmets are available at docking stations. The feasibility study for *Pronto* estimated a 30% reduction in usage due to the mandatory helmet laws (Alta Planning + Design, 2012), although it was not clear how this figure was determined. The strategy employed by *Pronto* to limit the deterrent impact of MHL is to place two large bins at either end of each docking station, with one reserved for unused helmets, and another for people to deposit their used helmets. These bins are sponsored by a local hospital and it is thought the low level of misuse is in part due to the association with a health care establishment. Nevertheless, the Seattle bike share program has suffered from low usage levels than other large city programs in the US and is currently in financial difficulty, in part due to lower than expected usage. In Melbourne, anecdotal reports suggest the vast majority of *Melbourne Bike Share* provided helmets are actually used on private bikes.

5.3. Sign up process

The speed and ease with which people are able to sign up to a bike share program can have an impact on likelihood of using the program. The vast majority of 3rd generation bike share systems allow prospective users to sign up on the spot, with a credit card. Where this is not the case, users and would-be users have reported the lack of immediate sign-up is a barrier to usage (Fishman et al., 2012a). This section documents the experience of *CityCycle*, which is among the few modern bike share programs in English-speaking countries not to offer automated sign-up at docking stations.

The Brisbane City Council commissioned a survey of registered *CityCycle* users (Roy Morgan Research, 2013), emailed to 13,495 long and short-term subscribers with a response rate of 11.5%. The results showed that one in three *CityCycle* users report not wishing to re-subscribe, with the complex subscription process noted as one of the key reasons short-term subscribers are not repeat *CityCycle* users. Moreover, the complex subscription process was highlighted by 54% of short-term local subscribers as the main area requiring improvement, many of whom noted they would not return as *CityCycle* users (Roy Morgan Research, 2013). The *CityCycle* experience offers an important lesson for cities such as Adelaide, currently in the process of exploring bike share options. A clear theme emerging from the available research shows that bike share users and '*would be*' users value bike share's spontaneity (Fishman et al., 2012a) and policies should seek to minimise hurdles associated with becoming bike share users. A number of barriers are presented to prospective *CityCycle* users. In addition to not accepting credit card swipe on the spot, users are required to call a number, during office hours, to manually sign up to the program. Initially, these callers were required to listen to up to 24 minutes of legal disclaimer notices before being granted access to the bicycles. Users could of course sign up on line, but would have to wait between 5 – 10 days before receiving their membership material. With most bike share trips under 16 minutes, it appears members of the public viewed these delays as unreasonable and chose to make alternative travel arrangements. This was a lost opportunity that failed to capitalise on the interest people had in trying Brisbane's bike share program.

In summary, the major barriers to bike share relate to a lack of convenience and competitive advantage with other modes, safety concerns and anything that impedes spontaneity. There is a critical paucity of research with large samples of those who are not bike share members and this needs to be addressed in order to better understand how bike share can be tailored to be more attractive to those who do not currently view it as a viable option. In relation to spontaneity, the obvious implication for Adelaide is that any future system must ensure sign up can occur within one or two minutes, at any time of day or night, and without the need to call the bike share operator (as is the case in Brisbane). For a more detailed account of barriers to bike share, with an emphasis on the Australian context, readers are encouraged to see Fishman et al. (2014).

6. Impacts of bike share

There are a number of purported benefits of bike share, including travel time saving, connection with public transport, as well as health, air and noise pollution benefits (Shaheen et al., 2013). Added to these is the possibility that bike share may serve to normalise the image of cycling (Goodman et al., 2013) and reduce congestion. Implicit in many of the benefits associated with bike share is an assumption that bike share is used to replace trips previously made by car. Whilst there is no doubt that some bike share users are riding in replacement of a trip formally done by car, the data suggest this is seldom the case (Fishman, Washington, Haworth, et al., 2014; Midgley, 2011). This section examines the few studies that have evaluated the impacts of bike share, on car use, health and safety.

6.1. Car Use Reduction/Mode Substitution

A consistent theme to emerge from the literature on the mode bike share replaces (mode substitution) is that most of the trips are replacing trips formerly made by public transport and walking (Fishman, Washington, & Haworth, 2014). This finding is crucial to the impacts of bike share, as the benefits are largely (but not wholly) limited to the degree to which bike share reduces car use.

A study of a bike share program in Shanghai, China showed that the majority of users are replacing walking and public transport (Zhu, Pang, Wang, & Timmermans, 2013). The mode substitution rate for a selection of bike share programs is provided in Figure 18:

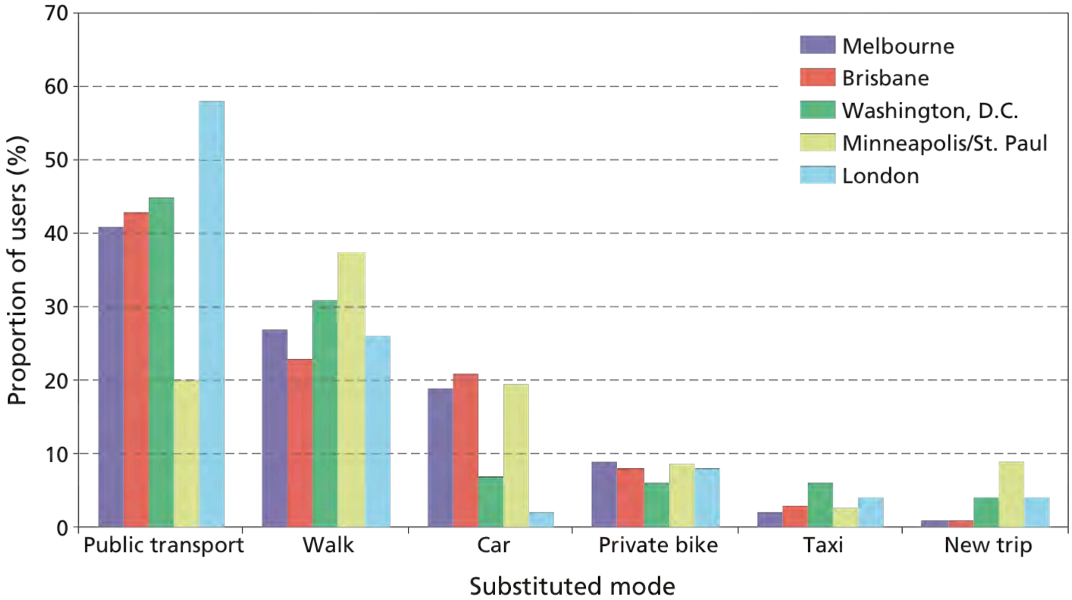


Figure 18 Mode substitution in selected cities

Source: Melbourne and Brisbane (Fishman, Washington, & Haworth, 2014), Washington, D.C. (LDA Consulting, 2012), Minnesota (Nice Ride Minnesota, 2010) and London (Transport for London, 2011)

A number of additional metrics are required before any assessment of the impacts of bike share can be determined. Table 5 provides a summary of many of these key indicators, for a selection of cities with operational bike share programs. The key metrics include the number of trips and trip duration.

	Melbourne	Brisbane	Washington, D.C.	Minnesota	London
Bikes	600	1,800	1,800	1,325	8,000
Trips (2012)	138,548	209,232	2,008,079	268,151	9,040,580
Trips per day per bike	0.6	0.3	3.0	0.9	3.1
Regional population[5]	3,999,980	2,065,998	5,860,342	3,759,978	7,170,000
Mean trip duration	22.0	16.2	15.8	17.5	17.5
Est. travel speed (km/h)	12	12	12	12	12
Est. distance travelled per trip (KM)	4.4	3.2	3.1	3.5	3.5
Est. distance travelled per system 2012 (KM)	609,611	677,912	6,345,530	940,152	31,642,029
Car substitution	19%	21%	7%	19%	2%
Est. car travel reduction (KM)	115,826	142,361	444,187	182,390	632,841
Est. car travel reduction per bike (KM)	193	79	247	135	79
Annual members	921	1,926	18,000	3,500	76,283

Table 4 Bike share size, usage and car travel reduction

NB: Data accurate as of 2012. Programs outside of Australia have expanded since 2012. Source: Fishman, Washington, & Haworth (2014)

Another important consideration when determining the impacts of bike share is the amount of driving from program operators, to rebalance and maintain bicycles. Fleet rebalancing is typically achieved through the use of trucks and trailers, and these are associated with many of the very impacts bike share aims to reduce (e.g. congestion, pollution). Table 6 provides an indication of the fuel used and distance travelled for the cities included in this analysis.

[5] Method of demarcating regional boundaries differs and those interested are encouraged to examine cited sources.

City	Annual distance travelled (KM)	Diesel consumed (litres)	Unleaded petrol consumed (litres)	CO_2 emissions (Tons)
London	1,399,182	116,605	391	316
Minnesota	88,000	-	11,436	26
Melbourne	27,851	2,952	-	8
Washington, D.C.	200,896	23,765	-	64

Table 5 Fuel consumption of bike share operators' vehicles, 2012
Source: Fishman, Washington, & Haworth (2014)

Figure 19 compares the amount of car travel reduced due to bike share to the amount of vehicle travel associated with fleet rebalancing. The results indicate that for all but one of the cities included, bike share is responsible for an overall lowering of car use. The exception is London, and this is due to the very low car mode substitute rate (only 2% of trips on the London bike share program substitute for car journeys). Indeed for every kilometre of car use avoided, London bike share operators travel an estimated 2.2km, redistributing bicycles (Fishman, Washington, & Haworth, 2014).

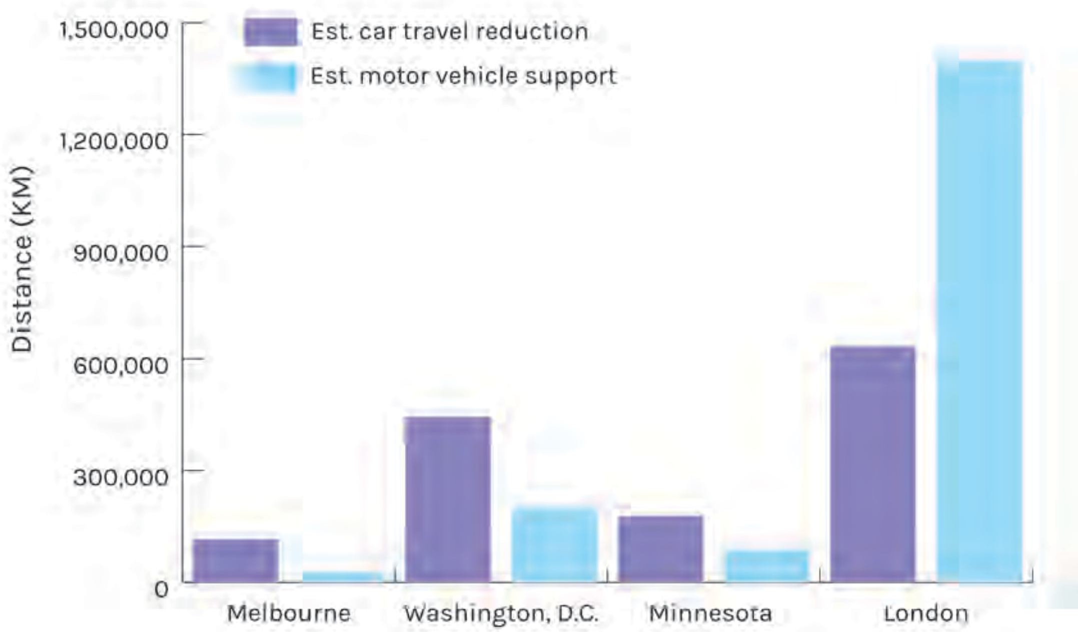


Figure 19 Impact of bike share on car use
Source: Fishman, Washington, & Haworth (2014)

A growing number of cities, including all Australian cities, have a stated policy of attempting to reduce car use. The planning of a new bike share program should therefore attempt to create a system that maximise the likelihood of reducing car use, to the greatest extent possible. For Adelaide, designing a system to increase use by those who would have otherwise taken a short car trips is paramount, in order to avoid the experience of London. For this to occur, marketing efforts attracting car drivers will be necessary, as well as increasing the value proposition of bike share relative to car use. An example of such a policy would be an increase in the cost and decrease in supply of inner city car parking. Whilst recognising the at times divisiveness of this issue, it is clear that the most successful bike share cities are all in places where car use is expensive and difficult (e.g. Paris, London, Barcelona, Washington, D.C.). Additional policy features focused on increasing the ability of bike share to reduce car use will be provided as part of the Stage Three report.

6.2. Health impacts of bike share

Several studies have attempted to quantify the health impacts of bike share, with some focused on one outcome variable, such as changes to physical activity levels, while others attempt to capture a larger range of outcomes. The most comprehensive examination of the health impacts of bike share was published by Woodcock et al. (2014) on the London bike share program. The researchers focused on three issues; *physical activity*, *crashes* and *exposure to air pollution*. This study used trip data to model the health impacts of the program via comparison to a scenario in which the program did not exist. Physical activity was found to increase considerably at the population level. The benefits were shown to differ by gender and age, with men's major benefit coming from reductions in ischaemic heart disease, whereas women were more likely to benefit in terms of reductions in depression. In relation to crashes, the results of the study suggest that on balance, the program delivers more benefit than harm, although the effects are not uniform for all age groups or genders. Interestingly, the researchers found that more benefit would be gained if users were older, as older people have fewer healthy life years to lose (if involved in a crash). Conversely, when a young person crashes, they have many more healthy life years at risk. It is important to note, however, that an older person is less likely to fully recover from the same crash that involves a younger person, that is, older people are more vulnerable (Li, Braver, & Chen, 2003). When the researchers applied the general crash risk for all cycling in central London, they found a negative health impact for women, due to the greater fatality rate among female cyclists in London.

In terms of air pollution, the study found that while cycling routes typically have slightly lower levels of air pollution (PM2.5), the higher ventilation rate means that on balance, there is little impact of the bike share program on air pollution exposure (Woodcock et al., 2014). Overall, the researchers conclude that the greatest health benefit would come from seeing an increase in middle-aged and older people using the scheme.

In the first multi-city analysis of the physical activity impacts of bike share, Fishman, Washington, and Haworth (2015a) estimated changes in physical activity due to bike share in Melbourne, Brisbane, Washington, D.C., London and Minneapolis/St. Paul. The results suggest an average of 60% of bike share trips replace sedentary modes, but when bike share replaces walking, a net *reduction* in physical activity results (walking is more physically intensive on a per distance basis). Overall, however, bike share was found to have a positive impact of physical activity, leading to an additional 74 million minutes of physical activity in London, through to 1.4 million minutes of physical activity in Minneapolis/St. Paul, for 2012 (Fishman, Washington, & Haworth, 2015b). The transfer of minutes of travel, based on mode substitution rates reported earlier, is shown in Figure 20.

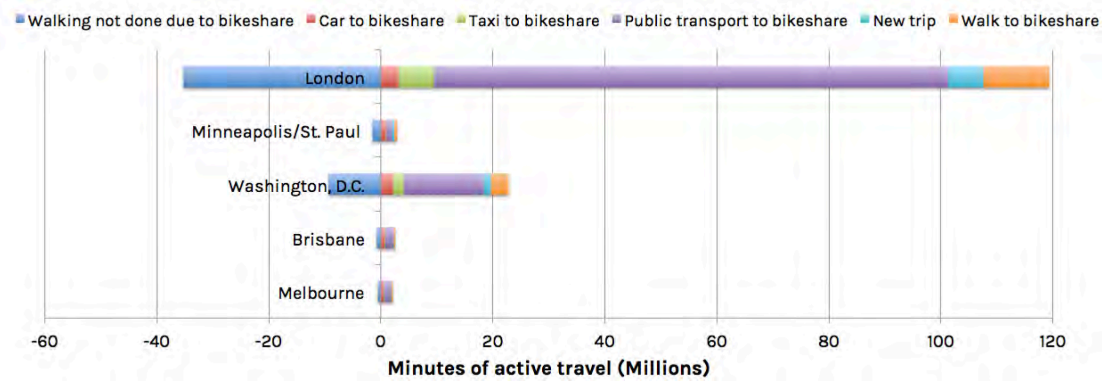


Figure 20 Estimated changes to active travel due to bike share

NB: Readers wishing to see full figures should consult Fishman, Washington and Haworth (2015b)

The results demonstrate that in order for bike share programs to improve their impact on active travel levels, it is necessary to implement measures focused on encouraging mode shifts from car, taxi and even public transport to bike share. As most bike share programs are relatively new, few have specifically attempted to attract those using sedentary modes, but these results suggest that such efforts may be well justified in terms of active travel impact.

6.3.Bike Share and Safety

Over a decade ago, Jacobsen (2003) published a landmark paper describing what has become known as '*Safety in Numbers*', showing that cyclists are less likely to be injured when volumes of cyclists are higher. More recently, researchers have compared crash risks of 'private bike riders' to those riding bike share bikes. Prior to the introduction of North America's largest bike share program in New York City (*Citi Bike*), a bicycle researcher (Professor John Pucher) was quoted in the *New York Times* predicting '*at least a doubling and possibly even a tripling in injuries and fatalities among cyclists and pedestrians during the first year*' (Flegenheimer, 2013b). As of February 2016, no deaths have been recorded among those using the *Citi Bike* program.

Perceptions of fear and low safety levels have been established as a major deterrent to cycling in Australia (Fishman, Washington, & Haworth, 2012b). Given the well-established evidence that safety concerns deter bicycle use, it is important that any future bike share program address the real and perceived threat posed by motor vehicles to the safety of cyclists. There is growing interest in the safety issues related to bike share, including a somewhat volatile debate that straddles the academic and mainstream media, sparked in part by an article published in the *American Journal of Public Health* (Graves et al., 2014). Graves et al. assessed hospital injury data from five US cities with bike share programs and five without, during a 24-month period before bike share implementation and also for a 12-month period post implementation. The non-bike share cities essentially acted as a control. What the researchers found but failed to include in their discussion was the dramatic reduction in the total number of hospital-recorded injuries in the bike share cities, post implementation. Figure 21 uses data collected by Graves et al. (2014) to illustrate the reduction in recorded injuries in bike share cities compared to a slight increase in control cities.

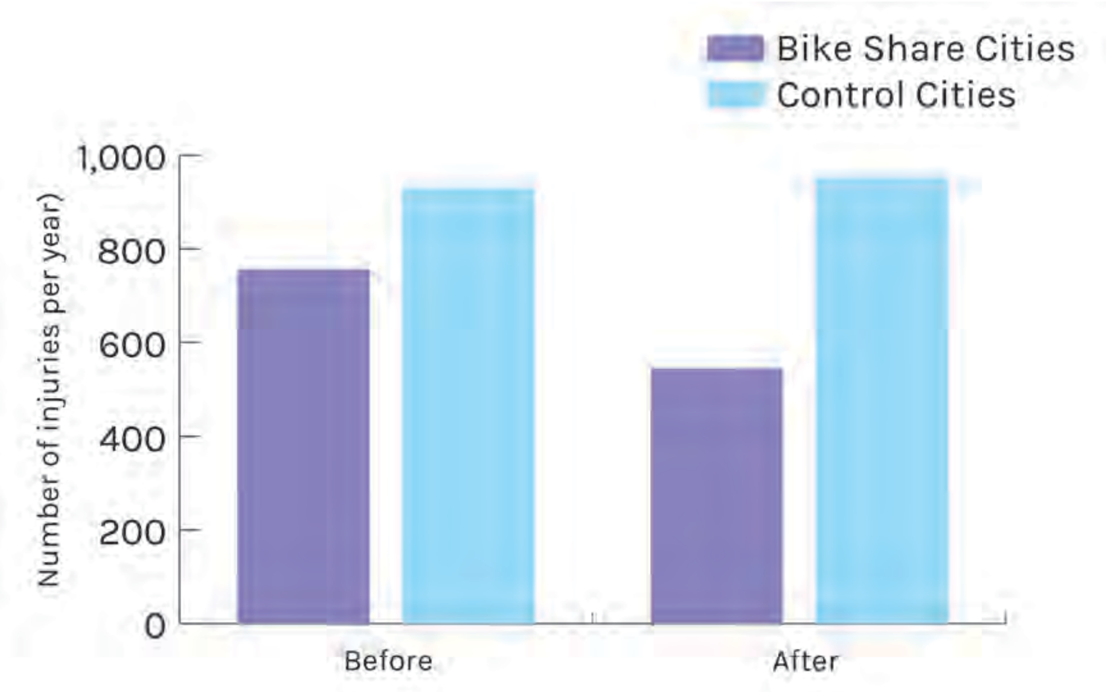


Figure 21 Injuries (all types), bike share cities and non-bike share cities (control)
Source: Graves et al. (2014)

Graves et al. (2014) conclusions, which have been criticised by other scholars (e.g. see Teschke & Winters, 2014; Woodcock & Goodman, 2014), were for bike share operators to provide helmets, despite a clear reduction in the number of head injuries for bike share cities. The data reported by Graves et al. (2014) are especially significant when considering the overall amount of cycling increases after the introduction of a bike share program. This is consistent with the *Safety in Numbers* phenomenon reported earlier (e.g. see Elvik, 2009), in which a rise in the amount of cycling does not lead to a proportional rise in the number of injuries.

Martin, Cohen, & Finson's (2012) North American, multi-system study included questions to bike share operators regarding safety data. This analysis found that operators employ different data collection procedures but crash rates are generally low. Of the operators involved in the study, 14 kept records on accidents, with an average of 1.36 crashes in 2011 (per system). Different methods were used by operators to express the crash rate. One operator reported one accident for every 50,000 – 60,000 rides. Another said they experienced one accident per 100,000 miles of riding. Injury severity data was generally not collected and nor was the precise method used to determine crash rates. The report notes that for systems with more than 1,000 bicycles, there is an average of 4.3 accidents per year. Montreal's bike share operator does collected data on crash type, and these results are shown in Figure 22.

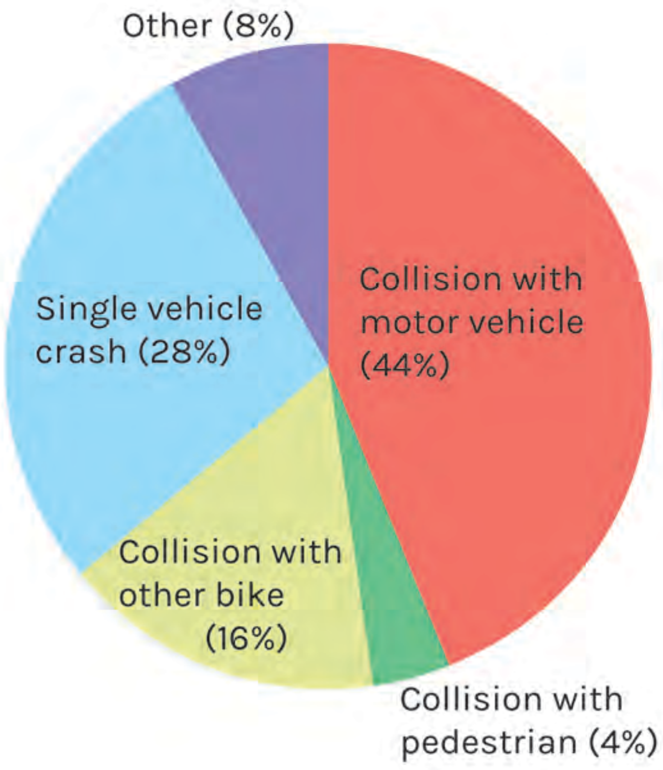


Figure 22 Reported crash type, Montreal bike share, 2013
Source: BIXI Montreal (2014)

In the first multi-city assessment of bike share safety that includes exposure factors, Fishman and Schepers (2016) assessed both the distance travelled and the number of reported injuries on bike share for 2013 in various US, European and Australian cities. Much of the bike share usage data is drawn from Table 5 above and the author contacted bike share operators to collect crash data, which is provided in Table 7.

	Slight injury	Serious injury	Fatal
Paris	159	19	0
London	62	17	1
New York City	71	9	0
Montreal	22	0	0
Washington, D.C.	23	2	0
Chicago	5	2	0
Minneapolis/St. Paul	0	0	0
Melbourne	0	0	0
All city total	*342*	*49*	*1*

Table 6 Number of reported incidents to bike share operators, selected cities, 2013

Source: Fishman & Schepers (2016)

Table 8 expresses injury rates on a per million kilometre basis for two levels of severity. In terms of *slight* injuries, New York City recorded the highest rate of slight injuries, followed by Washington, D.C. London and Chicago recorded the highest estimated *serious* injury rate, at 0.7 serious injuries per million kilometres travelled. However, overall the differences between programs are very small when considering they are expressed per million kilometres. The average number of slight injuries per million bicycle kilometres is 1.9. Based on these estimates, a person would to commute every weekday for 260 years before encountering a slight injury (assuming a 4 km trip each way for 240 days per year). The numbers of serious injuries are too low to compare between bike share systems.

	Slight injuries per million KM	Serious injuries per million KM
Paris	1.3	0.2
London	2.6	0.7
New York City	4.0	0.5
Montreal	2.2	0
Washington, D.C.	3.3	0.3
Chicago	1.8	0.7
Minneapolis/St. Paul	0	0
Melbourne	0	0
All city average	*1.9*	*0.3*

Table 7 Injuries and fatalities per distance travelled, selected cities, 2013

Source: Fishman & Schepers (2016)

Of the cities included in this study, only London recorded a fatality in 2013 (Woodcock et al., 2014). This is too low to reliably estimate an average fatality rate for bike share systems. Instead, an average fatality rate is calculated using Paris data collected between 2007 and 2012, during which time police recorded eight deaths among bike share users (Byrne, 2013). Usage during this time period is estimated at some 0.58 billion-bicycle kilometres. By combining these figures to those in Table 5 and 7, a bike share fatality rate of some 12 per billion bicycle kilometres (9 fatalities divided by 0.76 billion bicycle kilometres) has been estimated.

It is also useful to compare the bike share crash rates with general bike crash rates. General bicyclist injury rates for Paris and London are shown in Table 9, using data collected for the jurisdiction known as Île-de-France (which encompasses Paris) as well as Greater London. The other cities included in this paper do not have sufficiently detailed travel survey data available to estimate the amount of bicycle use. Without knowing the number of kilometres cycled, it is not possible to estimate crash rate. In this analysis, travel survey data (Department for Transport, 2013; DRIEA, 2013) has been combined with police recorded crash figures between 2009 and 2011 for Île-de-France (DRIEA, 2010, 2011) and Greater London (Transport for London, 2012). Table 9 reveals that Paris is considerably safer for non-fatal crashes than London, but both cities are almost identical in terms of fatalities per billion kilometres.

Injury numbers	Slight injuries	Serious injuries	Fatalities
Île-de-France	2859	599	36
Greater London	10184	1416	43
Bicycle use		***Billion bicycle km***	
Île-de-France		1.4	
Greater London		1.8	
Injury rates	***Slight injuries per million km***	***Serious injuries per million km***	***Fatalities per billion km***
Île-de-France	2.0	0.4	25
Greater London	5.8	0.8	24

Table 8 Injuries and fatalities, bicycle use and injury rates between 2009 and 2011 in Ile-de-France and Greater London

Source: Fishman & Schepers (2016)

The comparison presented here begins with fatalities because the reporting rate will be more reliable than non-fatal crashes. Paris and London data have been combined, as numbers are too small to present individually. However, the figure is largely based on Paris for which a longer time period could be used. The fatality rate has been estimated for the average bike share system at *12 fatalities per billion bicycle kilometres*. Figure 23 in which the fatality rates are included shows that the fatality rate for bike share systems is lower than the fatality rate for Île-de-France and Greater London. This suggests that the average bike share user is less likely to be fatally injured than other cyclists in the same jurisdiction. Even though the estimate for bike share systems is based on a low number of only nine fatalities, it is still remarkable that the average is at the same level as the level in the two safest countries for cyclists in the world, the Netherlands and Denmark (Pucher & Buehler, 2008).

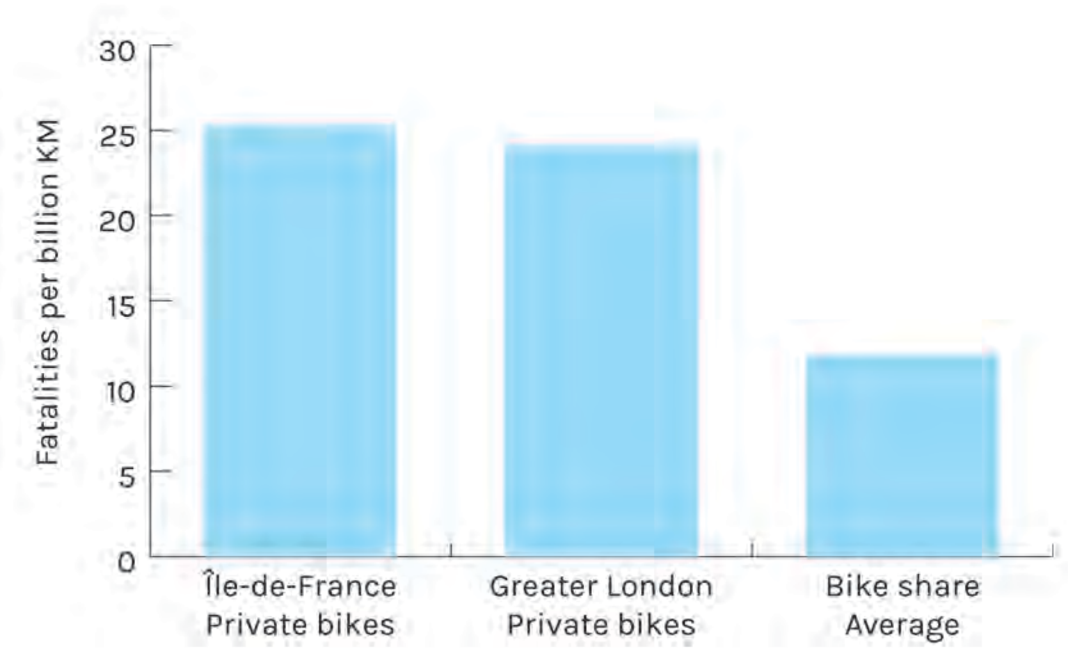


Figure 23 Fatality rates per billion bicycle KM
Source: Fishman & Schepers (2016)

Figure 24 compares the injury rates of the Paris and London bike share systems to the injury rates in the jurisdictions of which these are part. For both levels of severity and both bike share systems the injury rates are lower for bike share. This is consistent with the estimates for fatality rates and may show actual safety differences. However, a lack of information on the reporting rate by bike share operators compared to the police prevents us from drawing definitive conclusions.

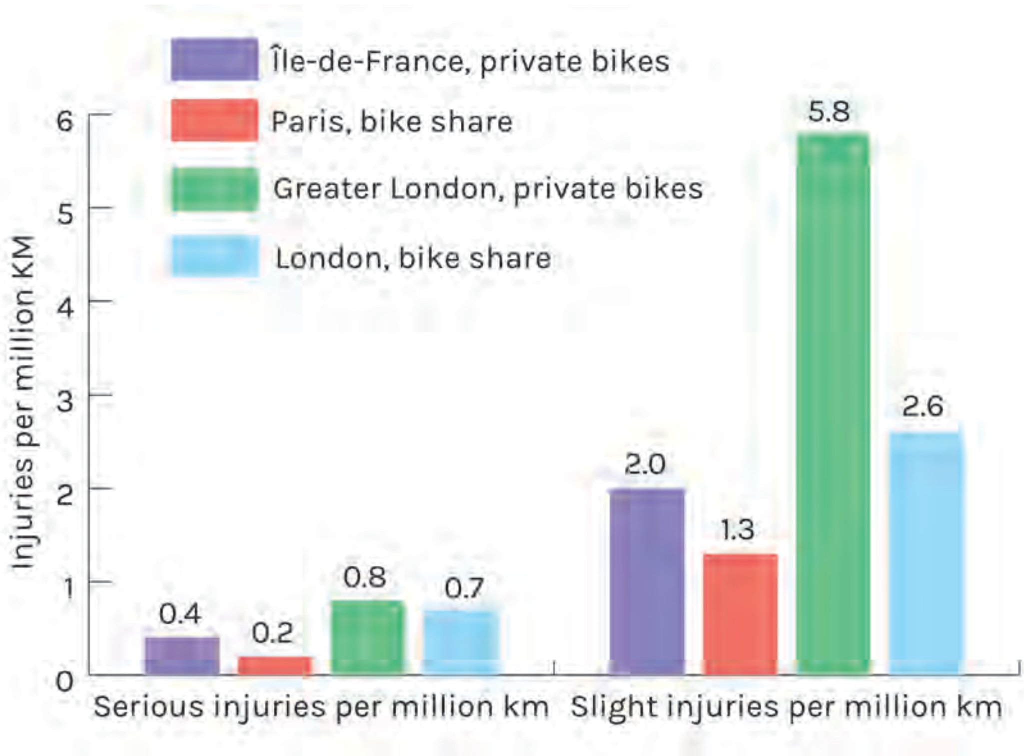


Figure 24 Injuries per million KM travelled
Source: Fishman & Schepers (2016)

6.3.1. Discussion and recommendations

The results presented here suggest that bike share users are less likely than other cyclists to sustain fatal, severe or slight injuries. A relatively reliable measure for this is the fatality rate which was in the same range as the safest cycling countries in the world, the Netherlands and Denmark. According to the results of this analysis, a bike share user is half as likely to be fatally injured, per kilometre travelled, than a general cyclist, in jurisdictions in which a bike share program operates. However, the number of fatalities on which this comparison is based is still relatively low. Comparing serious and slight injuries leads to the same conclusion, but this comparison is hampered by the fact that the bike share data was based on information reported to operators while the numbers for other cyclists were based on police reported crashes. Although there are uncertainties, the fact that the literature and outcomes for all levels of injury severity point in the same direction yields some support for lower risk for bike share users compared to other cyclists.

An explanation for why bike share reduces road safety risk is not immediately obvious. One explanation might be that their speeds are substantially lower than for other cyclists. Bike share speeds are generally in the same range as countries such as the Netherlands (Van Oijen, Lankhuijzen, & Van Boggelen, 2013). A slower speed increases the time available for cyclists to react to avoid crashes that may have occurred at higher velocities. It is also possible that motorists perceive bike share users to be less experienced and/or tourists and therefore display a greater level of caution, as revealed in qualitative research on perceptions of bike share (Fishman et al., 2012a). Bike share users in this same study also reported significantly improved levels of perceived awareness and respect from motorists when using bike share bikes compared to their private bicycles. The notion that drivers behave differently depending on the appearance of the cyclist has been established by Walker (2007) who found that drivers overtook closer to helmeted cyclists. The upright position of bikeshare bikes may improve cyclists' visual observation of the road environment, potentially helping to avoid crashes. Finally, most bike share systems occupy the inner area of cities, which typically have better bicycle infrastructure than outer suburbs. Bike infrastructure is known to reduce crash risk between cyclists and motor vehicle drivers (Teschke et al., 2012). In a study that contrasts with the aforementioned findings, Fuller et al. (2013) were unable to find a statistically significant difference in collisions or near misses after two years of the BIXI programme in Montreal, but expressed caution when interpreting findings, due to a lack of power associated with their sample size.

In terms of recommendations, this analysis of the available data on bike share safety has highlighted some important shortcomings regarding current practice. Firstly, there is no established industry standard for the reporting of bike share incidents. The use of a standard online form, with some modifications accounting for different local contexts would provide individual bike share operators, the wider industry and government with easily comparable data. This would enhance the ability of relevant stakeholders to identify emerging safety issues, providing an important tool in maximising the safety of bike share users, and the wider public.

7. Rebalancing

Rebalancing refers to bike share operators moving bicycles across the network, to maintain a reasonable distribution across docking stations (Fishman, Washington, & Haworth, 2014). The need for rebalancing is caused when 'tidal flows' of bike share trips move *from* or *to* certain areas of a city, such as from residential to commercial zones in morning peak hour. This leads to some stations being completely full while others are empty, and this can lead to a lack of reliability for the user and reduced satisfaction (e.g. see Transport for London, 2014), as well as significant costs imposed on operators to manually redistribute the fleet (Fishman, Washington, & Haworth, 2014). These twin issues have spurred a diverse range of investigations into effective measures to improve fleet redistribution. Researchers have documented variation between bike share programs in different cities regarding the proportion of docking spots that are full or empty (O'Brien et al., 2014) and this may provide a basis upon which cities can begin to reduce the number of docking stations suffering from distribution issues. Rebalancing is a burgeoning sub-topic within bike share research. Some researchers have examined the factors associated with higher and lower levels of docking station activity (e.g. Faghih-Imani, Eluru, El-Geneidy, Rabbat, & Haq, 2014), finding that weather and the presence of restaurants have a predictable impact of station activity. Other researchers have also identified a relationship between weather and station activity (Rudloff & Lackner, 2013); however, inclement weather is much more likely to impact on casual users than members with a commuting function. Other work has examined the impact of topography on station activity (e.g. Frade & Ribeiro, 2014; Jurdak, 2013).

Parkes et al. (2013) suggest altering the price to achieve rebalancing objectives may increasingly be employed as an option to resolve fleet distribution issues, although it is not clear that any scheme has successfully carried out such an initiative. Some have investigated the effectiveness of providing users with incentives to redistribute bikes, using complex mathematical modelling (e.g. Fricker & Gast, 2014), although in the case of Fricker and Gast (2014) a lack of real-world data collection and the omission of factors known to influence docking station activity (e.g. density) reduces the reliability of the findings. Pfrommer et al. (2013) used historical data on the London bike share program to model the effectiveness of employing trucks for redistribution as well as the impact of introducing price incentives to the user to mitigate fleet imbalance. The results suggest that while price incentives may be sufficient on weekends, usage patterns on weekdays are such that a combination of operator and user redistribution is required to maintain an adequate level of service.

This brief introduction to research examining bike share redistribution has identified that it is a burgeoning area of research, and signifies the importance of redistribution as an operational issue. The research has attempted to tackle the twin problems of user inconvenience and large operator costs, both of which are incurred when a system is unbalanced.

The challenge will be to integrate user preference and behaviour data with appropriate mathematical modelling techniques to test the effectiveness of solutions, ideally with the cooperation of a bike share operator. New insights from the field of behaviour economics (Thaler & Sunstein, 2008) may enhance incentive opportunities for users to redistribute bicycles against typical tidal flows.

8. Bike share models of provision & costs

8.1. Models of provision

Bike share programs can be delivered through a range of financing models. For capital expenditure, this can vary from fully publicly funded systems (e.g. *Melbourne Bike Share*), through to private sector financing in exchange for outdoor advertising rights (e.g. Brisbane's *CityCycle*). These two models are said to represent opposite ends of the spectrum and there are hybrid models that hold characteristics of both private and public sector financing, especially through the use of sponsorship. In fact, the *CityCycle* scheme is perhaps best described as a hybrid, whereby the outdoor advertiser, JC Decaux provide the bicycles and operational expertise, but Brisbane City Council are required to contribute to the scheme. One report suggests *CityCycle* has cost Brisbane City Council $14.63 million in the five years to 2015, but returned $6.3 million in revenue, meaning, the scheme has effectively cost Brisbane City Council $8.3 million over 5 years, or $1.6 million per annum. This equates to $890 per bike, per year.[6]

It is not clear from the available literature whether public or private models of provision are superior. The most pertinent point appears to be that a successful contract is one in which *performance-based* criteria are embedded, that *incentivise* ridership. Parallels might be drawn from the experience of private bus operator contracts, in which incentives to boost ridership are recognised as necessary to enhance overall operational performance. For bike share programs in North America, it is common for the establishment of a profit sharing arrangement between the government agencies responsible for the system and the private bike share operator.

On a cautionary note, private bike share operators, many of which run dozens of systems as part of a global operation, often have more experience than government authorities in bike share contract preparation. This has previously led to instances in which the private operator has achieved highly favourable contract terms, often resulting in reduced levels of service for potential users of the system. It is therefore imperative that government source the necessary expertise to complement their staff's experience in contract management and transport policy. This will enable the crafting of *Request for Quotation* (RFQ) documents that *build in* financial incentives linked to performance. Whilst this report does not seek to identify the other components a RFQ should include, the issue of *incentivisation* is considered paramount.

---

[6] The Contract between Brisbane City Council and JC Decaux was requested but denied to the author. The figures quoted in this report are instead based on the reports referred to here http://www.brisbanetimes.com.au/queensland/citycycles-83-million-cost-to-ratepayers-revealed-20150622-ghurav.html

8.1.1. Considerations for Adelaide

Whilst it is too early to identify a preferred business model for bike share in Adelaide, some initial points to consider regarding sponsorship/advertising are offered below:

- Sponsorship can reduce the public financing required to establish and operate bike share.
- Heavily branded bicycles (e.g. *CityCycle* in Brisbane) can potentially act as a deterrent to riding, if the rider feels that their use of the bike is an implicit endorsement of the brand advertised.
- Sponsorship of the bicycles with a brand that is viewed as *complementary* to the concept of bike share can increase public acceptance of bike share (e.g. Google, AirBNB, health insurer, renewable energy provider).
- Outdoor advertising associated with a bike share sponsorship arrangement may detract from the visual appeal of the urban environment.
- Given the low performance of Australian bike share programs, fear of *reputation damage* from potential sponsors must be considered. Furthermore, the public acceptance of cycling as a transport mode is not as favourable in Adelaide as it is in many other cities, and this could act to limit the degree to which commercial organisations consider sponsorship a prudent investment. The government agencies associated with an underused bike share program potentially expose themselves to reputation damage as well.
- Many sponsorship arrangements are in place for a decade or more (Brisbane's contract is for 20 years). For this reason, the choice and terms of sponsorship must be made very carefully, considering a wide range of potential risks and unintended consequences.

Finally, building in expansion options into a contract will help facilitate growth requirements as the system matures. These expansions often occur in cities with well-used bike share programs (e.g. London and Washington, D.C.). *Capital Bikeshare* in Washington, D.C. is considered a global leader in governance arrangements associated with system expansion and can be looked to for guidance on this issue.

The *Melbourne Bike Share* program is funded by the Victorian Government ($5m for the initial five year trial). The program currently requires $2m per annum, for operating costs. In 2014 the Victorian government released a tender for the scheme to be operated by a third party, without any public funding. Three bids were received but none were able to meet the requirement of zero public financing. It is the authors view that based on current conditions in Australia, it is highly unlikely a bike share program will be able to be established and operated without significant government assistance. It is also important to bear in mind that other forms of public transport in Australia do not generally meet their costs via fare box revenue.

For instance, most Australian cities recover about 30% of the cost of public transport system operation (Major Cities Unit, 2012)

8.2. Bike Share Costs and Revenue

The costs of providing a bike share system consist of the capital expenditure for bicycles and docking stations, and operating software and hardware. Marketing and management establishment costs are also incurred. Bike share also includes substantial operating costs, in the form of fleet redistribution, servicing and replacement of bike hardware, as well as customer service and marketing costs.

In most cases, bike share program operators are not obliged to disclose their capital and operating costs. In general however, it is estimated that most 3rd generation bike share programs have capital costs of around $3,000 - $5,000 per bike, which include the supporting infrastructure such as docking stations, computer systems, control centre and maintenance and marketing expenditure. Table 10 provides as detailed a breakdown as possible of the costs and revenue associated with several bike share programs. These figures should be taken as an approximate guide, as each bike share operator may have different methods of calculating their costs and revenue. Of the many operators approached as part of this study, only two (Washington, D.C. and London) provided sufficient information to report on their operating cost recovery ratio (operating revenues divided by operating expenses). In both cases they recover just over 60% of the costs incurred to operate their systems, which is comparable (and in many cases favourable) with motorised public transport systems.

	Washington, D.C. Arlington only[7]	Montreal	London	Dublin	Minneapolis
Number of bikes	600	5,200	Confidential data for the City of Adelaide only.	1,500	Confidential data for the City of Adelaide only.
Number of docking stations	81	460		100	
Capital cost per bike	$1,231	-		N/A[8]	
Capital cost per docking spot	$1,660	-		N/A	
Annual operating cost per bike	$1,366	-		1,280[11]	
Income from sponsorship (annual)	$50,000	-		300,000	
Income from user fees	$890,000				
Operating cost recovery[12]	63%	-		-	
Total cost recovery[13]	51%	-		-	

Table 9 Bike share costs and revenue

NB: Information contained in this Table related to London and Minneapolis is confidential and cannot be made public. All currency US Dollars unless shown otherwise.
Sources: Arlington's Capital Bike share (Washington, D.C.) provided to the author by Paul DeMaio. London's data provided by Helen Sharp of Transport for London. Dublin information provided by Michael Rossiter of Coca Cola dublinbikes, Mitch Vars provided Minneapolis data.

[7] Arlington only. Capital Bike share includes several jurisdictions and this data only includes the Arlington component. Financial Year 2015.
[8] The operator was not able to provide these costs, however they do report that the recent system expansion of 950 bikes, and 57 stations cost 6.1m.
[9] Station costs vary depending on number of DPs. A terminal is the user interface which allows users to hire a bike. Each docking station has a terminal. Typically, there are between 24 and 36 docking points per terminal.
[10] Marketing and admin. Costs not included, which amount to an additional £257 per year. A sponsorship change included a cost to Transport for London of £1,595,000
[11] Estimate based on annual operating cost of 1.92m
[12] Operating cost recovery is the ratio of operating revenues divided by operating expenses (Arlington County, 2015).
[13] Total cost recovery is the ratio of operating revenues divided by the sum of operating, marketing and management expenses (Arlington County, 2015).

8.3. User fees

Although there is some minor variability, almost all modern bike share programs have the same general fee structure. Broadly speaking, this includes a choice of membership periods (e.g. annual, monthly, daily), with usage fees only charged for trips in excess of 30 minutes. Some systems have a 45 minute period before usage fees are incurred. The general experience among systems globally is that around 90 – 95% of trips are completed within the free period and this is especially true for trips by annual members. Shorter term subscriptions, which are more often used by visitors, are more likely to be in excess of the free 30 minute period (Fishman, 2014).

City	Casual		Registered	
	1 day	**3 day**	**30 day**	**Annual**
Washington, D.C.	$8	$17	$28	$85
Montreal	$C5	$C14	$C30	$C87
London	£2	-	-	£90
San Francisco	$9	$22	-	$88
Boston	$6	$12	$20	$85
Minneapolis/St. Paul	$6	-	$15	$65
NYC	$9.95	-	-	$149[14]
Chicago[15]	$9.95	-	-	$99
Melbourne[16]	$A3	-		$A60
Brisbane	$A2	-	-	$A60.50
Paris	€1.70	-	-	€29/ 39[17]

Table 10 Bike share subscription rates, selected cities

As of 12th January 2016

NB: Some systems offer discount rates to students and age related discounts. Some membership periods not listed here. All currency US Dollars unless shown otherwise.

Membership revenue from the London bike share program is presented in Figure 25. Presented as a percentage of total usage fees (not including charges imposed on those who's rental period is longer than 30 minutes). The total revenue generated from usage fees is [redacted], broken down as shown in Figure 25. These proportions are broadly similar to other bike share programs, with the general pattern being that daily access fees

[14] NYC's Citi Bike offers annual subscribers 45 minutes before excess usage charges are incurred, per trip. 7 day passes are also available, at $US25.
[15] Prices quoted here become applicable 1st February 2016.
[16] Melbourne Bike Share offers annual subscribers 45 minutes before excess usage charges are incurred, per trip.
[17] These prices are for 30 minutes/45 minutes as the free period per trip.

generate a substantially higher rate of return to operators, compared to the amount of riding they account for. Annual members contribute less, on a $/km basis than do casual users.

Confidential data for the City of Adelaide only.

Figure 25 Usage fees from the London bike share program

NB: Information contained in this figure is confidential and cannot be made public.

Source: Helen Sharp, Transport for London

In summary, the costs associated with the establishment of a bike share program can be substantial, but are modest when compared to other forms of public transport. The cost recovery ratio, where figures are provided, amount to around 60% of operating costs. Usage fees vary only slightly between bike share programs, and are generally designed to favour annual memberships, and short trips, under 30 minutes.

9. Current and emerging bike share technologies

Technology has been central to the development of modern bike share programs. As identified earlier, technology was crucial to overcoming the challenge of misuse that led to the demise of the first generation bike share program (Amsterdam's *White Bikes*). Since that time, the technology underpinning bike share programs has grown increasingly sophisticated, which has enhanced both the user experience, as well as the capacity of operators to manage the bicycle fleet. This section briefly identifies some of the key technologies that help to underpin modern bike share programs, as well as some of the emerging technology likely to play a major role in future bike share programs.

9.1. Radio Frequency Identification

Third generation bike share programs, which account for the vast majority of the bike share programs globally, rely on the use of radio-frequency identification (RFID) to allow users to unlock and return bicycles, into docking stations. Operators are also able to remotely detect the presence of each bike when it is parked at a docking station. A new row is created in an automatically generated .csv file each time a bicycle is removed, including the time of its removal, as well as the time and location the bicycle was returned (usually to a different docking station). This has created rich datasets that have enabled researchers to produce detailed geospatial visualisations of bike share activity (e.g. see http://bikes.oobrien.com/melbourne). The benefits of using RFIDs are that they are affordable, proven, and provide automated data on usage. The limitations of RFIDs is that they are only able to provide information when bicycles interact with the docking stations (removed or returned) and do not provide any information while the bicycle is actually in use (e.g. what route the bicycle has taken).

9.2.GPS and Dockless Systems

As of early 2016, GPS is not routinely incorporated into bike share systems, in part because the fleets are very often five to ten years old. However, for newer systems, or those currently being planned, GPS is an increasingly attractive option, as it becomes more affordable. Indeed, at current prices, it would appear that the benefits of a GPS integrated system outweigh the costs. Indeed Copenhagen's new BSP, established in 2014, already has a GPS-embedded fleet as well as on-board tablet computer and Wi-Fi hotspot functionality. The on-board tablet is used to assist riders in wayfinding/route planning. Additionally, local businesses can partner with the bike share operator, to offer specials/discount offers to riders, based on their proximity to the business.

Figure 26 Copenhagen's GPS, tablet integrated bike share system

Some researchers (e.g. Parkes et al., 2013) have identified that GPS may reduce the need for physical docks and at least one US-based operator (SocialBicycles) operates systems in which on-board solar-powered GPS replaces docking stations. Figure 27 shows how GPS enabled bicycles can utilise existing bicycle parking infrastructure, rather than more infrastructure intensive docks.

Figure 27 GPS enables operators to offer bicycles without docks

Apart from the obvious security benefits, GPS may assist bike share operators by providing a 'geo-fence', detecting when a bicycle has moved outside a given area (Parkes et al., 2013). Operators may also use GPS to assist with the challenging task of re-distributing bicycles across their fleet via the use of real-time tracking. Users may benefit by enhanced real-time information on bicycle availability. The automated data collection offered through GPS provides new opportunities for data analysis, which may not only be useful for bike share operators to understand how their system is being used, but also from a wider transport planning perspective. Openly available GeoJSON data files may assist governments plan and evaluate bicycle route usage and effectiveness. These geographic data sets will help build on the impressive work that has begun using start and end docking station locations provided by non-GPS BSPs (e.g. see Beecham & Wood, 2014; Romanillos, Zaltz Austwick, Ettema, & De Kruijf, 2015; Zaltz Austwick et al., 2013). Integrated a bike share system with GPS does however increase the costs to the operator, in the form of unit costs, as well as monthly data charges.

9.3.Near Field Communication

Near field communication (NFC) is a form of wireless data transfer that detects and then facilitates compatible devices within five centimetres to communicate directly, without using the Internet. NFC is increasingly being used in a wide range of applications, such as in store, contactless payment (e.g. PayPass), as well as public transport mobile ticketing (e.g. Portland's *Mobile Tickets* and Chicago's *Ventra Mobile App). Apple Pay* and *Google Wallet* use NFC to enable subscribers to pay using their Smartphone. Significant, untapped potential exists for bike share to use NFC to make accessing bicycles easier than it currently is, especially for new users. Potential users could use their Smartphone (providing it has NFC functionality) to pay for and release bicycles, lowering the 'friction' that can sometimes prevent those who have not yet used bike share to begin the process. Moreover, for existing users, a Smartphone could replace the current key or '*fob*' they are currently required to use bike share as long term subscribers. It is the authors understanding that most large bike share operators are currently working to make their systems Smartphone accessible, through the use of NFC.

9.4.E-bikes and bike share

The growth of bike share noted earlier has coincided with a similarly rapid growth in e-bike performance, affordability and usage. In recent years a number of cities have launched bike share programs that offer electric assistance, known as pedelecs (e-bike share). These cities include the European capitals of Copenhagen (reporting 2,000 bicycles and pictured in Figure 26) and Madrid with 1,560 bicycles, as well as a handful of small Italian cities. There are currently over 14 e-BSPs in Italy as well as one in Stuttgart and at least two in Japan. Barcelona and Milan both plan to introduce e-bike share as part of their existing systems in 2015. A university-based e-bike share program has been trialled in the USA (Langford, Cherry, Yoon, Worley, & Smith, 2013). A conceptual e-bike share design from a provider is shown in Figure 28.

Figure 28 E-bikes as part of Copenhagen's new bike share program
Source: GoBike A/S

E-bike share offers the potential to increase the attractiveness of bike share to
those who may not have previously seen it as an option. Longer trips, challenging topography, excessive heat and other factors associated with physical exertion can act as barriers to transport cycling generally (Heinen, van Wee, & Maat, 2010). Furthermore, many bike share cities have experienced re-balancing issues associated with the city's topography. It is typical for users to ride downhill and show a reluctance to return bicycles to stations located at a higher elevation (Jurdak, 2013). E-bikes may assist in reducing this flow imbalance. Some cities (e.g. Brisbane) have avoided placing docking stations in hilly suburbs, on the assumption that it will cause redistribution issues. E-bike share may therefore assist both users as well as bike share operators and may be especially applicable in hilly, hot or dispersed cities. Whilst Adelaide does not present many topographical challenges, its dispersed land use arrangement, coupled with hot summer weather, may help e-bike share provide sufficient benefit to increase ridership levels.

10. Best practice principles

A number of best practice principles can be drawn from this review of the bike share literature. Safety, convenience and spontaneity are the key principles upon which current and prospective bike share planners should focus in their efforts to increase usage and overall system effectiveness. These principles and their sub components are identified in Figure 29.

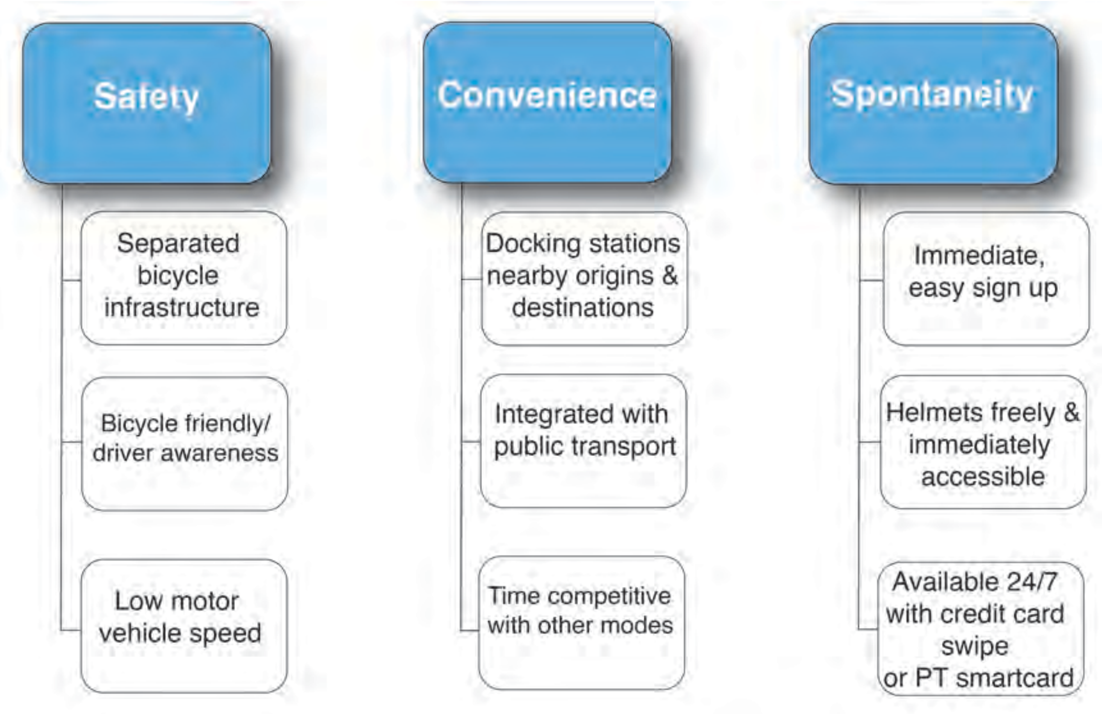


Figure 29 Synthesis of best practice principles
Source: Fishman (2014)

The best practice principles identified in Figure 29 have been developed with a particular focus on the Australian experience with bike share (Brisbane and Melbourne). As highlighted earlier, both these systems have struggled to attract the ridership initially expected, and this section discusses the principles of best practice that should be considered in the planning of a future bike share program in Australia. One overarching consideration that may be helpful for Adelaide as it begins the process of examining a future bike share program is the *value proposition* such a program may offer. Just as public transport planners have been encouraging to '*think like a passenger*', it is helpful for bike share planners to '*think like a rider*'. What compelling value proposition do people have to use bike share in Adelaide? Is it faster than competing travel options? Is it more pleasant to use? Is it cheaper than other forms of transport? Are docking stations located close to where people live, work and shop? Does it feel safe to use? Is sign up easy and fast? Can users integrate bike share with public transport easily? Designing a system with these questions in mind is crucial to the success of a future bike share program and are discussed in more detail below.

10.1. Safety

As highlighted earlier, safety concerns are the primary reason people choose not to cycle in Australia. This review has found that people that do not currently cycle are even more sensitive to the degree of protection from motorised transport (compared to those that do cycle). In terms of best practice, London, Paris and New York City (among others) all embarked on bicycle infrastructure campaigns in the years prior to the establishment of bike share. This infrastructure included a large number of separated bicycle lanes/paths and these helped to provide prospective users with the confidence necessary to start using the bike share system. In Paris, the infrastructure also included many targeted *'contra-flow'* lanes, that allowed two way travel for cyclists, but only one way travel for motorists. This helps to increase the value proposition for bike share over motorised forms of travel. In London, a large number of separated bicycle lanes, that extend for many kilometres have now been added to the network, helping to provide safe conditions for cycling. By contrast, very little bicycle infrastructure was developed in the planning of the bike share programs in Melbourne and Brisbane and both have a level of hostility to prospective cyclists, to the point that it has detracted from usability (Fishman et al., 2012a).

The overwhelming theme emerging from the international assessment of bike share program success is that a substantial investment in separated, connected bicycle lanes and paths need to be constructed, as well as a lowering of speed limits *before* bike share is likely to succeed. In a survey to members of the public in Brisbane, *'More bike lanes and paths'* received the highest mean score when non-bikeshare members were asked *'What factors would encourage you to become a CityCycle member?'* (Fishman, 2014). Moreover, in addition to helping to bolster the bike share program itself, these lanes and paths will also help to increase road safety, for all road users, including cyclists on private bikes.

10.2. Convenience

The most consistent finding in the international literature on bike share is that people choose to use bike share when it meets their convenience criteria. What this means in practice is that docking stations need to be close to their home, workplace and other destinations they frequently visit. Moreover, best practice bike share cities, in addition to providing relatively large systems, have also worked to integrate them into the existing public transport service. Data on user attitudes and behaviour show a very strong desire to make multimodal journeys that involve segments of walking, bike share and public transport. Although by no means an industry standard yet, integrating bike share access into public transport smartcard ticketing taps into a very strong user preference to have an *access all modes* pass that works on both bike share and other forms of public transport. Emerging technological developments suggest that in the near future, it will be common for bike share users to be able to access both bike share and public transport through the use of a smartphone. Ultimately, what much of the research and user surveys suggest is that bike share needs to be *time competitive* with competing modes. This is especially the case for commuting trips (in which users are more time sensitive). *Convenience* often suffers from a lack of specificity (i.e. what do people really mean when they cite '*convenience*' as a motivation for use?). In the context of bike, it is best thought about in terms of the *value proposition*. What is the value proposition bike share offers a potential user? Central to the success of bike share therefore is the degree to which bike share competes with car use for short to medium car trips. If car use is faster, door-to-door, it will be difficult to attract people to bike share. Thinking about the bike share service in relation to competing modes is central to its ability to provide the level of convenience necessary to attract ridership.

10.3. Spontaneity

The average bike share trip is between 12 and 16 minutes in duration. These short trips are very often not planned well in advance. The evidence from Australia and abroad is that people wishing to use bike share would like to gain access immediately. Programs that require a user to sign up days in advance have lost large numbers of potential users. Generally, existing best practice is to allow for credit card swipe sign up, that offers immediate access to the user, 24/7. As highlighted earlier, in Brisbane, especially in the early phase of *CityCycle*, users were asked to listen to over 20 minutes of legal disclaimer notices and were not permitted to use the system after 10pm or before 5am. These factors severely limited the ability of new users to sign up as fast as they would have liked, with many forgoing the opportunity (Fishman, 2014). Moreover, mandatory helmet use hampered the spontaneity with which people could use the bike share systems in Australia. For the first 12 months or so, very little was provided in terms of immediate access to free helmets at the bicycle itself, and this further damaged usability. Eventually helmets were provided with many of the bicycles. Although this did have the effect of increasing usage, many people had become accustomed to seeing the bicycles sit un-used. Figure 30 illustrates a typical scenario seen in both Melbourne as well as Brisbane in the early months following the launch of bike share. Interested users walked up to the bikes, showed some interest, but left upon realising they needed a helmet in order to legally use the system – and no helmets were provided. The experience from Brisbane and Melbourne show that everything needs to be done in the early months to capitalise on the public's intrigue with bike share. The best marketing strategy for bike share is for people to see other people riding, and unfortunately this was lacking in the launch of bike share in both Brisbane and Melbourne.

Figure 30 Providing bikes without helmets, Melbourne Bike Share, 2010

11. Conclusion

This review of the available literature on bike share has provided the initial basis upon which to develop an evidence-based understanding of options for bike share in Adelaide. A brief history of bike share has been identified, as well as technologies likely to play a role in future bike share programs. A number of bike share programs have been described, including funding models as well as some considerations for effective contractual arrangements for cities seeking to embark on a bike share program.

Bike share programs have shown to vary considerably in terms of overall usage and some of the key determinants of bike share membership have been described. The synthesis of the available literature shows that higher population density, people aged 18 – 34 and higher income groups are all factors increasing the propensity for using bike share. Moreover, the closer one lives to a docking station, the more likely they will be to use bike share. The quality of the bicycle infrastructure network (bike lanes and paths) has also been found to be an important determinant of bike share usage. The overarching factor stated to motivate bike share users to become members relate to convenience factors (e.g. fast, safe, easy to use, affordable).

A particular focus of this report has been the analysis of barriers to bike share, using data drawn from a Brisbane based sample. The most powerful barriers to using bike share appear to be the ease with which people can travel by car, as well as safety concerns related to cycling. Mandatory helmet legislation has been shown to reduce the usage levels of bike share programs in Brisbane and Melbourne. A critical factor governing usage is the value proposition bike share offers prospective users. Without a competitive value proposition, bike share usage levels are likely to be low.

The research reviewed for this report show that bike share has a number of public policy impacts. These include a reduction in car use (albeit modest in many cases), as well as improvements to physical activity levels and air pollution/climate change. The key factor governing bike share impact is the level of usage (busier systems being more impactful), as well as the degree to which bike share replaces trips formally done by car. The available evidence also suggests that bike share can have a positive impact on safety – reducing the number of crashes.

This review has also found that there are now several different models through which bike share programs can be delivered, ranging from fully publically funded systems, through to advertiser financed programs. The review of the Australian experience with bike share suggests that the most significant risk for a bike share program in Adelaide is low usage levels. As shown in this report, Melbourne and Brisbane currently have around 0.8 and 0.4 trips per day, per bike and this is substantially lower than many other bike share programs. A detailed analysis of bike share options for Adelaide is scheduled to occur in Stage 3 of this program of research, and although firm judgements on bike share's ability to succeed in Adelaide cannot yet be made, it would appear that the transport context for bike share in Adelaide is not substantially more favourable than it is in Melbourne or Brisbane. Three principles have been developed for this report, in order assist Adelaide in advancing possibilities for bike share, broadly classified in terms of *safety*, *convenience* and *spontaneity*. These principles will be used to structure the detailed assessment of bike share options for Adelaide, which will be the subject of the Stage 3 report.

12. References

Ahmed, F., Rose, G., & Jacob, C. (2010). *Impact of weather on commuter cyclist behaviour and implications for climate change adaptation.* Paper presented at the Australasian Transport Research Forum, Canberra.

Alta Bike Share. (2011). *Melbourne Bike Share Survey*. Melbourne.

Alta Bike Share. (2012). *Bike Rental Data 2011*.

Alta Planning + Design. (2012). *King County Bike Share Business Plan*. Retrieved from Seattle: http://pugetsoundbikeshare.org/wp-content/uploads/2012/07/KCBS_Business_Plan_FINAL.pdf

Arlington County. (2015). *Arlington County Fiscal Year 2015 Summary Report on Capital Bikeshare*. Retrieved from Arlington, Virginia: http://www.bikearlington.com/pages/bikesharing/reports-and-analysis/arlington-fy-2015-capital-bikeshare-report/

Australian Bureau of Statistics. (2012). *Census 2011*. Canberra: Australian Government.

Bachand-Marleau, J., Lee, B. H. Y., & El-Geneidy, A. M. (2012). Better Understanding of Factors Influencing Likelihood of Using Shared Bicycle Systems and Frequency of Use. *Transportation Research Record: Journal of the Transportation Research Board, 2314*, 66 - 71. doi:10.3141/2314-09

Basch, C. H., Ethan, D., Rajan, S., Samayoa-Kozlowsky, S., & Basch, C. E. (2013). Helmet use among users of the Citi bike bicycle-sharing program: A pilot study in New York City. *Journal of Community Health*, 1-5. Retrieved from http://download.springer.com/static/pdf/249/art%3A10.1007%2Fs10900-013-9785-7.pdf?auth66=1399809419_af9de2a0c4f08984bca66c127c94a814&ext=.pdf

Basch, C. H., Zagnit, E. A., Rajan, S., Ethan, D., & Basch, C. E. (2014). Helmet use among cyclists in New York City. *Journal of Community Health*, 1-3.

Beecham, R., & Wood, J. (2014). Characterising group-cycling journeys using interactive graphics. *Transportation Research Part C: Emerging Technologies*(0). doi:http://dx.doi.org/10.1016/j.trc.2014.03.007

BIXI Montreal. (2014). *BIXI Accident Data 2013*.

Buck, D., Buehler, R., Happ, P., Rawls, B., Chung, P., & Borecki, N. (2013). Are Bikeshare Users Different from Regular Cyclists? *Transportation Research Record: Journal of the Transportation Research Board, 2387*(1), 112-119.

Byrne, D. (2013, Issue date: 20th November). How safe are the world's cities for cyclists? *The Guardian*. Retrieved from http://www.theguardian.com/lifeandstyle/2013/nov/20/how-safe-are-worlds-cities-for-cyclists

DeMaio, P. (2009). Bike-sharing: History, impacts, models of provision, & future. *Journal of Public Transportation, 12*(4), 41 - 56. Retrieved from http://nctr.usf.edu/jpt/pdf/JPT12-4DeMaio.pdf

Department for Transport. (2013). Road traffic statistics. Retrieved from https://www.gov.uk/government/collections/road-traffic-statistics
Department of Transport Planning and Local Infrastructure. (2013). Census 2011 journey to work - the story behind the movement. Retrieved from http://www.transport.vic.gov.au/research/statistics/census-2011-journey-to-work - 5
Doonan, K. (2010). *Setting the transport scene in SEQ*. Retrieved from Brisbane:
DRIEA. (2010). *Sécurité Routière; Bilan 2009 Nombre de tués par année de 2005 à 2009*. Retrieved from
DRIEA. (2011). *Bilan Île-de-France 2010*. Retrieved from
DRIEA. (2013). *Enquête globale transport; La mobilité en Île-de-France*. Retrieved from
Elvik, R. (2009). The non-linearity of risk and the promotion of environmentally sustainable transport. *Accident Analysis & Prevention, 41*(4), 849-855. Retrieved from http://www.sciencedirect.com/science/article/pii/S0001457509000876
Faghih-Imani, A., Eluru, N., El-Geneidy, A. M., Rabbat, M., & Haq, U. (2014). How land-use and urban form impact bicycle flows: evidence from the bicycle-sharing system (BIXI) in Montreal. *Journal of Transport Geography*.
Fischer, C. M., Sanchez, C. E., Pittman, M., Milzman, D., Volz, K. A., Huang, H., . . . Sanchez, L. D. (2012). Prevalence of Bicycle Helmet Use by Users of Public Bikeshare Programs. *Annals of emergency medicine, 60*(2), 228-231. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0196064412002880?showall=true
Fishman, E. (2012). Fixing Australian bike share goes beyond helmet laws. Retrieved from https://theconversation.edu.au/fixing-australian-bike-share-goes-beyond-helmet-laws-10229
Fishman, E. (2014). *Bikeshare: barriers, facilitators and impacts on car use.* (PhD Thesis by Publication), Queensland University of Technology, Brisbane.
Fishman, E. (2015). Bikeshare: A Review of Recent Literature. *TRANSPORT REVIEWS*, 1-22. doi:10.1080/01441647.2015.1033036
Fishman, E., Böcker, L., & Helbich, M. (2015). Adult Active Transport in the Netherlands: An Analysis of Its Contribution to Physical Activity Requirements. *PloS ONE, 10*(4), e0121871. doi:10.1371/journal.pone.0121871
Fishman, E., & Schepers, J. P. (2014). *Global bike share: What the data tells us about safety*. Paper presented at the International Cycling Safety Conference, Göteborg, Sweden.
Fishman, E., & Schepers, J. P. (2016). Global bike share: What the data tells us about road safety. *Journal of Safety Research, 56*, 41-45.
Fishman, E., & Schepers, P. (2016). Global bike share: What the data tells us about road safety. *Journal of Safety Research, 56*, 41-45.
Fishman, E., Washington, S., & Haworth, N. (2012a). Barriers and Facilitators to Public Bicycle Scheme Use: A Qualitative Approach. *Transportation Research Part F-Traffic Psychology and Behaviour, 15*(6), 686-698.

Retrieved from http://www.sciencedirect.com/science/article/pii/S1369847812000733
Fishman, E., Washington, S., & Haworth, N. (2012b). Understanding the fear of bicycle riding in Australia. *Journal of the Australasian College of Road Safety, 23*(3), 19-27. Retrieved from http://www.sensibletransport.org.au/sites/sensibletransport.org.au/files/ACRSjournalVol23No3Aug12webV2.pdf
Fishman, E., Washington, S., & Haworth, N. (2013). Bike Share: A Synthesis of the Literature. *TRANSPORT REVIEWS, 33*(2), 148-165. doi:10.1080/01441647.2013.775612
Fishman, E., Washington, S., & Haworth, N. (2014). Bike Share's Impact on Car Use: Evidence from the United States, Great Britain, and Australia. *Transportation Research Part D: Transport & Environment, 31*, 7. doi:10.1016/j.trd.2014.05.013
Fishman, E., Washington, S., & Haworth, N. (2015a). Bikeshare's impact on active travel: evidence from the United States, Great Britain, and Australia. *Journal of Transport & Health [In Press]*. doi:10.1016/j.jth.2015.03.004
Fishman, E., Washington, S., & Haworth, N. (2015b). Bikeshare's impact on active travel: Evidence from the United States, Great Britain, and Australia. *Journal of Transport & Health, 2*(2), 135-142. doi:http://dx.doi.org/10.1016/j.jth.2015.03.004
Fishman, E., Washington, S., Haworth, N., & Mazzei, A. (2014). Barriers to bikesharing: an analysis from Melbourne and Brisbane. *Journal of Transport Geography*. Retrieved from http://dx.doi.org/10.1016/j.jtrangeo.2014.08.005
Fishman, E., Washington, S., Haworth, N., & Watson, A. (2015). Factors influencing bike share membership: an analysis of Melbourne and Brisbane. *Transportation Research Part A, 71*, 17-30. doi:doi:10.1016/j.tra.2014.10.021
Flegenheimer, M. (2013a). Bike-Share System for New York Is Built With Ideas From Around the World. *New York Times*. Retrieved from http://www.nytimes.com/2013/05/22/nyregion/a-bike-share-system-for-new-york-built-from-ideas-around-the-world.html?_r=1&
Flegenheimer, M. (2013b). No Riders Killed in First 5 Months of New York City Bike-Share Program. *New York Times*. Retrieved from http://www.nytimes.com/2013/11/05/nyregion/no-riders-killed-in-first-5-months-of-new-york-city-bike-share-program.html?_r=0
Frade, I., & Ribeiro, A. (2014). Bicycle Sharing Systems Demand. *Procedia-Social and Behavioral Sciences, 111*, 518-527.
Fricker, C., & Gast, N. (2014). Incentives and redistribution in homogeneous bike-sharing systems with stations of finite capacity. *EURO Journal on Transportation and Logistics*, 1-31. doi:10.1007/s13676-014-0053-5
Fuller, D., Gauvin, L., Morency, P., Kestens, Y., & Drouin, L. (2013). The impact of implementing a public bicycle share program on the likelihood of collisions and near misses in Montreal, Canada. *Preventive Medicine, 57*(6), 920-924. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-

84887815600&partnerID=40&md5=a20b919c7c9c2af59a81e7317b7ab37f

Gardner, G. (2002). The trends that are shaping our future. New York: W.W Norton and Company.

Goodman, A., & Cheshire, J. (2014). Inequalities in the London bicycle sharing system revisited: impacts of extending the scheme to poorer areas but then doubling prices. *Journal of Transport Geography, 41*, 272-279. doi:http://dx.doi.org/10.1016/j.jtrangeo.2014.04.004

Goodman, A., Green, J., & Woodcock, J. (2013). The role of bicycle sharing systems in normalising the image of cycling: An observational study of London cyclists. *Journal of Transport & Health, 1*(1), 5-8. doi:doi:10.1016/j.jth.2013.07.001

Goodyear, S. (2013). Bike-Share Is Key to Closing the Cycling Gender Gap. *The Atlantic Monthly*. Retrieved from http://www.theatlanticcities.com/commute/2013/08/bike-share-may-be-one-key-closing-cycling-gender-gap/6580/

Graves, J. M., Pless, B., Moore, L., Nathens, A. B., Hunte, G., & Rivara, F. P. (2014). Public Bicycle Share Programs and Head Injuries. *American Journal of Public Health*, e1-e6. doi:10.2105/AJPH.2014.302012

Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by Bicycle: An Overview of the Literature. *TRANSPORT REVIEWS, 30*(1), 59-96. doi:10.1080/01441640903187001

Horton, D., Rosen, P., & Cox, P. (2007). *Cycling and Society*. Farnham: Ashgate.

Jacobsen, P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention, 9*(3), 205-209.

Jäppinen, S., Toivonen, T., & Salonen, M. (2013). Modelling the potential effect of shared bicycles on public transport travel times in Greater Helsinki: An open data approach. *Applied Geography, 43*, 13-24.

Johnson, M., Charlton, J., & Oxley, J. (2010). The Application of a Naturalistic Driving Method to Investigate On-Road Cyclist Behaviour: A Feasibility Study. *Road & Transport Research: A Journal of Australian and New Zealand Research and Practice, 19*(2), 32-41. Retrieved from http://qut.summon.serialssolutions.com/link/eJx9UtFu2jAUTVs6ad36GfTFSoiTOCFI0UqhSCABU6F76AtyE0PMHBvZTgr_sI-ekwykSdOkRLn3nHvuvcexZT2uXufz5cJePa9WU_MtPsi75xykyBxVFoXgjiKSYqaUYKWmgisnFYUNQzcKbIgidGXdrSZoPkLrGfpxff0r1_ow6PXUFhUp0ntUmQZYpvk_-3xL9XFTEZm8-bHT79ue6wYPNUZ4mlC-FV1_KLa0600MYOLX9cTuP8it3NCs4QeKZr3_LGpq9abCbLMtdCsw7XomGfwk1aDQx8FelJJjVhc6O8IlSbDUNGWkQbCmmpFknRMwPBwYTXHdGogtwGCBdSkxo8qUg7GkFeU7MCc6FxnQAkx5RQy1w5qAJbdfBM7A6JTW9eCJ5LiiZrLxBIZgQrCi75RRfQIrXWanZva-nd0Iu14I1hJzdRBSgxfSnmmrnrUO6qWGpdL1SpgDzDOw

Jurdak, R. (2013). The impact of cost and network topology on urban mobility: A study of public bicycle usage in 2 U.S. cities. *PloS ONE, 8*(11). Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84893347402&partnerID=40&md5=3cec583064f56a6095a5d5dcc33003c6

Langford, B. C., Cherry, C., Yoon, T., Worley, S., & Smith, D. (2013). North America's first E-bikeshare. *Transportation Research Record: Journal of the Transportation Research Board, 2387*(1), 120-128.
LDA Consulting. (2012). *Capital Bikeshare 2011 Member Survey Report*. Retrieved from Washington, D.C.:
LDA Consulting. (2013). *2013 Capital Bikeshare Member Survey Report*. Retrieved from Washington, D.C.: http://capitalbikeshare.com/assets/pdf/CABI-2013SurveyReport.pdf
Lewis, T. (2011). Has London's cycle hire scheme been a capital idea? *Guardian* Retrieved from http://www.guardian.co.uk/uk/bike-blog/2011/jul/10/boris-bikes-hire-scheme-london?commentpage=all - start-of-comments
Li, G., Braver, E. R., & Chen, L. H. (2003). Fragility versus excessive crash involvement as determinants of high death rates per vehicle-mile of travel among older drivers. *Accid Anal Prev, 35*(2), 227-235. doi:doi:10.1016/S0001-4575(01)00107-5
Major Cities Unit. (2012). *State of Australian Cities 2012*. Canberra: Commonwealth of Australia.
Meddin, R. (2014). *Bikeshare cities 1998 - 2013: Dataset provided to author.*
Meddin, R. (2015). Dock It - 2014, Bike Sharing World. Retrieved from http://bike-sharing.blogspot.com.au/
Meddin, R., & DeMaio, P. (2016). The Bike-sharing World the Last Week of December 2015. Retrieved from http://bike-sharing.blogspot.com.au/2015/12/the-bike-sharing-world-last-week-of.html
Midgley, P. (2011). *Bicycle-Sharing Schemes: Enhancing Sustainable Mobility In Urban Areas*. Retrieved from New York: http://www.un.org/esa/dsd/resources/res_pdfs/csd-19/Background-Paper8-P.Midgley-Bicycle.pdf
Murphy, E., & Usher, J. (2015). The role of bicycle-sharing in the city: analysis of the Irish experience. *International Journal of Sustainable Transportation, 9*(2). doi:10.1080/15568318.2012.748855
Nice Ride Minnesota. (2010). Nice Ride Minnesota Survey November 2010. Retrieved from http://appv3.sgizmo.com/reportsview/?key=102593-416326-6d13ea0276ea0822c9f59f4411b6c779
O'Brien, O. (2014). *Bicycle sharing systems - Global Trends in Size*. Retrieved from London: http://www.bartlett.ucl.ac.uk/casa/pdf/paper196.pdf
O'Brien, O., Cheshire, J., & Batty, M. (2014). Mining bicycle sharing data for generating insights into sustainable transport systems. *Journal of Transport Geography, 34*, 262-273. doi:http://dx.doi.org/10.1016/j.jtrangeo.2013.06.007
Office of National Statistics. (2014). National Statistics Retrieved from https://www.gov.uk/government/statistics/announcements. from United Kingdom Government https://www.gov.uk/government/statistics/announcements
Ogilvie, D., & Goodman, A. (2012). Inequities in usage of a public bicycle sharing scheme: Socio-demographic predictors of uptake and usage of the London (UK) cycle hire scheme. *Preventive Medicine, 55*(1), 40-45. doi:10.1016/j.ypmed.2012.05.002

Parkes, S. D., Marsden, G., Shaheen, S. A., & Cohen, A. P. (2013). Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. *Journal of Transport Geography, 31*, 94-103.

Pfrommer, J., Warrington, J., Schildbach, G., & Morari, M. (2013). Dynamic vehicle redistribution and online price incentives in shared mobility systems. *arXiv preprint arXiv:1304.3949*. doi:10.1109/TITS.2014.2303986

Pucher, J., & Buehler, R. (2008). Making cycling irresistible: Lessons from the Netherlands, Denmark and Germany. *TRANSPORT REVIEWS, 28*(4), 495-528. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01441640701806612 - .VJlWxcAAw

Pucher, J., & Buehler, R. (2012). *City Cycling*: MIT Press.

Pucher, J., Greaves, S., & Garrard, J. (2010). Cycling down under: a comparative analysis of bicycling trends and policies in Sydney and Melbourne. *Journal of Transport Geography, 19*(2), 332-345.

Queensland Parliamentary Committee. (2013). *A new direction for cycling in Queensland*. Brisbane: Queensland Government Retrieved from http://www.parliament.qld.gov.au/documents/tableOffice/TabledPapers/2013/5413T4163.pdf.

Rissel, C. (2011). Have helmet laws put the skids on Australia's bike share scheme? http://theconversation.com/have-helmet-laws-put-the-skids-on-australias-bike-share-scheme-2703 Retrieved from http://theconversation.com/have-helmet-laws-put-the-skids-on-australias-bike-share-scheme-2703

Romanillos, G., Zaltz Austwick, M., Ettema, D., & De Kruijf, J. (2015). Big Data and Cycling. *TRANSPORT REVIEWS*, 1-20. doi:10.1080/01441647.2015.1084067

Roy Morgan Research. (2013). *Brisbane City Council CityCycle Customer Satisfaction Research*. Retrieved from Brisbane:

Rudloff, C., & Lackner, B. (2013). *Modeling demand for bicycle sharing system-neighboring stations as a source for demand and a reason for structural breaks*. Paper presented at the Transportation Research Board Annual Meeting 2013, Washington, D.C.

Schimmelpennink, L. (2014, 30th December) *Dutch Transport Innovation/Interviewer: E. Fishman*. Institute for Sensible Transport, Amsterdam.

Sener, I. N., Eluru, N., & Bhat, C. R. (2009). An analysis of bicycle route choice preferences in Texas, US. *Transportation, 36*(5), 511-539. doi:10.1007/s11116-009-9201-4

Shaheen, S., Cohen, A. P., & Martin, E. W. (2013). Public Bikesharing in North America: Early Operator Understanding and Emerging Trends. *Transportation Research Record: Journal of the Transportation Research Board*(2387), 83–92. doi:DOI: 10.3141/2387-10

Shaheen, S., & Guzman, S. (2011). *Worldwide Bikesharing*. Retrieved from Access Magazine: http://www.escholarship.org/uc/item/6f16b7sv

Shaheen, S., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia. *Transportation Research Record: Journal of the Transportation Research Board, 2143*, 159-167. doi:10.3141/2143-20

Shaheen, S., Martin, E., Cohen, A. P., & Finson, R. (2012). *Public bikesharing in North America: Early operator and user understanding* (11-26). Retrieved from San Jose:

Shoup, D. (2005). *The High Cost of Free Parking*: Planners Press.

Teschke, K., Harris, M. A., Reynolds, C. C. O., Winters, M., Babul, S., Chipman, M., . . . Cripton, P. A. (2012). Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study. *American Journal of Public Health, 102*(12), 2336-2343. doi:10.2105/AJPH.2012.300762

Teschke, K., & Winters, M. (2014). *Letter to Editor, American Journal of Public Health*. Retrieved from http://cyclingincities-spph.sites.olt.ubc.ca/files/2014/06/Graves-AJPH-as-submitted.pdf

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*: Yale University Press.

Traffix Group. (2012). *Evaluation of Melbourne Bike Share*. Traffix Group, for VicRoads. Melbourne.

Transport for London. (2010). *Measuring Public Transport Accessibility Levels*. Retrieved from London: http://data.london.gov.uk/documents/PTAL-methodology.pdf

Transport for London. (2011). *Barclays Cycle Hire customer satisfaction and usage - wave 2*. London: Transport for London.

Transport for London. (2012). *Travel in London Report 5*. Retrieved from http://www.tfl.gov.uk/cdn/static/cms/documents/travel-in-london-report-5.pdf

Transport for London. (2014). *Barclays Cycle Hire customer satisfaction and usage survey: Members Only*. Retrieved from London: http://www.tfl.gov.uk/cdn/static/cms/documents/barclays-cycle-hire-css-and-usage-members-q3-2013-14.pdf

United States Census Bureau. (2013). State and Country QuickFacts. Retrieved from http://quickfacts.census.gov/qfd/states/11000.html

Van Oijen, J., Lankhuijzen, R., & Van Boggelen, O. (2013). *Feiten over de Elektrische Fiets (Facts about Electrically Assisted Bicycles)*. Retrieved from Utrecht: http://www.fietsberaad.nl/?lang=nl&repository=Fietsberaadpublicatie+24+Feiten+over+de+elektrische+fiets

Walker, I. (2007). Drivers overtaking bicyclists: Objective data on the effects of riding position, helmet use, vehicle type and apparent gender. *Accident Analysis & Prevention, 39*(2), 417 - 425. doi:10.1016/j.aap.2006.08.010

Wardman, M., Tight, M., & Page, M. (2007). Factors influencing the propensity to cycle to work. *Transportation Research Part A: Policy and Practice, 41*(4), 339-350. doi:http://dx.doi.org/10.1016/j.tra.2006.09.011

Webster, K. M., & Cunningham, C. J. L. (2012). Preparing for Bike-Sharing: Insight From Focus Groups and Surveys, Chattanooga, Tennessee, 2010. *Health Promotion Practice*. doi:10.1177/1524839912447191

Woodcock, J., & Goodman, A. (2014). Hard Evidence: do bikeshare schemes lead to more head injuries among cyclists? http://theconversation.com/hard-evidence-do-bikeshare-schemes-lead-to-more-head-injuries-among-cyclists-30135 Retrieved from

http://theconversation.com/hard-evidence-do-bikeshare-schemes-lead-to-more-head-injuries-among-cyclists-30135
Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. *BMJ, 348*. doi:10.1136/bmj.g425
Zaltz Austwick, M., O'Brien, O., Strano, E., & Viana, M. (2013). The Structure of Spatial Networks and Communities in Bicycle Sharing Systems. *PloS ONE, 8*(9). Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84883619196&partnerID=40&md5=a1722a8c79eb7126aa67adf05205e8e3
Zhu, W., Pang, Y., Wang, D., & Timmermans, H. (2013). *Travel Behavior Change After the Introduction of Public Bicycle Systems: Case Study in Minhang District, Shanghai.* Paper presented at the Transportation Research Board 92nd Annual Meeting.