Evaluation of a suburban, campus-based bike arrival station

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ABSTRACT

End of trip facilities can be a barrier that limits the potential of the bicycle as a commuter transport mode. In recent years there has been increasing interest in development of large cycle centers or bicycle arrival stations which provide secure bicycle storage, changing rooms, showers, lockers and repair facilities. This paper reports the results of an evaluation of a bicycle arrival station built on suburban university campus about 20 km from the CBD in Melbourne, Australia. Use of this un-staffed facility, which provides secure parking for 100 bicycles, is offered free of charge to staff and students. While users where generally satisfied with many features of the facility, concerns emerged over the adequacy of the towel drying facilities, the availability of lockers and the management of the locker facilities. Nearly half of the users indicated that they had switched from commuting by car to the bicycle as a result of access to the facility. In an absolute sense the impact of the facility on commuting to campus is small given that on a typical day during the semester it caters for 55 users and replaces about 52 motor vehicle trips. Measures to encourage greater use by staff throughout the year, and discourage lockers being captured by infrequent users, would help to increase its utilization. That would improve the cost effectiveness of providing facilities like this to stimulate bicycle use while simultaneously reducing car use and greenhouse gas emissions.
INTRODUCTION

Considerable research is being directed at understanding the role that infrastructure, along with supporting programs and policies, has in increasing cycling (1, 2, 3). While valuable insight is being obtained from national and international comparisons which showcase the success of initiatives in different cities (4, 5), studies consistently highlight the negative impact of barriers including infrastructure and end of trip facilities (5, 6). There has been growing international interest in the development of high quality, full service, end of trip facilities for commuter cyclists. These facilities are known by a variety of names including bike arrival stations, bike centres, bike stations, bike depots or cycle centres. While these facilities have operated in the US for more than 10 years they have only recently emerged in Australia (7). They operate on a user pays basis and provide an opportunity for cyclists to shower and change for work/study along with somewhere to securely store their bicycle and equipment. While the shower and change facilities are important for commuter comfort, the provision of adequate security for the bicycles should not be overlooked since that has been identified as a deterrent to riding (8).

Recent cycle centre evaluations have focused on CBD based facilities which operate on a user-pays basis (7). The focus here is on a suburban based facility, located on a university campus where access is provided free of charge to staff and students. The James Gormley Bike Arrival Station (JGBAS) at Monash University’s Clayton campus in Melbourne, Australia, provides secure bike parking, showers, lockers and change rooms. By virtue of its location outside the Central Business District (CBD) of a major capital city, it is the first of its kind in Australia. This bike arrival station is a $1.2 million facility that was jointly funded by Monash University and the Victorian State Government. The bike arrival station opened in late 2010 and was named posthumously in honour of the staff member who had the vision for the facility. The evaluation reported in this paper was undertaken to assess the facility from the perspective of users and measure its impact on their travel behaviour.

The paper begins by briefly reviewing the insight from a literature review undertaken to guide the development of the evaluation methodology. That is followed by a description of the location, context and features of the JGBAS. The evaluation framework and methodology are then detailed prior to presenting the results of a user survey. The final section presents the conclusions and identifies directions for future research.

INSIGHT FROM THE LITERATURE

While literature exists detailing the need for bike arrival stations, assessing demand and determining the most appropriate locations (9, 10 and 11) very little research has been published which reports evaluation of these facilities. The recent work of Burke (7) which evaluated the King George Square Cycle Centre (KGSCC) is an exception.

The KGSCC was the first of its kind in Australia and after its first 12 months of operation, Burke et al (12) conducted a detailed evaluation of the cycle centre. Their approach involved a series of interviews with the centre’s funding agencies and manager-operators along with a survey of the users of the facility. The intention of the KGSCC evaluation was to determine whether or not the KGSCC had:
1. reduced private motor vehicle kilometres travelled,
2. encouraged mode shift to the bicycle from motorised modes, and
3. generated sufficient income to cover its operating expenses.

Burke et al (12) developed key performance measures based on the evaluation criteria and used them to determine the exact information needed to establish whether or not the KGSCC had been effective in meeting its goals.

Quality bike arrival stations have been found to have a positive influence on an individual’s decision to commute by bicycle (15). Burke et al (12) asked respondents to indicate how important a range of factors were in their decision to travel by bicycle to the KGSCC. The provision of quality end-of-trip facilities, including secure parking, storage and showers, was the most important factor influencing people’s decision to ride and use the KGSCC. Having access to a safe route and an adequate cycle network both rated only slightly lower on the importance scale while having no, or poor, access to a car or public transport were the least important factors.

The distance from a bike arrival station to a person’s ultimate destination is often a critical factor in determining whether commuters will use the facility (11, 13, 14). Larsen and El-Geneidy (14) used the distance decay method to show the decline in bike path usage as the facilities were further and further away from the preferred route. This approach has been used to understand the catchment of a bicycle arrival station (12) in terms of the distance to the user’s ultimate destination.

**JGBAS: LOCATION, CONTEXT AND FEATURES**

Monash University’s Clayton campus is over 100 hectares in size and services over 27,000 students and approximately 6,000 staff. In contrast to many North American campuses, only a minority of students live on campus with accommodation available for only 1,200 students. The campus, located approximately 20km south-east of the Melbourne CBD, is bounded on three sides by three-lane primary arterial roads controlled by the State road authority (left hand panel of Figure 1). There are no dedicated on-road cycle lanes on the arterial roads close to the campus. An off-road bicycle path runs along the Monash Freeway located about 1.5 km north of the campus. While cyclists can filter through local streets, and use some limited sections of kerb-side bicycle lanes on nearby collector streets, the local area provides limited dedicated facilities for cyclists. The JGBAS was constructed under a ramp in a car park located on the north-west corner of the campus and the majority of the buildings on campus are located within 750 metres of the facility (right hand side of Figure 1).

Public transport to the campus consists of 14 public bus routes and University provided inter-campus shuttle buses. As is typical of buses operating in Australian cities, none of them are fitted with racks for carrying bicycles. About half the bus routes provide connections to the nearby rail stations located on the radial lines focused on the CBD. Significant amounts of car parking is available on campus, with prices starting at $350 for blue parking permits (available to all staff and students) and increasing to $900 for premium green parking permits (available only to senior staff only). Limited off campus free parking is available in a remote Monash parking lot located approximately a 15 minute walk from campus. Students and staff who carpool are eligible for free on campus parking.
Prior to the construction of the JGBAS, end-of-trip facilities for cyclists were limited and scattered. Bicycle parking consisted of hoops and lockers, with each scattered around the campus and in varying states of cleanliness and usability. The bicycle lockers were managed by Traffic and Security and required users to book them for 6 or 12 months. They were chronically oversubscribed, with a waiting list of close to 100 people, and underused. The management system was altered to a daily use system in 2010 which required users to bring their own padlock and use the lockers on a first come first served basis.

Results from the 2009 staff and student travel survey (the latest reliable travel survey available for the Clayton campus) indicated that the bicycle mode share was 6% against public transport at 33%, drive alone at 29%, carpool at 17% and walk at 13%. Since that travel survey asked respondents to nominate the mode that was the longest (distance) part of their journey it is likely to underestimate bike use by ignoring short distance bicycle use as part of a multimodal journey. The availability of private student housing around the campus results in walking being a viable access option for nearby residents. The parking permit prices provide a disincentive for driving which help to stimulate use of other models.

Figure 2 shows a series of views of the JGBAS. The facility provides racks for securing 100 bicycles and has 108 lockers for which users must supply their own lock. It includes male and female shower/change rooms and toilets along with a bicycle maintenance area. Located nearby are 10 bike lockers and nine external bike parking rails. Users must register to gain access by swiping their ID card. The facility, which is
monitored by video surveillance and patrolled by security staff, operates on a self-service basis and is provided free to staff and students who register. By way of contrast, users of the KGSCC in Brisbane pay between $4.00 per day (on a 6 month contract) to $12.00 per day (casual rate) to access that facility. That daily charge includes a fresh towel and use of a lock. Users of the JGBAS must supply those items themselves.

It is appropriate to place the scale of the JGBAS into perspective in relation to cycling to campus. As noted earlier, about 6% of the campus population report riding and that equates to about 1,900 bike trips to campus. Given it incorporates parking for about 100 bikes, the JGBAS only has the capacity to cater for a small proportion of the people who ride to campus. However the university was keen to understand the impact of improved end-of-trip facilities since consideration was being given to developing similar types of facilities in other locations on the campus.

Figure 2: Images James Gormley Bike Arrival Station (JGBAS): External front and rear entrances [top panels]. Bicycle racks and lockers [lower panels]

EVALUATION FRAMEWORK AND METHODOLOGY

The JGBAS had three main objectives which were set out by team members who worked on the design and development of the facility. Those objectives were:

1. To increase the number of people commuting to the Clayton Campus by bicycle,
2. To provide the Clayton campus students and staff with an appropriately located end-of-trip facility that met the needs of the users, and
3. To promote cycling as the preferred mode of transport to the Clayton campus, particularly targeting drivers of single occupancy vehicle and encouraging public transport users to adopt or integrate the healthier and environmentally preferred alternative with their public transport journey.
No quantitative targets were established in relation to any of those objectives. By adopting a similar method to that used in the evaluation of the KGSCC (7), the evaluation criteria summarized in Table 1 were established for this study.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Evaluation Question</th>
<th>Key Performance Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the number of people commuting to the Clayton campus by bicycle</td>
<td>Has the frequency of travel increased for users of the facility?</td>
<td>• Increased frequency in travel by bicycle by users</td>
</tr>
<tr>
<td></td>
<td>Have people started riding due to the quality end-of-trip facilities being constructed?</td>
<td>• New cyclists commuting due to end-of-trip facilities</td>
</tr>
<tr>
<td>Appropriate location of the BAS</td>
<td>Are the facilities located in an appropriate position?</td>
<td>• Consistent use by staff and students over the whole campus</td>
</tr>
<tr>
<td></td>
<td>Is the location of the facility deterring potential users?</td>
<td></td>
</tr>
<tr>
<td>Facility that meets the needs of the users</td>
<td>Do the facilities meet the needs of the users?</td>
<td>• Needs of users are met</td>
</tr>
<tr>
<td></td>
<td>Are the users satisfied with the facilities provided?</td>
<td>• Majority of users are satisfied with individual facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adoption or integration of healthier and environmentally preferred modes of travel by users</td>
<td>Has the BAS encouraged and influenced people to commute by bicycle rather than a motorised form of transport?</td>
<td>• Reduced private motor vehicle kilometres travelled (VKT)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While an experimental design involving measurements before and after opening the facility, preferably along with the inclusion of a control group who did not have access to the facility, would have provided a rigorous basis for the evaluation, such as approach was not feasible for this study. Since the evaluation was initiated after the facility was constructed, it had to rely only on ‘after’ measurements. Given that the focus was on the satisfaction of the users and the impact of the facility on their travel decisions, a user survey was a logical choice for collecting the data to underpin the evaluation.

An online survey was chosen as the preferred survey option as it was the cheapest and easiest alternative to implement. All registered users have university email accounts and they were sent a recruitment email explaining the background to the survey and inviting them to click on an embedded link to begin the survey. The survey ran for one week in the middle of May 2011. A reminder email was sent to all registered users in the middle of the survey week. That email thanked those who had already responded and
encouraged those who had not yet completed the survey to do so before it closed at the start of the following week.

**EVALUATION RESULTS**

There were a total of 702 registered users for the JGBAS at the time of the first email and a total of 158 responses. The survey had a 23.4% response rate after adjusting for 26 registered users whose email accounts had been closed because they were no longer at the university. The response rate was therefore marginally higher than the 22% reported by in the evaluation of the King George Square Cycle Centre in Brisbane (7).

One issue with surveys like this is that their voluntary nature leads to a relatively low response rate, which can result in non-response bias. In the case of this survey, it was evident that the responses were biased toward the commuters who use the JGBAS most often. The facility averaged 55 users per day based on the swipe card access data and 55.2 users per day based on the survey data. This suggested that the respondents to the survey were the ones using the facility the most often. Individuals who used the JGBAS most often had the most to gain from completing the survey because they possibly believed that their input would help to improve the facility. While this result was expected, it means that results obtained from the respondents may not be able to be extrapolated to the entire population of registered users.

Given on average 55 users accessing the facility each day, the bicycle parking is operating at about 50% utilization. However users have claimed all the lockers by installing their own locks. It is possible that lack of available lockers may constrain growth in use of the facility particularly when some people who claim a locker are infrequent users.

**Demographics**

Differences in the demographics of the people who registered for the JGBAS and the respondents is another potential area of concern in relation to non-response bias. Reassuringly, the percentage of responses from staff and students was exactly the same as in the registration data (29% staff and 71% students). The gender split was also quite similar with a 75%/25% male/female split in the registration data and a 73%/27% split in the survey responses. Many people chose not to answer optional demographic questions at the time of registration and so it was not possible to compare the responses on the basis of other variables such as age. However, from an occupation and gender point of view, the sample appears to be representative of the population.

**Trip Distance**

The trip distance to the campus was calculated for each respondent using Google Maps based on the shortest route from the suburb in their residential address as provided on the survey. This provided a conservative estimate of trip distance as commuters are more likely to take slightly more indirect routes in order to avoid major highways, overcome the lack of connectivity in the local street network created by the freeways and to use bike paths if they are located within a reasonable detour distance (14). The one-way trip distances ranged from 1 km to 37 kms. The mean trip distance was 11.6 kms. Mean trip distances for the men and women in the sample were essentially the same as the global
mean. International postgraduate students had mean trips shorter than the global mean (presumably reflecting their preference to live close to campus) while academic and general staff had mean trip distances above the global mean. Since the surveys targeted only users of the JGBAS it is not possible to make any statements about whether the trip length distribution is any different for users who park their bikes elsewhere on campus.

To examine whether the trip length distribution for users of the JGBAS was any different to other commuter cyclist journeys in Australia, use was made of two comparable data sources. Figure 3 presents the trip length distribution of one-way travel to the JGBAS with comparable data from the KGSCC evaluation in Brisbane (7) and the 2010 National Ride to Work Day (NRTWD) event. The Annual NRTWD, which was last held on the 13th of October 2010, aims to encourage people to commute by bicycle to work and school (17) and attracted over 36,000 participants nation wide in 2010. The general trip distance distribution of the JGBAS, NRTWD and KGSCC are all fairly similar. The NRTWD data is the most evenly spread due to the fact that the trip destinations were in many different locations all over Australia. It does show a slightly higher number of participants travelling greater than 30 km which may be due to it being a once a year event. The mean travel distance in the NRTWD event was 11.8 km. The average travel distance for the KGSCC was 10.9 km. The KGSCC data shows a larger percentage of the users of that facility commuting from locations closer to the Brisbane station. This is most likely due to the relatively high population density surrounding the Brisbane CBD. In summary, the mean trip distance ridden by commuters using the JGBAS is similar to those reported elsewhere in Australia.

![Trip Distance (one way)](image)

Figure 3: One way trip distance distribution of JGBAS, NRTWD and KGSCC.
Mode Change
In the survey, participants were asked how they typically travelled to campus before the JGBAS was built. They had range of modes to select from, with respondents asked to choose the mode that they used for the greatest distance.

The survey responses indicated that as a result of the provision of the JGBAS, there had been a mode shift of 47% of respondents from private motor vehicles and 29% of respondents from motorised public transport to the bicycle (Figure 4). Clearly the facility has had an impact on mode choice. There are several reasons for why this mode change is quite high. Firstly, the mode change figures are consistent with what would be expected from a city that is very car dependent (16) as many respondents drove to the Monash campus before they started riding. It also potentially reflects the relative unattractiveness of public transport access to the Clayton campus for staff and students who regard the bicycle as a viable option.

Figure 4 also includes results from the evaluation of the KGSCC. That facility recorded a 5% mode shift from car and a 73% shift from public transport (bus, train and ferry). The JGBAS was more effective in drawing commuters from the private car than the KGSCC while it had less effect on public transport ridership.

![Mode Change Comparison](image)

Figure 4: Mode change for JGBAS and KGSCC.

It is appropriate to note that not all of the respondents ride for every trip that they make to campus. Due to the nature of University courses, not all students attend campus every weekday. The average attendance from all of the respondents was 4.1 days per week and the respondents ride an average 1.7 days per week. Even though 47% have made a shift in mode from the private motor vehicle to the bicycle, on average, approximately half of their trips are made by bicycle and approximately half their trips are still made by their previous mode of transport.

It is important to keep the overall impact of the facility on commuting patterns to campus in perspective. While proportion the users of the JGBAS who have switched
from a car to a bike commute is high (nearly 50 %) their absolute number is small (26 individuals per day) and corresponds to about 0.1 % of the campus population. Given that about 6 % of the campus population report they cycle to campus this amounts to about a 1.3 % increase in the number of commuter cyclists.

**Reduction in Vehicle Kilometres Travelled (VKT) and CO₂ emissions**

In order to calculate daily and annual VKT savings, the average number of daily commuters using the JGBAS was estimated from the swipe card access data. After eliminating access by security staff and cases of invalid ID reads (which did not provide access to the facility), the daily number of swipe card accesses was divided by two to produce an estimate of the number of people using the facility on an average day. On average, 55 commuters used the facility on days when the university was fully functioning and 3 used it on non-university days (weekends, holidays). Daily travel distance per user (23.2 km) was calculated by doubling the one-way travel distance reported in the previous section. The savings in vehicle kilometres traveled (VKT) was then calculated as follows:

\[
\text{Annual VKT Saving} = (C_u D_u + C_{n-u} D_{n-u}) \times \text{RTD} \times M
\]

\[
= (55 \times 130 + 3 \times 235) \times 23.2 \times 0.47
\]

\[
= 85,650 \text{ km}
\]

where:

- \(C_u\) = Average daily bicycle commuters (University days)
- \(D_u\) = Total University days during calendar year
- \(C_{n-u}\) = Average daily commuters (non-University days)
- \(D_{n-u}\) = Total non-University days during calendar year
- \(\text{RTD}\) = round trip travel distance (km)
- \(M\) = mode change from private motor vehicle to bicycle

As a result of nearly half the users switching from motor vehicle to bicycle, the annual VKT savings is higher than for the larger KGSCC which have previously been estimated to be 56,400 km (7).

Using the assumptions adopted in the Monash University Green House Gas Inventory (18) (Scope 1 CO₂ emissions intensity of 2.289 kg CO₂ per litre of fuel), and the estimated average fleet fuel economy in Australia (19) (11.7 L/100km), means that the annual VKT savings translates into an annual reduction in CO₂ emissions of approximately 23 tonnes.

**Cost Effectiveness**

Different measures of cost effectiveness can be calculated when the figures from the previous section are combined with an estimate of the Equivalent Annual Cost (EAC) of the facility. Burke et al (12) assumed a design life of 20 years for the KGSCC. Assuming a similar value for the JGBAS, and a real discount rate of 5 % p.a., the equivalent annual capital cost of the facility is about $96,000. Assuming the annual operating costs are about 15 % of the capital cost yields a total annual cost of about $110,000. Alternatively if the design life is assumed to be 10 years, the total annual costs are about $170,000.
The estimated annual cost used was to calculate a range of cost effectiveness measures as shown in Table 2. These results provide another perspective on the effectiveness of the facility. The cost per bicycle trip, which amounts to a subsidy to riders, is on the order of $7 to $10 is much higher than the $2.33 per trip reported by Burke et al (12) for the KGSCC. The differences in utilization of the JGBAS and the KGSCC facilities over the course of the year is a major reason for that difference. The JGBAS is predominantly used during the teaching semesters (26 week per year) while the KGSCC attracts users throughout the year. As a carbon abatement measure, the JGBAS appears expensive given that the carbon abatement curve for Australia (20) identifies high cost abatement measures as costing on the order of $100/tonne.

<table>
<thead>
<tr>
<th>Cost effectiveness measure</th>
<th>10 year design life EAC = $170,000</th>
<th>20 year design life EAC = $110,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per bicycle trip</td>
<td>$10.82</td>
<td>$7.00</td>
</tr>
<tr>
<td>Cost per car trip avoided</td>
<td>$23.02</td>
<td>$14.90</td>
</tr>
<tr>
<td>Cost per VKT avoided</td>
<td>$2.01</td>
<td>$1.30</td>
</tr>
<tr>
<td>Cost per tonne CO₂ avoided</td>
<td>$7,391</td>
<td>$4,783</td>
</tr>
</tbody>
</table>

There would be scope to use measures like those shown in Table 2 to compare the relative effectiveness of different initiatives designed to increase cycling, reduce car use or reduce transport related greenhouse emissions. Clearly that is an area where there is scope for further research.

**Bicycle Commuting Frequency**

The first evaluation criteria was to determine if there had been an increase in the number of people commuting to the Clayton campus by bicycle as a direct impact of the JGBAS being built. The survey asked participants to assess their change in commuting by bicycle frequency after the bike arrival station was built. Nearly half (44 percent) the respondents indicated that their frequency of bicycle commuting had increased.

**Location Impacts and Distance Decay to Final Destination**

The location of a bike arrival station relative to a person’s place of work or study can have a significant influence on its impact on their decision to commute by bicycle. In the survey, participants were asked to estimate how far they walked to their final destination from the JGBAS. The question simply asked about their ‘final destination’ and avoided the complexity that while staff may have a single office, students would have a more varied final destination depending on their class location.

Figure 5 compares the distance decay of the JGBAS with that of the KGSCC. The distance decay graph shows that bicycle commuters are willing to park their bike a considerable distance away from their place of work to take advantage of good quality end-of-trip facilities. In the case of the Monash facility, only about 5 % of users travel more than 750 metres to their final destination. This is most likely due to the size of the Clayton campus which means there are few destinations outside a 750 m radius of the facility. The distance decay curve is much flatter in the case of the KGSCC reflecting the
broader geographic spread of rider destinations in the CBD and their willingness to travel up to around one kilometer after using the cycle centre. The latter could be influenced by the two free downtown loop bus services which operate around the Brisbane CBD and have stops near the KGSCC. On the basis of the information in Figure 5, the distance from the JGBAS to a user’s final destination does not appear to be a major deterrent for potential users – it is serving users from throughout the campus.

![Distance Decay](image)

**Figure 5**: Distance decay comparison between JGBAS and KGSCC.

**User Satisfaction**

It is important to gauge the satisfaction of users to ensure that the facilities are adequately catering for their needs. User satisfaction was considered in two ways: first, their overall satisfaction with the facility as a whole and second, their satisfaction with individual features of the facility.

The survey participants were asked to rate their overall satisfaction of the JGBAS. The results showed that 93% of respondents were either very satisfied or satisfied with the JGBAS. This shows a very high level of overall satisfaction with the facility.

The survey participants were asked to rate their satisfaction of individual features of the facility. The results were evaluated using a 5 point satisfaction scale (5 = very satisfied to 1 = very unsatisfied). The facility features were then ranked according to the mean satisfaction value and the results are presented in Table 2.
Table 2: Satisfaction of the JGBAS individual features

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Very Satisfied (5)</th>
<th>Satisfied (4)</th>
<th>Neutral (3)</th>
<th>Unsatisfied (2)</th>
<th>Very Unsatisfied (1)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swipe card</td>
<td>97</td>
<td>45</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4.49</td>
</tr>
<tr>
<td>Bike hangers</td>
<td>75</td>
<td>57</td>
<td>13</td>
<td>7</td>
<td>1</td>
<td>4.29</td>
</tr>
<tr>
<td>Number of bike hangers</td>
<td>73</td>
<td>60</td>
<td>12</td>
<td>7</td>
<td>1</td>
<td>4.28</td>
</tr>
<tr>
<td>Number of showers</td>
<td>67</td>
<td>60</td>
<td>24</td>
<td>2</td>
<td>0</td>
<td>4.25</td>
</tr>
<tr>
<td>Bike work stand</td>
<td>41</td>
<td>44</td>
<td>67</td>
<td>1</td>
<td>0</td>
<td>3.81</td>
</tr>
<tr>
<td>Locker size</td>
<td>29</td>
<td>58</td>
<td>55</td>
<td>6</td>
<td>4</td>
<td>3.67</td>
</tr>
<tr>
<td>Individual locker layout</td>
<td>29</td>
<td>44</td>
<td>65</td>
<td>9</td>
<td>4</td>
<td>3.56</td>
</tr>
<tr>
<td>Bike tools</td>
<td>21</td>
<td>36</td>
<td>77</td>
<td>12</td>
<td>6</td>
<td>3.36</td>
</tr>
<tr>
<td>Towel drying facilities</td>
<td>20</td>
<td>37</td>
<td>55</td>
<td>29</td>
<td>10</td>
<td>3.19</td>
</tr>
<tr>
<td>Locker management</td>
<td>16</td>
<td>31</td>
<td>57</td>
<td>24</td>
<td>23</td>
<td>2.95</td>
</tr>
<tr>
<td>Number of lockers</td>
<td>16</td>
<td>31</td>
<td>31</td>
<td>33</td>
<td>41</td>
<td>2.66</td>
</tr>
</tbody>
</table>

The respondents were most satisfied with the swipe card access, the design of the bike hangers and the number of bike hangers. The respondents were least satisfied with the number of lockers, locker management and towel drying facilities respectively. In relation to those features, 31% of respondents were unsatisfied with the locker management and 49% of respondents were unsatisfied with the number of lockers. At the time of the survey, the University did not have an explicit locker management plan. Users of the JGBAS are required to bring their own lock and even though lockers are meant for short term (daily) use, it is common for people to claim them for extended periods of time regardless of whether they are a regular user of the facility. This aggravates users who are unable to get access to a locker and most likely deters potential users. A change in lockers management could result in a greater number of lockers becoming available for regular users, thereby addressing another concern of the respondents.

Summary, Conclusions and Research Directions

The JGBAS is a state-of-the-art facility located at the Clayton campus of Monash University in Melbourne, Australia. Survey responses highlight that the facility has increased the number of people commuting to this suburban campus by bicycle and aided in the adoption or integration of healthier and environmentally preferred modes of travel by users. In an absolute sense however the impact of the facility is small given that on a typical day it caters for 55 users and replaces about 52 motor vehicle trips. While the lockers are in use, the bike parking at the facility is only about half full on a typical day. Unless measures can be taken to increase turnover of the lockers by infrequent users the bike parking facilities are likely to continue to be under utilised.

The facility has increased the frequency of travel by bicycle by users with nearly half (44 %) of respondents indicating they now ride more frequently as a result of access to the facility. The provision of the end of trip facility also resulted in 83% of respondents
indicating they have changed their usual mode of transport to cycling. Importantly, nearly half the users have switched from using a motor vehicle to riding as a result of the facility.

Because its usage is concentrated over a period of about half the year (reflecting the university semesters), the effective cost per bicycle trip served (about $7 to $10), cost per car trip avoided (about $15 to $23), cost per vehicle km avoided (about $1.30 to $2.00) and cost per tonne of CO2 avoided (about $5,000 to $7,500) are all relatively high. The cost effectiveness of the facility would improve if it attracted a higher number of users who were full time staff and made use of the facility throughout the year.

The location of the facility on the north-west corner of the campus does not appear to be a major problem with staff and students from throughout the campus making use of the facility. The facility clearly meets the needs of users overall, with 93% of respondents indicating they were satisfied. However, the evaluation did highlight concerns with towel drying facilities, locker management and the number of lockers. The University’s Facilities and Services Division is implementing changes in response to those issues. Additional towel hooks have been fitted and the locker management system is to be changed to provide greater access to the available lockers by regular users. The survey will be repeated to see if those changes are reflected in greater user satisfaction.

As noted earlier there are few examples of evaluations of end of trip facilities reported in the literature. There is a need to expand the number of evaluations like this which are reported. There is scope to use the results from evaluations like this to assist in the development of appraisal systems for new facilities and to better understand the potential of facilities like the one described here in encouraging sustainable travel choices. Further research could also obtain insight into the opinions and behaviours of those people who chose not to respond to the survey (about 75% of those who registered to gain access to the facility). Since the non-respondents appear to be non-users it would be desirable for a follow up study to target that group to understand why they are not using the facility even though they registered to gain access. They could have a different perspectives on the facility from those presented here which reflects the views of users. That would strengthen the understanding of the barriers which may need to be overcome to maximize the potential of facilities like this to support sustainable commuting options. Likewise there would be merit in conducting a survey of all cyclists on campus to examine whether there are differences in ridership patterns (e.g. trip frequency or trip length) between users of the JGBAS and those who park their bike elsewhere on campus. Further research should also be conducted into the cost effectiveness of a range of facilities and initiatives designed to increase commuter cycling. A greater understanding of the relative cost effectiveness of different measures would help to identify where scarce resources should be directed to achieve the greatest impact.
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