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Bicycle access to Melbourne metropolitan rail stations[1]

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Abstract

Bicycle storage facilities at railway stations provide a convenient option for commuters who cycle to the station to leave their bicycle during the day given that bicycles are not encouraged on trains during peak travel times. In large metropolitan areas encouraging commuters to link their journey to the train station with active transport has broad social benefits including increasing incidental exercise, reducing on-road vehicle congestion to the station and reducing the vehicle parking space required. However, to date there has been little research investigating the utility of bike storage facilities at train stations and the factors that influence individuals to cycle to stations in the Australian context. The aim of this study is to advance understanding of the bicycle as an access mode to metropolitan rail stations. As part of this research a multi-level analysis approach was adopted where aggregate analysis using Parkiteer (secure bicycle parking facility) swipe card access data and disaggregated analysis through self-completion surveys were used to gain valuable insight about the utility of bicycle storage facilities across the entire railway network and the factors that affect bike-and-ride rates in Melbourne. Key findings from this study show there is a continued demand for secure bicycle parking facilities as indicated by a 35.54% average annual growth rate in Parkiteer utility for each year from 2010 to 2015. Parkiteer users surveyed reported riding 5.5km or less to the station and over half cited that lack of available car parking spaces contributed to their decision to bike-and-ride.

1. Introduction

The Melbourne metropolitan train network carried 232 million passenger trips in the financial year 2013/14, up 2.7 percent on the previous year (ABC 2014). In response to continued passenger growth, the Victorian government has committed to substantial investment in infrastructure and rolling stock including a new underground rail link (the Melbourne Metro Rail), extended platforms for high capacity trains, rail line extensions, 24-hour public transport and a multi-year program of level crossing removals. While these investments will expand network capacity and reduce impacts on road based transport, an issue which will become of increasing importance in the years ahead will be the capacity of the access modes which passengers use to get to suburban railway stations. As a result of Melbourne's low population density and car-centric culture suburban railway station parking facilities are often filled early in the peak period (Mead, Johnson et al. 2016)

The availability of secure storage areas for bicycles has been identified as a key determinant of whether commuters decide to cycle to the station (Barajas 2012) and therefore supports increased use of the bicycle to access public transport (Fleming 2012),. The potential is

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perhaps best exemplified by the situation in the Netherlands where bicycles account for 35 per cent of access trips to train stations (Rietveld 2000). While in Australia the cycling culture is not as prominent, the economics of providing bicycle parking instead of car parking are compelling. An additional 250 car parks were recently provided at Syndall station in metropolitan Melbourne. The multi-level parking structure cost $10.8 million or $40,000 per vehicle parking space. In contrast the provision of secure bicycle parking cages costs on the order of $4,000 per bicycle (Martin and den Hollander 2009). Further, at stations where passengers are willing to lock their bicycles to existing poles or fences the provision for bicycle parking facilities is effectively zero cost to the rail operator. However, where secure bicycle parking facilities are provided there is often considerable variability in the utilisation of those facilities (Mead, Johnson et al. 2016) with limited bicycle facilities in the area surrounding the station and the availability of free car parking inhibiting uptake of the bicycle as an access mode (Cervero, Caldwell et al. 2013).

Against that background, the overall aim of this study is to advance understanding of the bicycle as an access mode to metropolitan rail stations. The research objectives (RO) of the study were to:

- identify the trends and variability in use of existing bicycle parking at stations (RO1)
- explore the factors which influencing individual's decisions when choosing to access local stations by bicycle (RO2).

The structure of this paper is as follows. The next segment, section 3, outlines the methodology and distinguishes between the aggregate and disaggregate components of the research. The results are presented in Section 4 and then the final section highlights the conclusions and identifies directions for future research.

2. Study Approach

This study employed a multi-level analysis approach as illustrated in Table 1. A combination of aggregate and disaggregate analysis was used to achieve the study objectives. Aggregate analysis was concerned with identifying the trends and variability of secure bicycle parking at railway stations across the entire Melbourne train network through the use of access card data for all Parkiteer cages. Characteristics and factors which influence individuals to commute to the train station by bicycle were identified through disaggregate analysis which involved acquiring data through a self-completion questionnaire at 5 metropolitan railway stations. Table 1 identifies the sources of data and the approach taken in each component of the analysis.

Table 1: Study Approach

Research objective	**Method**	**Data**	**Analysis**	
			Aggregate	Disaggregate
RO1: identify the trends and variability in use of existing bicycle parking at stations	Quantification of trends and levels of variability across Parkiteer locations	Swipe card access data from secure bicycle parking facilities at Metro rail stations	✓	
RO2: explore the factors which influencing individual's decisions when choosing to access local stations by bicycle	Descriptive statistics and cross tabulations, spatial representation of data using GIS	Self-completion questionnaire distributed to individuals who parked a bicycle at 5 Metropolitan railway stations		✓

2.1. Aggregate usage data: Parkiteer entries

Secure bicycle storage facilities at train stations were first trialled in metropolitan Melbourne, Australia in 2008 at 23 locations. Trademarked *Parkiteer (Figure 1)*, these bicycle cages provide a secure location for bicycle storage that reduces the risk of theft and vandalism for train passengers who leave their bicycle at the station. Parkiteers are located close to the entry point of the railway station and users of Parkiteer register online and pay a $50 bond to receive an access card that they swipe to enter (bond is refunded on return of the access card). Electronic access is solar powered, maintenance of the bike cages and user registration are managed by the cycling organisation Bicycle Network.

Parkiteers are having an impact on commuter mode choice in their journey to the train station. A case study of commuter mode shift at three Melbourne train station reported that over a third of Parkiteer users had previously driven to the station (Hoppers Crossing: 37%; Brighton: 38%; Werribee: 45%) (Martin and den Hollander 2009). These findings may indicate that more Melbourne commuters would be willing to bike-and-ride if secure bicycle storage facilities were available.

At the time of this study 73 Parkiteer facilities had been installed across the Victorian rail network. However, there is a high degree of variability in their usage across the network. For example, the Parkiteer cage in Laverton (21km west of CBD) has a waiting list for registration and is frequently overcapacity with all bike racks inside the Parkiteer occupied and commuters also locking up bicycles outside the cage. In comparison, Parkiteers at Roxburgh and Diggers Rest (22km and 33km from CBD) are at less than 5 per cent capacity most days.

For each Parkiteer facility, the number of daily entries were identified by daily swipe card access. Some locations such as Frankston (44km from CBD) and Laverton have multiple Parkiteers to accommodate high use and patrons arriving from multiple directions. While this data captures all users of the Parkiteer facility, commuters may also choose to ride to the station and lock their bicycle outside the Parkiteer. The data on the number of people who cycled to the station and did not use the Parkiteer were not available and collection was outside the scope of this study.

Figure 1: Parkiteer Secure Bicycle Parking Facility

2.2. Disaggregate Data: Bicycle rider survey

In addition to the aggregate data, user surveys were conducted at five metropolitan railway stations. The survey data augmented the aggregate data which does not provide any insight into the characteristics or usage patterns of individual users, nor details about individuals who ride to the station but do not park in a Parkiteer.

The Melbourne metropolitan train network includes 207 stations. Resource constraints meant that only a small number of stations could be targeted. Carnegie, Murrumbeena, Oakleigh, Huntingdale and Springvale station, all on the Cranbourne/Pakenham line were ultimately selected for investigation. This is because they were in Melbourne's highly urbanised south-east, were not currently subject to any construction works, exhibited a number of different bicycle station access routes and were comparatively close to each other. This last point was especially important as it would allow for the establishment of "capture areas" for each station, and give indications of when two stations are adjacent which one would attract more bike access users.

The disaggregate survey took the form of a self-completion questionnaire, four pages in length. The survey asked commuters that cycled to one of the target train stations questions relating to their journey from home to the station, their experiences with the station facilities and motivations for choosing to travel by bicycle. In addition to this, demographic information, primarily relating to age and gender was gathered and respondents were asked if they would be willing to be contacted for future surveys. Respondents had the option of filling out the survey online (by going to a website or scanning a QR code), or through filling out the paper survey that was handed to them and sending it back in a reply paid envelope which was provided. These forms were distributed either directly to cyclists immediately after they parked their bicycles, attached to bicycle handlebars in a zip-locked plastic bag, or slid underneath the doors of bicycle lockers.

In order to mitigate variation in results that could be caused by surveys distributed at different days of the week or under different weather conditions, all stations were circulated in the same 6:30am - 9:30am window on Tuesday, 19 of April 2016. The survey was late in autumn, with a minimum temperature of 14°C and a maximum of 27°C, no rain and partly cloudy conditions throughout the day. The survey day was not a school or public holiday.

3. Results and Discussion

This section examines the results from each component of the analysis. Section 3.1 focuses on the aggregate analysis component while Section 3.2 focuses on the disaggregate results. Overall conclusions are then drawn in Section 4.

3.1. Aggregate Analysis

Parkiteer swipe card access data available from 2010 to 2015 was analysed to identify the trends in utility and variability in usage across the years. The findings indicate that there has been a continued demand for secure bicycle parking facilities and that as the Parkiteer program matures more people are willing to use such facilities while the variability in usage across these facilities tend to decrease, signifying that a core group of regular users are starting to form.

Figure 2 identifies the average daily Parkiteer entries for each year from 2010 to 2015. It can be seen that the utility of Parkiteer facilities are steadily growing at an almost exact linear rate signifying that there is a continued demand for this service. A linear model of average daily Parkiteer entries over time was created using the least squares method which has a correlation coefficient (r) value of 0.9991 signifying a strong linear relationship. The model predicts that every year after 2010 the average daily Parkiteer entries rise by 63.95 users. This demonstrates that providing secure bicycle parking is desired by many bike-and-ride participants and concurs with the previous research (Rietveld 2000, Barajas 2012). By providing secure bicycle parking the share of bike-and-ride is likely to increase although it should be investigated whether these additional users are pre-existing bike-and-ride users who used other parking facilities or whether a mode shift to cycling has occurred due to the availability of the secure bicycle parking facilities at train stations.

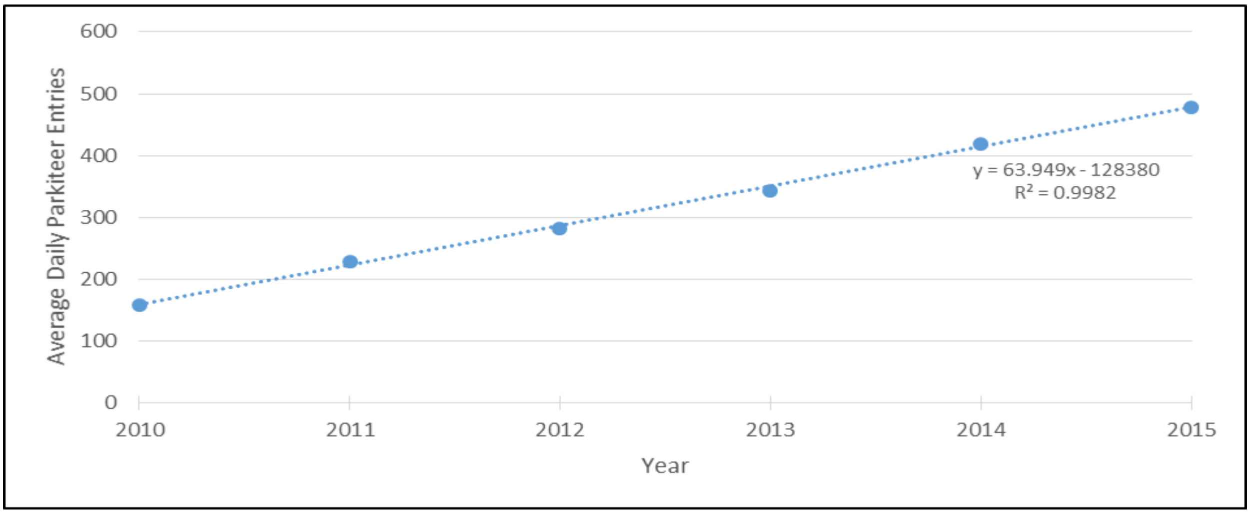

Figure 2: Average daily Parkiteer users by year

The coefficient of variation for the daily Parkiteer entries that were operational both in 2010 and 2015 were plotted against the average daily Parkiteer entries as seen on Figure 3. A moderate negative correlation is observed between the two variables in 2010 with a correlation coefficient (r) of -0.598. For the two variables in 2015 a weak negative correlation exists with a correlation coefficient of -0.393. This indicates that in both 2010 and 2015 the variability in daily Parkiteer entries decreases as the average daily Parkiteer entries increase, although this effect is more pronounced in 2010. A possible explanation for this could be that as Parkiteers are newly commissioned their use is low while the variability in use is high, over time as more commuters become aware of this facility the use increases and subsequently the variability decreases.

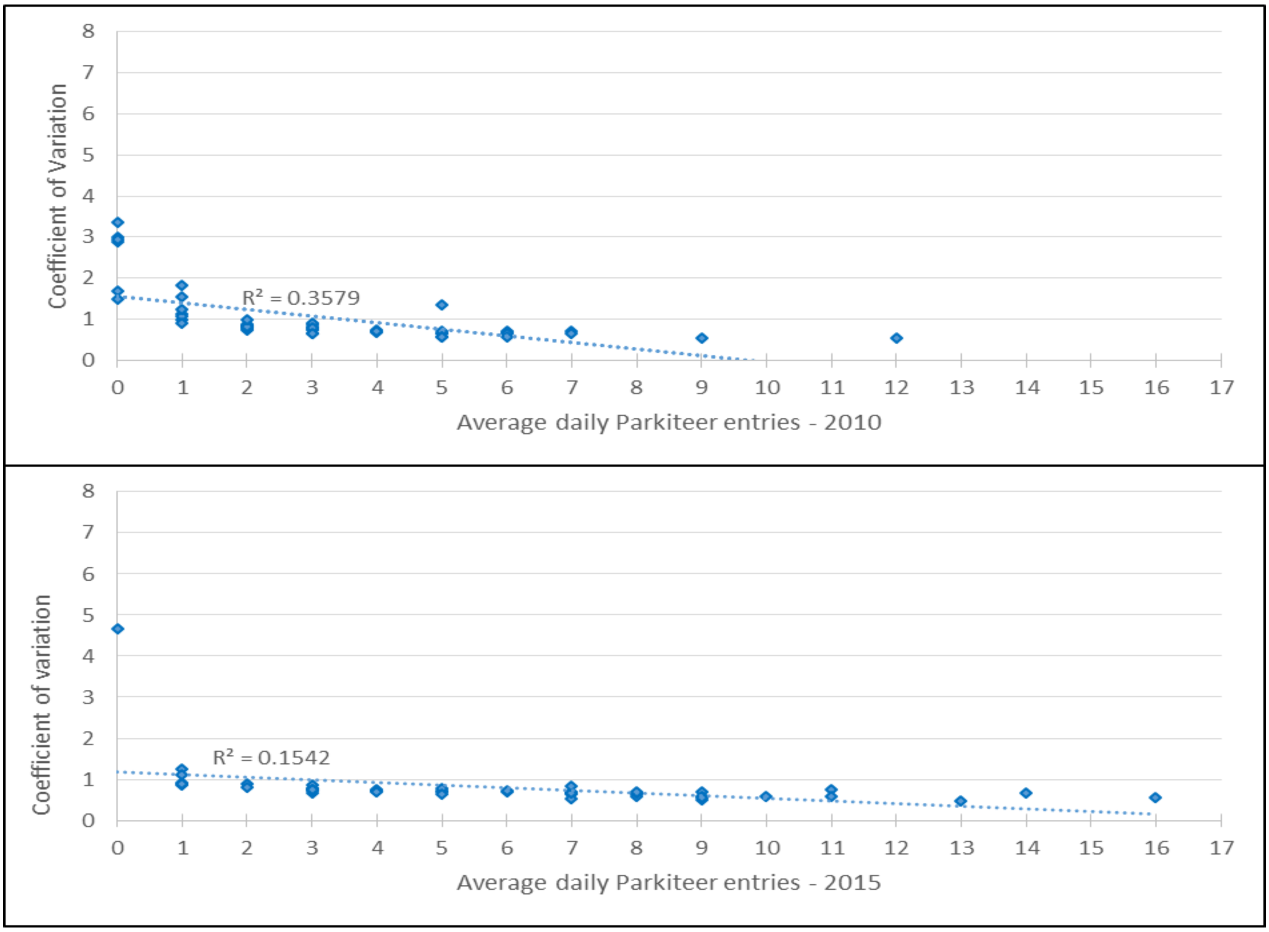

Figure 3: Variability in daily Parkiteer usage by average daily Parkiteer entries in 2010 and 2015

3.2. Disaggregate Analysis

Across the stations which were targeted, a total of 77 questionnaires were handed to cyclists as they parked their bicycles at these stations. A total of 27 were returned (35%) which can be considered reasonable for a self-completion questionnaire of this nature (Richardson, Ampt et al. 1995). The response rate varied across the stations from the highest at Oakleigh (52%) to the lowest at Springvale (8%). Overall 37 per cent of respondents were female which is higher than in the general cycling population (Bell, Garrard et al. 2005). Respondents were travelling primarily for work (77.8%) or education (18.5%) and about half (51.2%) cycled to the station at least five days per week, with a further 37 per cent cycling to the station three or four days per week.

Respondents were asked about the extent to which they agreed or disagreed with a range of statements. Nearly 90 per cent (88.9) either strongly agreed or agreed that cycling is quicker than using either buses or trams (where available) to access the railway station. While 55 per cent of respondents agreed or strongly agreed that the availability of off-road facilities were important in their decision to access the station by bicycle, only 41 per cent had similar opinions of on-road cycling facilities perhaps because only about one third of respondents strongly agreed or agreed that the presence of few motor vehicles on their route to the station was influential in their decision to ride.

Over half the respondents (55 per cent) agreed or strongly agreed that the difficulty of finding a carpark at the station influenced their decision to ride. Analysis of the station arrival times revealed a clear peak in the 45-minute window between 8am and 8:45am. This would allow commuters to arrive at most Melbourne CBD locations around 9am. While car parking had completely filled before 7:45am at all survey sites, the Parkiteer cages were not filled to capacity and there were plenty of locations to lock a bicycle apart from where Parkiteers were provided. This suggests that for cyclists their arrival time at the station may be influenced more by their desired train departure time rather than the need to arrive in time to secure a parking spot, as may be the case for those accessing the station by car.

Respondents indicated the closest cross street to their home address. This provided scope to get a more accurate estimate of station access distance than if the postcode alone was used to locate the start of each person’s journey. Bicycle trip distance from home to the station was estimated using the Google Maps cycling journey generator (Google 2016). This gave the distribution of estimated journey distance shown in Figure 4.

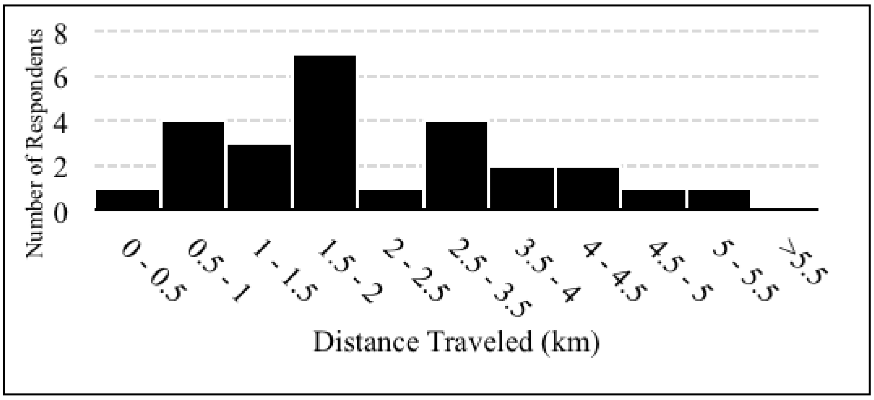

Figure 4: Distance cycled from home to the station

As shown in Figure 4, about three quarters of respondents (77 percent) cycled less than 3.5 km in order to reach their respective train stations, and no cyclists rode for more than 5.5 km. This supports research previously conducted by (Krizek and Stonebraker 2010), which found that cyclists traveling to public transport hubs would generally choose to cycle if the distance to be covered was between 2.2 and 5 km.

The home locations were then processed in the GIS software package *CartoDB* to generate Figure 8. In that figure, respondents' points of origin (reflected by the nearest cross street) are represented by point features, and the stations they rode to are represented by the corresponding point feature's colour. Other train stations are denoted by smaller marker icons. Local bus routes have been marked by brown dotted lines. Only the bus routes which most closely pass each respondents' point of origin are shown. Local bicycle paths are marked by green dotted lines. Only off-road bicycle trails, and roads with dedicated bike lanes have been displayed. Again, only the bicycle lanes closest to respondents' houses are shown. Bike lanes which lead away from the train line were not shown. Through connecting the commuter points of origin it was possible to establish capture zones, which have been included in Figure 5. When generating these zones, it was assumed that the areas could also be bounded by adjoining parks, the mid-distance between stations and train lines, and a one block distance from a station's most remotely located point or origin. These capture zones are all orientated in an 'L' shape, indicating that on their morning commute cyclists will choose the path with minimal turns, preferably with accompanying bike lanes (as indicated by the Murrumbeena and Carnegie capture zones). The general preference reflected here is to cycle to stations closer to the CBD from the cyclist's point of origin. These capture zones around each station do not correspond to the circular catchments often assumed in analysis of bicycle parking to stations (Mead, Johnson et al. 2016).

The number of cyclist journeys being along bus routes, as shown in Figure 8 indicates that the presence of bus routes largely had no effect on respondents' choice to cycle to a given station. The most noticeable instances where cyclists chose not to cycle to the station closest to them was in the case of Oakleigh and Carnegie/Murrumbeena, where some respondents were closer to Huntingdale and McKinnon station respectively. In the instance of Oakleigh, this may be because it is a station with greater ridership and more retail/hospitality land uses in the local area, while with Carnegie and Murrumbeena it is most likely the case that the train line they are on has more frequent services than the Frankston line that McKinnon station is on.

(Hull and O'Holleran 2014) inference on cyclist demand being driven by the 'relative desirability' of cycling has been supported by these results, as shown by "cycling to the station is quicker than catching a bus" scoring the highest of all agreement questions.

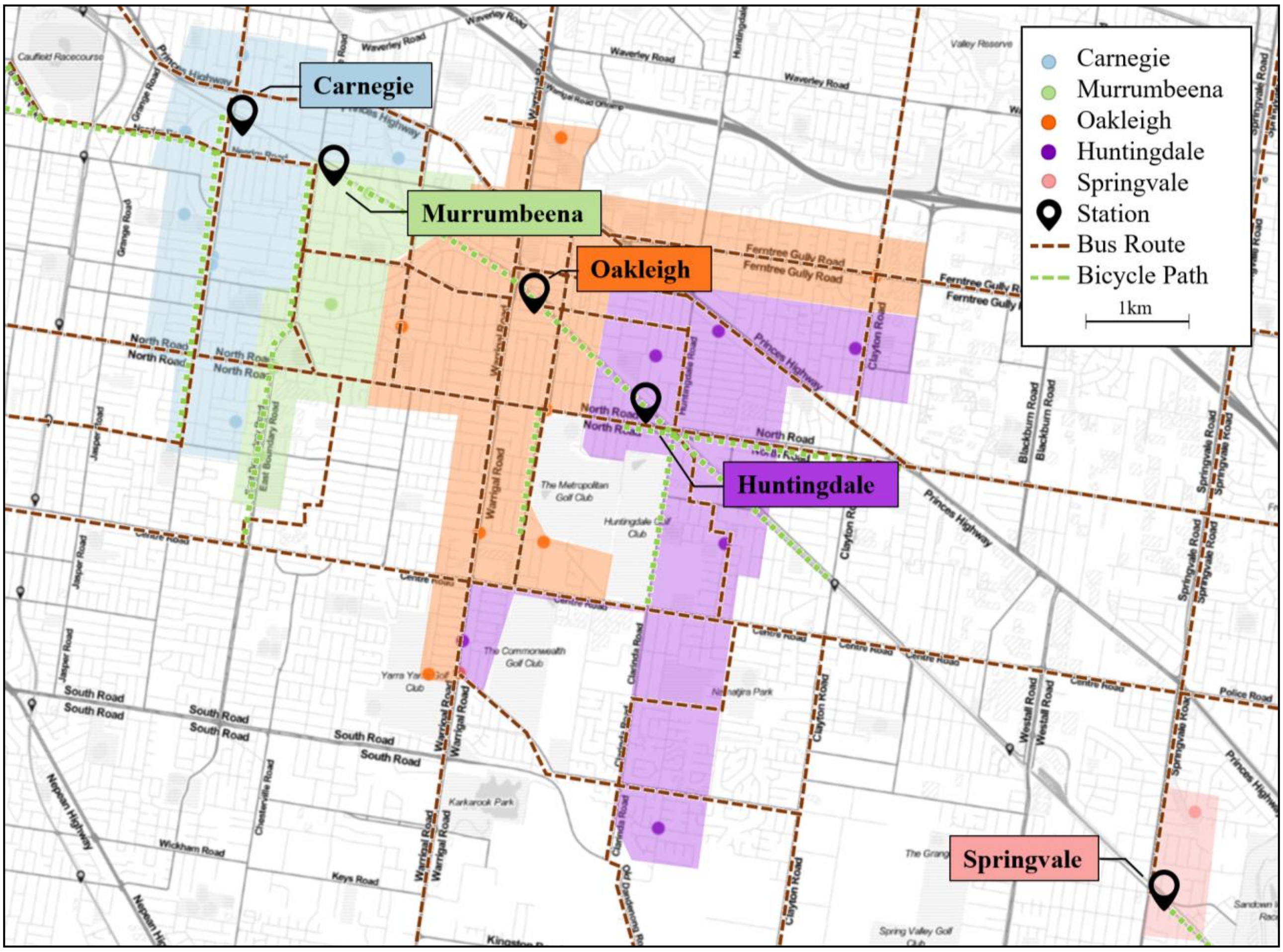

Figure 5: Station catchment analysis and access options
Source: CartoDB (2016), Google (2016), OpenStreetMap (2016), Public Transport Victoria (2016b)

The findings from the self-completion questionnaires are based on a response to surveys conduced at five metropolitan railway stations; three of which had a Parkiteer (Springvale, Huntingdale and Oakleigh) while the other two (Murrumbeena and Carnegie) did not have a Parkiteer facility. Due to the small sample size (n=27 responses received) the findings should be interpreted with caution and that the disaggregate component of this research is perhaps best considered as a pilot study. A larger data set would be required to develop defensible evidence on which to formulate policy. However, the results suggest that the catchment area for cyclists is greater for stations with a Parkiteer facility. Further research is needed to identify factors that influence bicycle access to train stations and the effects of secure storage facilities on bike-and-ride levels.

4. Conclusions and Research Directions

Usage rates of secure bicycle parking in metropolitan Melbourne indicate that there is a demand for this service among current bike-and-ride train passengers. The continued growth suggests that additional bicycle parking will be utilised, particularly at those stations where there is an existing ridership or at stations with known demand (e.g. stations with a waiting list). While there are seasonal impacts on use, the increases in use suggest there is greater potential for mode shift if additional facilities were available to riders at the station.

However, given the small survey response rate in this study, the findings of the disaggregated data should be considered as indicative, pilot finding and interpreted with caution. Further research with a larger sample is needed to determine the representativeness of these findings, including surveying at a greater number of stations.

Findings from this study provide interesting insights into existing bike-and-ride users, however further research is needed to understand the latent demand for these facilities, particularly at the locations which currently do not have secure bike parking facilities. Also, while Parkiteer storage facilities are significantly less expensive to install than parking for vehicles, they are still a considerable cost compared to unsecured bicycle parking (e.g. bicycle hoops). It would be advisable to determine the latent need for additional, well-positioned, well-lit bicycle parking before investing extensively in secured parking across the train network. Finally, it is important to take into consideration the entire trip from origin to the station and the potential impact the on- and off-road infrastructure, or lack thereof, may have in influencing people's decision to bike-and-ride.

Acknowledgements

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