



Does the role of a bicycle share system in a city change over time? A longitudinal analysis of casual users and long-term subscribers

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ABSTRACT

Bicycle Sharing Systems (BSS) are rapidly being implemented globally providing a low-cost active transport option that extends travel distances with greater flexibility than other transport modes. The role a BSS plays in a city can be characterised by the type of users and their trip purposes, but little is known about how use changes over time or the factors impacting change. This longitudinal case study identifies trends in BSS patronage disaggregated by types of users and examines how policies (e.g., helmets, public transport fares) can affect usage by different user types. Time-stamped origin and destination trip data for the Melbourne Bike Share System (MBSS) from 2010 to 2016 was analyzed to identify trends by casual users and long-term subscribers (LTS). Overall, usage increased marginally, but the proportion of casual trips increased from 50% (in 2010) to 80% (in 2016). Policy changes within the MBSS area (e.g., provision of courtesy helmets, the introduction of a Free Tram Zone (FTZ)) affected use by the two types of users differently. However, the initial system objectives and system architecture have not changed in response. Usage by the two market segments by socio-demographic and geographic variables highlighted that both user groups correlated strongly with proximity to major transport hubs. However, while LTS usage is positively correlated with proximity to high-density employment districts, casual usage is positively correlated with the availability of separate bicycle lanes and paths and proximity to tourism destinations. Findings underline the importance of understanding BSS use by market segments and reviewing BSS policy, objectives, planning and design to adequately respond to changing user needs and manage the future evolution of BSS.

1. Introduction

Globally, the number of bicycle share systems (BSS) is growing rapidly. Originating in Europe, BSS have gathered momentum in North America and Asia, particularly in China. As of February 2018, 1560 BSS operate worldwide (Meddin and DeMaio, 2018). Most existing systems are a third generation (DeMaio, 2009) with docked bicycles, cashless payment, online booking systems and real-time monitoring.

BSS offer numerous benefits to users and the community. Cycling is an active, healthy transport alternative to fuel intensive alternatives, generates minimal emissions, greater trip flexibility and financial savings (Shaheen and Guzman, 2011; Shaheen et al., 2010). BSS use has led to mode shift to replace car trips (Bachand-Marleau et al., 2012; Fishman et al., 2014a), replace walking or public transport (PT) trips

(Shaheen et al., 2011) or augment PT use by providing last mile connectivity (Jappinen et al., 2013; Ma et al., 2015). BSS also contribute to normalising the image of cycling (Goodman et al., 2014) and can increase personal bicycle use (DeMaio, 2009; Shaheen and Guzman, 2011).

However, as for all new mobility options, the success of BSS is supported or hindered by the broader policy context. This study focuses on a system in Australia, the Melbourne Bike Share system (MBSS). Launched in 2010 in the central business district (CBD), the system has 600 bicycles in 50 docking stations. Low usage of MBSS in the initial two years of operation has been correlated with mandatory helmet use laws (Fishman et al., 2014a; Traffic Group Report cited in Fishman et al., 2015). This study extends earlier research in two important dimensions. First by drawing on a more extended time series of data

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which spans a range of policy initiatives that have impacted the scheme and second by disaggregating users and examining their usage patterns. The extended longitudinal analysis facilitates comparisons with international BSS and when combined with the user segmentation enhances knowledge in this field and offers insights which inform policy action in different geographic contexts.

This paper is structured as follows. The next section draws insight from the literature to identify the two key gaps in knowledge addressed by this study. The study context and methodology are outlined after that. Results are presented and discussed in Section 3, and finally, Section 4 is the conclusions of the study and directions for future research.

1.1. Literature review

Bicycle share systems (BSS) have been introduced to address a range of objectives, for example: to provide last mile connectivity to public transport (Montreal and San Francisco) (Gauthier et al., 2013; Shaheen and Guzman, 2011), to provide a cost-effective alternative to PT upgrading (Guangzhou) (Gauthier et al., 2013); as a mode for tourists (Paris and Hangzhou) (Gauthier et al., 2013; Shaheen et al., 2011), or to reduce parking demand (Washington) (Ahillen et al., 2016). While some systems are primarily designed to cater for casual use by short-term tourists (e.g., Hangzhou), others, including Melbourne, aimed to provide a long-term use for commuters. There has been limited research attention on whether cities have managed to achieve the objectives initially established for these schemes (Ricci, 2015).

Research into BSS is increasing as systems continue to be implemented around the world. Little is known about patronage trends, elasticities and market segments, particularly over time as these systems evolve. Most BSS studies have analyzed usage at one or two points in the lifetime of a system (Fishman et al., 2014b; Noland et al., 2016). Findings have identified that expansion of the BSS has resulted in increased usage (Zhongshan, China) (Zhang et al., 2016), including into lower income areas (London, UK) (Goodman and Cheshire, 2014), and the impact of weather has been identified from BSS monthly usage variation data (Corcoran et al., 2014; Gebhart and Noland, 2014). To date, the largest longitudinal study of BSS usage, by Ahillen et al. (2016), analyzed an 18-month period using data from cities in North America (Washington) and Australia (Brisbane). They reported increases in both cities following policy action (Washington: 323% increase following system expansion. Brisbane: 99% increase following provision of helmets, more membership options, and reduced prices). So, while there is some evidence on how change in BSS architecture and pricing policies affect usage; it is unclear how these policies affect different market segments.

Previous research has categorised BSS users into two market segments based on subscription status: casual users are short-term subscribers 'who pay for subscriptions of seven days or less', and; long-term users 'subscribe for a month or longer' (Gauthier et al., 2013). Casual users are often leisure or recreational users and tourists (Buck et al., 2013), display a single peak, high usage throughout the day or higher weekend use (O'Brien et al., 2014). Long-term subscribers (LTS) are typically associated with two peaks during weekdays, suggestive of commuter trips (O'Brien et al., 2014). BSS usage can depend on a range of factors including population, age, ethnicity, network density, capacity of dock, altitude, jobs and students in surrounding area, land use around dock, presence of bicycle paths, and proximity to railways station (Buck and Buehler, 2012; El-Assi et al., 2017; Guo et al., 2017; Maurer, 2012). However, only Noland et al. (2016) and Faghih-Imani et al. (2016) have undertaken disaggregate analysis for LTS and casual users. Noland et al. (2016) reported that LTS use is high in residential areas and low in areas with recreational and parking land use and the opposite for casual users. They also found that usage by both market segments was strongly related to availability of bicycle infrastructure. Faghih-Imani and Eluru (2016) also reported casual usage was

positively related to proximity to parks. Residential density and job density had a smaller effect on casual usage than LTS usage. Both the studies reported that proximity to train stations encouraged BSS usage for both market segments. This study builds on this analysis by developing comprehensive BSS demand models for the two user segments and analysing the results in light of the evolving role of the BSS in Melbourne.

The literature is mostly silent on how BSS usage changes over its life course and what types of policies contribute to these usage changes. This paper uses a case study of Melbourne to address these questions. This study had two objectives, first to understand how the role of BSS has transformed since inception by tracing longitudinal trends in use by LTS and casual users. The second objective was to examine the factors and policy actions that have influenced BSS demand by LTS and casual users.

1.2. Study context

The Melbourne Bike Share system (MBSS) was launched in May 2010, inspired by the success and reported benefits of BSS in Paris. MBSS was primarily designed for long-term subscribers (LTS) and to enhance last mile connectivity. With 600 bicycles in 50 docking stations spanning 16 km² mainly concentrated in central Melbourne and surrounding inner suburbs (Fig. 1), MBSS is considerably smaller and sparser than most international BSS (Gauthier et al., 2013; Lathia et al., 2012; O'Brien et al., 2014; Shaheen et al., 2011). The system was planned to be incrementally extended to the whole of inner Melbourne. However, no additions have been made to date (June 2018). The system is operated for the Victorian State Government by a motoring membership organization (Royal Automobile Club of Victoria, RACV). The Government meets all capital and operating cost shortfalls (estimated at A\$2 million per annum). The key objectives of the system were: "social sustainability within an integrated public transport system"; to "promote short distance cycling around central Melbourne"; to "extend the reach of the public transport system", and; to improve cycling mode share and help reach greenhouse emission reduction targets (VicRoads, 2017). Bicycle helmet use is mandatory for all cyclists in Australia, including BSS users.

1.2.1. Melbourne bike share subscriptions

There are three types of long-term subscriptions available online: 'annual with no helmet provided' (\$60 per year), 'annual with medium-size helmet provided' (\$65 per year), and 'pay as you go' (\$3 per day to access MBSS). Long-term subscribers (LTS), create an online account, provide necessary demographic information and set up an online payment schedule. LTS receive a unique bicycle key code by post to access a shared bicycle without a deposit and for free unlimited 45-min use. Longer trips are chargeable. Casual users, can buy a daily or weekly pass from self-service MBSS kiosks using a credit card pay a deposit (A\$10) and for free unlimited 30-min use. Longer trips are chargeable.

1.2.2. Usage and public policy

Docked BSS in Australia (in Melbourne and Brisbane) have struggled with low usage rates of 0.3–0.8 trips per bicycle per day (tbd) (Fishman et al., 2014b) as compared to international systems with high usage of 8 tbd in New York and Lyon (Gauthier et al., 2013), 6 tbd in Paris (Gauthier et al., 2013; Nair et al., 2013), 5.8 tbd in Shanghai (Zhao et al., 2014), 4 tbd in Boston. Key barriers identified include mandatory helmet regulations, the location of docking stations and living outside the MBSS area (Fishman et al., 2014a; Traffix Group, 2012 report cited in (Fishman et al., 2015:19)).

Over the study period, two key policy decisions were made. First was an increase in the affordable and easy access to helmets with the aim of increasing patronage. In October 2010, affordable helmets (\$A5) were available for sale at select retail stores around docking stations (e.g., 7-Eleven convenience stores). In April 2013, the Victorian

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