# Users and non-users of bikesharing: How do they differ?

## Abstract

What makes some people eschew bikesharing? What distinguishes users from non-users? The present study examines the transport priorities and socio-demographic characteristics of both users and non-users of bikesharing in the context of Adelaide, an Australian metropolis of 1.3 million people. We apply statistical techniques, including Principal Component Analysis (PCA) and two-level Nested Logit (NL) modelling, to original survey data collected in 2018. We find that younger age, digital literacy, full-time work status, household size, and certain transport priority dimensions which we term Safekeeping, Ease, and Fitness, are key factors associated with the likelihood of choosing or shunning bikesharing as a mode of transport.

## Introduction

Bikesharing represents an attractive travel alternative for many urbanites as demonstrated by a rapid uptake of this mode over the past few decades (Julsrud and Farstad 2020; Fishman 2016). While the bikesharing concept dates back to the 1960s, the number of cities that offer bikesharing services has grown from just a handful in the late 1990s to over 1,000 worldwide (Wu and Kim 2020; Fishman 2016). Bikesharing has competitive advantages over other modes, including affordability, convenience, flexibility, opportunity for physical exercise, and environmental-friendliness (Wang et al. 2020; Bauman et al. 2017; Faghih-Imani and Eluru 2016; Götschi et al., 2016). Its users can purchase the service (cycling) by the hour without having the own the vehicle (the bicycle).

Bikesharing has been in existence long enough to have attracted considerable attention from transportation researchers. Many studies have extensively investigated bikesharing benefits, usage patterns, the characteristics of bikesharing users and the factors that may encourage the use of bikesharing service (Eren and Uz 2020; Si et al. 2019; Wang and Zhou 2017; de Chardon et al., 2017; Götschi et al., 2016; Ogilvie and Goodman 2012; Shaheen et al., 2010). Some studies gone a step further by also examining the traits of non-users of bikesharing, as well as the major barriers to bikesharing (see Fishman and von Wyss 2017; Fishman 2016; Ricci 2015; Fishman et al., 2012, 2013). However, so far, the emphasis has been on users rather than non-users.

The present study aims to fill a gap in the literature by focusing more closely on non-users of bikesharing. We seek to answer two research questions: What makes some people eschew bikesharing? What distinguishes users from non-users? To do so, we examine the individual transport priorities and socio-demographic characteristics of non-users of bikesharing in Adelaide, an Australian metropolis of 1.4 million people, and the state capital of South Australia. This is the first large-scale empirical study on bikesharing in Adelaide, as well as the first study to employ survey data collected from actual users. To analyse the data, we apply two statistical techniques, including Principal Component Analysis (PCA) and two-level Nested Logit (NL) modelling, to original survey data collected in 2018.

Beyond the specific context of Adelaide, research into active transport modes and micromobility is paramount in Australia - a country with a strong car culture (Butterworth and Pojani 2018; Kenworthy and Laube 1999). Nationwide, there are 20 million motor vehicles registered – for a population of 25 million (ABS 2020). In South Australia, the rate of cycling to work is under 3%, and only 14% of residents ride a bicycle in a typical week (ABS 2017). As people are gradually shunning suburbs and reclaiming the inner cities, traffic congestion is growing while parking is become scarcer. Car dependency comes with other socio-economic costs, including consumption of non-renewable energy resources, segregation, accidents, pollution, and climate change (Meyer and Shaheen 2017; Soltani et al. 2006). The situation has already become unsustainable in larger Australian state capitals.

This study contributes to the scholarly literature on sustainable transport by providing a more comprehensive understanding of the transport priorities and the socio-demographic characteristics of *non-users* of bikesharing in relation of particular built environment attributes. Unlike previous studies that simply compare users to non-users, we provide more nuance by segmenting survey respondents into three groups: (1) bikesharing users, (2) non-users of bikesharing who are interested in trying this mode in the future, and (3) non-users of bikesharing who do not want to try this mode. This helps us to investigate the determinants of people's behaviours and preferences in more detail. Moreover, we differentiate between CBD residents and suburban residents. Another novelty in this study is the coining of 'transport priorities', i.e., constructs that help explain people's transport behaviours and preferences. Our hope is that this study will help the formulation of policies to support bikesharing and cycling in Australian cities and father afield.

## Background: Bikesharing in Australia and around the world

Before proceeding to the empirical portion, we present an overview of the history of bikesharing, focusing more closely on Australia and Adelaide.

Public bikesharing systems have evolved through five generations (Galatoulas et al., 2020; Parkes et al. 2013). The first generation, born in 1965, included just Amsterdam's Witte Fiets. It was pioneered by Provo, an anarchic group of Dutch activists. As the name suggests, the fleet included regular white bicycles docked around the city, which were free to use. While the concept attracted much fanfare, it was short-lived. The second generation emerged in 1995 in Copenhagen. The system, called Bycyklen, was docked, coin-based, and featured 1000 bicycles. This still exists today, in an updated form. ICT technology was introduced in the third bikesharing generation, launched in the late 1990s in various cities. While bicycles remained conventional and the systems docked, magnetic user cards were now used. Vélo á la Carte in Rennes, France, is an example of a third-generation system - still in existence. The fourth generation, which appeared in 2005, was much more digitally sophisticated. A typical example is MOL-Bubi, Budapest (Mátrai and Tóth 2016).

The fifth and current generation, born in 2017, involves smartphone applications and dockless fleets in addition to the regular fleets docked at stations. Electric bikes are also being introduced in larger and/or hilly cities in which use of conventional push bicycles is impractical. High processing power, data-handling capacity, and geo-positioning capability allow current providers to manage a bulk of user transactions in real-time (Allan and Soltani 2019). On the negative side, dockless bikesharing is generally considered as a failure. Not only does it have higher capital and operational costs, but it is also prone to public vandalism and, as such, has been met with community hostility and high fines by local councils (Pojani et al. 2020; Heymes 2019).

European cities have better performing bikesharing systems relative to Asian, North American, and Australian cities. Barcelona, Dublin, and Turin are the top three bikesharing cities, with 8.4, 8.0, and 7.9 trips/day/bicycle respectively (Allan and Soltani 2019). This is probably due to their longer cycling history and stronger cycling culture (Pojani et al. 2017). London and Washington, D.C. are also high performers (de Chardon et al., 2016). Worldwide, bikesharing users tend to be younger, white-collar men who do not own a car (Eren and Uz 2020; Soltani et al. 2019; Wang and Akar 2019; Wang et al., 2018; Mattson and Godavarthy 2017; Molina-García et al., 2013; Buck et al. 2013).

Australia has lagged behind other countries in terms of bikesharing adoption. The first large-scale systems here, Melbourne's Bike Share and Brisbane's CityCycle, were not introduced until 2010 (Fishman, Washington, and Haworth 2012). These docked systems offered 600 and 2,000 bicycles in the respective inner cities; no attempt was made to extend bikesharing to car-dominated suburbia (Soltani et al. 2019; Mateo-Babiano et al. 2016).

In addition to docked schemes, by 2018 five major dockless bikesharing companies were operational in Sydney and some other state capitals: ofo, oBike, Mobike, ReddyGo, and LimeBike. The provision of bikesharing services has boosted cycling rates in some cities, especially for shorter trips (Fishman et al., 2014). But overall, the frequency of trips/day/bike is still low. Melbourne and Brisbane only reach a meagre 0.7 and 0.3 trips/day/bike respectively (Fishman 2016).[1] Here, bikesharing is considered more as an occasional or adjunct mode, while the car continues to reign supreme. In Adelaide two newer, dockless systems, ofo and oBike, entered the market in 2018. Since dockless bikes joined Adelaide Free Bikes, the fleet increased to a total of 550 bicycles (250 docked and 300 dockless).

# Theoretical framework

Upon reviewing the existing literature on bikesharing, we constructed a theoretical framework which rests upon three sets of interrelated factors, including: (1) transport priorities; (2) socio-economic characteristics; and (3) built environment characteristics. These are listed in Figure 1 and detailed below.

## *Transport priorities*

Research shows that comfort, convenience, safety, security, speed, time, health, and exercise are among the key transport priorities that affect modal choice (Soltani et al. 2021; Egset and Nordfjærn 2019; Rundmo et al., 2011). People who are less concerned about safety (from traffic) or security (from crime) are more likely to adopt bikesharing. However, access to designated cycling paths and bicycle parking racks is highly desirable as it increases perceptions of comfort, convenience, and safety (Shen et al., 2018; Shaheen et al., 2010). Well-lit streets make shift workers feel more secure when using bikesharing at night (Chandra et al., 2017).

Beyond safety and security, people who value independence, status, athleticism, and the environment are more often bikesharing users (Rérat 2019; Leister et al. 2018; Namgung and Jun 2018; Prabhakar and Rixey 2017; Pucher and Buehler 2017; Martin et al. 2016; Heinen et al., 2013; Akar et al., 2013; Nkurunziza et al., 2012; Pucher et al., 2011; Gatersleben and Appleton 2007; Scheiner and Holz-Rau 2007; Wardman et al., 2007).

Bikesharing is mainly used in shorter trips where driving, walking, or riding a bus is less convenient or potentially slower (Eren and Uz 2020; Jensen et al. 2010). Systems with simple sign-up displays and credit card readers invite more customers (Fishman 2016). At the same time, systems must guarantee user data privacy in order to be attractive. Also, bicycles must be easy to ride and park (Qian et al., 2020; Ma et al. 2020; Chen et al., 2020; Leister et al. 2018; Campbell et al. 2016). The bikesharing network coverage must be broad and stations must stay open during most of the day or possibly 24/7 – in order to increase the perception of convenience.

### *Socio-economic characteristics*

Research has established that the “typical bikesharer” tends to be male, white, wealthier, and younger than average; he tends to be employed (full-time or part-time), live and work closer to the inner city and bikesharing catchment areas, and own a car (Eren and Uz 2020; Fishman 2016; Ricci 2015; Fishman et al., 2014; Shaheen et al., 2012; Steinbach et al., 2011).

Women are socialised to be more risk-averse and therefore tend to use bikesharing less than men; also, they often cycle at a slower speed and take shorter trips (Fishman 2016; Zhao, Wang, and Deng 2015). Helmet use is more widespread among women too (Eren and Uz 2020; Kaplan et al., 2015; Bonyun et al., 2012). However, in countries with a very strong cycling culture, such as the Netherlands, Denmark, and Germany, women are more likely to adopt bikesharing than men (Harms et al., 2013; Steinbach et al., 2011; Garrard, 2003).

Parents are less likely to use bikesharing as this is less convenient for child transport than cars (Barbour et al., 2019; Nikitas 2018; Nikitas et al., 2015). People with access to a smartphone and those who are more technologically literate are more likely to take up bikesharing; youth are advantaged over the elderly in this respect (Tao and Pender 2020; Chen et al., 2020; Shen et al., 2018). In this study, we look at socio-economic characteristics including: age, gender, ethnicity, job status, employment type, income, car ownership, household size, and smartphone access.

### *Built environment attributes*

Those who are attracted to bikesharing believe that this mode will save them time, money, and effort. This tends to be the case in dense urban cores, which concentrate residences and jobs and feature a mix of other land-uses (Dällenbach 2020; Hamilton and Wichman 2018; Xie and Wang 2018; Prabhakar and Rixey 2017; Campbell et al. 2016; Madhuwanthi et al. 2015; Bachand-Marleau, Lee, and El-Geneidy 2012). Bikesharing uptake is also higher near recreational centres, schools, and transit nodes – where these include bikesharing docks (Eren and Uz 2020; Mateo-Babiano et al. 2016; Wang and Akar 2019; El-Assi et al., 2017; Noland, Smart, and Guo 2016; Faghih-Imani et al. 2014).

As expected, the presence of specialised cycling infrastructure, in the form of an interconnected network of dedicated paths, possibly tree-lined, increases the likelihood of bikesharing (Eren and Uz 2020; El-Assi et al., 2017; Faghih-Imani et al. 2014; Winters et al., 2010). Some studies have also found that housing type and location can affect the uptake of bikesharing (Fishman 2016; Guo and He 2020; Shen et al., 2018). For example, people living in exurban areas with lower population densities, wide roads with frequent intersections, and inadequate public transit and cycling infrastructure coverage may be less likely to adopt bikesharing (Guo and He 2020). In this study, we look at the following indicators: population density; employment density; intersection density; distance to CBD; land use mix; and housing value (as a proxy for neighbourhood quality).

## Method and analysis

The case study setting and the data collection and analysis procedures, along with the key findings, are reported below.

## *Case study setting*

Adelaide is the capital of South Australia and Australia’s fifth-most populated city. It was founded in the mid-19th century as the planned capital of the only freely-settled British province in Australia. As such, Adelaide’s inner city features a colonial, gridiron street pattern, good public transport services, and a higher population density than the rest of the metropolitan region, which is sprawling and car-oriented city (Nguyen et al., 2018). The CBD area is relatively compact and comprises many middle-income families, students, and singles. Recently, the inner city has been attracting a younger and more educated cohort of residents. Moreover, employment opportunities are concentrated in the urban core (Allan and Soltani 2019; Soltani et al. 2019). Hence the potential for cycling and bikesharing uptake is high.

Generally, the Adelaide City Council has been supportive of bikesharing, as well as other progressive planning tools such as infill development (Nguyen, Soltani, and Allan 2018; Government of South Australia 2017). The local bikesharing scheme (Adelaide Free Bikes or AFB) was introduced as early as 2005, although in a rudimentary form (Soltani et al. 2019). Adelaide’s network of cycling routes (BikeDirect) spans over 2,100 km. However, many of these are simple shared lane markings, known as ‘sharrows’, rather than dedicated paths, fully protected from cars (DTEI, 2006). Cycling is popular for recreation, with a third of individuals cycling at least once a year. Meanwhile, the share of cycling as a commute mode is minuscule (Table 1), with most cyclists concentrated in the inner city and a few master-planned suburbs (Figure 2).

## *Data collection*

This study employed both primary and secondary data. The primary data consisted of population surveys, collected in February-March 2018.[2] Respondents were recruited at six major destinations within the City of Adelaide boundary. These included: the Adelaide Oval, Royal Adelaide Hospital, Adelaide Railway Station, the University of Adelaide, Rundle Mall, and the Adelaide Central Market. All are considered as key trip attractors in the city.

In total, 422 complete questionnaires were received (at least 70 at each trip attractor). Respondents who lived more 60 km from the CBD were considered as outliers and eliminated, thus reducing the dataset to 408 questionnaires. As this study targeted younger and working individuals (who are more likely to use bikesharing, based on the literature), people over the age of 65 were removed from the dataset, resulting in 365 questionnaires. After cleaning the dataset and deleting incomplete responses, 353 questionnaires were retained in total. As Figure 3 shows, respondents were well-distributed throughout Adelaide. Overall, the study sample was representative and reflected the characteristics of the population in metropolitan Adelaide, South Australia, and Australia. Hence, we are confident that the findings are applicable beyond the case study setting.

The survey included 36 questions. Of these, 13 questions were designed to measure the participants’ transport priorities in relation to bikesharing, including: comfort, convenience, safety, security, health, exercise, time, speed, status/image, distance, environmental concern, cost (value) and independence. A slightly revised version of a validated survey instrument was used for this purpose (Mehdizadeh et al., 2019; Nordfjærn and Rundmo 2015; Şimşekoğlu et al., 2015; Nordfjærn and Rundmo 2015). Respondents were asked to rate on a five-point Likert scale each transport priority when deciding whether to adopt or shun bikesharing.

In the second part of the survey, we asked a few open-ended questions to find out more about people’s personal experiences with bikesharing schemes in Adelaide, including AFB, ofo, and oBike. Then the participants were asked to report their frequency of bikesharing usage within the last year (daily, a few times ago, once a week, once a month, a few times per year, yearly, never used but would be interested, never used and will never be used). The remaining questions collected socio-economic characteristics (age, gender, ethnicity, job status, employment type, income, car ownership, household size, and smartphone access) and residential built environment attributes such as housing type (a proxy for residential density) and residential addresses (a proxy for accessibility).

The data on built environment attributes (population density; employment density; intersection density; distance to CBD; land use mix, and housing value) were retrieved from secondary sources, including the Australian Bureau of Statistics website, the Open-source Street Map website, and Data.SA.gov.au (an open-source data portal provided by the South Australia state government). The study did not consider non-CBD-bound trips, as in Adelaide, the inner city tends to dominate the labour market. However, in the future, trips directed to suburban employment centres (or intra-suburban trips) should be included as well.

## *Descriptive statistics*

A summary of the descriptive statistics (for the variables ultimately modelled) is presented in Table 2. The surveys revealed that respondents utilise bikesharing infrequently. More than half (52%) only used bikesharing a few times a year; a mere 10% and 5% used bikesharing weekly and daily respectively. This finding is consistent with Fishman's (2016) data for other Australian cities. The key reasons for bikesharing included socialising (62%), shopping (25%), going to work (20%), returning home from work (23%), sightseeing (12%), and accessing public transport (8%) or educational sites (5%). These reasons are different from those provided in other studies - a finding which highlights the importance of context in transportation planning studies (LDA Consulting 2013).

## *Data reduction*

Based on the survey responses, current and potential bikesharing customers were segmented into three groups: users (U); interested non-users (I); and uninterested non-users (H). The definitions that we adopted for each group are below.

1. Users (U): people who had used at least one form of bikesharing in Adelaide at least once and enjoyed it.
2. Interested non-users (I): people who did not use bikesharing at the time of the survey but were willing to consider using it in the future.
3. Uninterested non-users (H): people who did not use bikesharing nor were considering using it in the future.

The distribution of participants among the three groups was the following: U = 15%; I = 33%; H = 52%. The fact that more than half of the respondents fell in the H group is problematic from a transport sustainability perspective but also highlights the need for a study such as this, which investigates the behaviours and preferences of non-users. At the same time, given a car-oriented context, it is encouraging to see that nearly a third of the respondents are interested to try bikesharing in the future.

The 13 transport priorities of the groups of participants (U, I, and H) are displayed in a radar graph (Figure 4). This shows that priorities varied by group. For example, group H prioritized safety and security whereas group U cared more about the environment, health, and exercise.

The original transport priorities were reduced though Principal Component Analysis (PCA).[3] Out of the 13 transport priorities, 5 (cost, independence, status, environment, and distance) failed to consistently load to a dimension.[4] Therefore, only 8 transport priorities (speed, time, health exercise, safety, security, comfort, and convenience) were retained. These resulted into the following 4 dimensions:

1. Punctuality, accounting for speed and time;
2. Fitness, accounting for health and exercise;
3. Safekeeping, accounting for safety and security; and
4. Ease, accounting for comfort and convenience.

These dimensions, which accounted for 73% of the variability in the data (Table 3), were then modelled in conjunction with the socio-economic characteristics and the built environment attributes to determine the behaviours and preferences of users and non-users of bikesharing in Adelaide.[5]

## *Data modelling*

Following the data description and reduction, a two-level Nested Logit (NL) model was applied in NLOGIT 6.0. By way of explanation, a two-level NL model is a discrete choice model, which allows groups of similar alternatives to be grouped into 'branches' and 'nests'. In this case, as shown in Figure 5, groups H and I (both non-users) are combined into one branch with two nests, whereas group U (users) constitutes a separate branch with a single nest.[6] In the interest of readability, the mathematical details of the model are provided in a note.[7] The model script and output are presented in the Appendix. The results follow below.

We found that only some socio-economic characteristics of the participants were influential in choice to adopt or shun bikesharing. Both use of, and interest in, bikesharing decline with age. Older people are more likely to fall within group H (uninterested non-users). Other studies have revealed a similar trend (Eren and Uz 2020; Ricci 2015; Fishman et al., 2014; Shaheen et al., 2012). However, among older cohorts, where people have access to a smartphone, they are more likely to choose bikesharing than their peers. The access to smartphones moderates the effect of advancing age on bikesharing (see Wang et al., 2018). This means that, as younger cohorts with high levels of digital literacy enter middle age, the effect of age on bikesharing may disappear altogether.

The model showed that the larger the household size, the lower the likelihood of belonging in group H (uninterested non-users). This finding is inconsistent with the literature. The understanding to date has been that larger households (e.g., families with multiple children) are less likely they use bikesharing. The discrepancy may be a function of local culture, with Australian parents cycling alongside their children during recreational outings. Or it may be due to a bias in the sample: larger households may have been composed of flatting students or recent graduates rather than families. Or, it may have been the case that individuals in smaller households were older empty-nesters and advancing age is negatively associated with bikesharing, as noted earlier.

Respondents who lived in single-family houses - in other words, in lower density suburbs - were more likely to fall within group I (interested non-users). Meanwhile, the literature maintains that living in higher residential densities increases the likelihood of bikesharing. While modifying residential densities takes time, bikesharing could be enabled in suburbs where interest in this mode is high by providing dedicated connected cycling paths that connect homes to transit stations, schools, and other key destinations. It is crucial to provide the suitable conditions and help people in group I take a first step in trying bikesharing, at least on a casual basis. That experience may lead to a longer-term commitment and possibly regular membership in a bikesharing scheme.

Individuals who were employed full-time were less likely to be interested in bikesharing – possibly because of their more rigid schedules and time poverty compared to casual workers. It may also be the case that, owing to their reasonable incomes full-time can afford their own bicycles (and have sufficient space to store them at home) and therefore are not interested in bicycle rentals. Notably, these findings contrast to some previous studies, which have found that full-time workers are more likely to take up bikesharing (see Fishman 2016; Woodcock et al., 2014). While bikesharing may never become a viable commuting more for this group in Adelaide, it can still be promoted by highlighting its recreational potential on a casual basis.

Other socio-economic factors such as car ownership, ethnic background, gender, and personal income, were not associated with bikesharing behaviour or interest. This finding contrasts with previous studies which have suggested that female gender and lower incomes lead to less bikesharing (Wang et al., 2018; Fishman 2016).

The modelling of the four key dimensions (*Ease, Safekeeping, Fitness, and Punctuality*) resulted in some interesting findings. Two dimensions (*Ease and Safekeeping*) had a negative and statistically significant association with bikesharing. Those who valued *Ease* and *Safekeeping* were more likely to fall within group H (uninterested non-users). To them, other modes such as private car or public transport may feel safer, more convenient, and more accessible. This was as expected based on the literature (AAA 2018; BicycleNetwork 2018; Pucher and Dijkstra 2003). On the other hand, the *Fitness* dimension had a positive and statistically significant association with bikesharing. Those who valued *Fitness* were more likely to fall within groups U and I, meaning that they either used bikesharing already or were interested in trying it in the future. As noted, other studies have reached similar conclusions (see Götschi et al., 2016). This shows that at least one portion of the public is aware of the health benefits conferred by cycling. One dimension, *Punctuality,* was not statistically significant. Built environment attributes such as population density, employment density, intersection density, distance to CBD, land use mix, and housing value were less significant in this study. This may be due to the study design: the data was collected at six major destinations in the inner city, whose built environment attributes are somewhat similar.

# Conclusion and policy recommendations

Adelaide's bikesharing market is driven by casually employed youth, possibly students. Bikesharing is hardly commonplace, but it is attracting increasing support and interest. Nearly a third of survey respondents are not current users but would like to try bikesharing in the future. This is promising. Those uninterested in using or even trying bikesharing tend to be older people with less access to smartphones. Gender is irrelevant here.

Retaining the youth and/or student market is crucial. Bikesharing companies need to ensure that these groups remain loyal bikesharing customers as they enter the regular workforce and move to suburban housing (see Kutela and Teng 2019). Policies should target bikesharing more specifically - for example by ensuring that (a) stations are placed in strategic spots near trip generators and transit stops, (b) the system is balanced so that bicycles and parking spots are available at all stations at all times, (c) digital user data is protected, (d) shared bicycles are comfortable, and (e) apps are easy to use (van Waes et al., 2020; Piatkowski et al., 2015; Martin and Shaheen 2014).

Importantly, policies should also focus on urban cycling more broadly. A wealth of experience from European and Asian cities is available on how to make cycling "irresistible" and could be harnessed in Australia (Lee, 2020; Schepers et al., 2017; Audikana et al., 2017; Weinberg et al., 2015; Pucher et al., 2011; Martens 2004; Lee and Pojani 2019). To guarantee success, cycling policies should not be applied in isolation. Policy packages are necessary, which strengthen the position of alternative modes (including other micro-mobility options such as e-scooters) while curtailing car use (Stead and Pojani 2017).

Much of the existing research in the bikesharing space has been quantitative and has targeted users. Future research should be qualitative, finer grained, and target non-users more directly. The use of qualitative approaches such as semi-structured interviews is encouraged for a more in-depth undersetting of the impact of transport priorities, socio-economic characteristics, and built environment attributes on bikesharing. While surveys and secondary census data paint a broad picture of the behaviours and preferences or user and non-users, the reasons for shunning bikesharing need to be investigated via in-depth interviews as well. The opinions of policy makers, cycling lobbyists, service providers, and professional planners need to be gathered too, as these groups are expected to have a wealth of information on opportunities and barriers to bikesharing.

# References

———. “Motor Vehicle Census.” Accessed 31/01/2020. https://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0.

Akar, Gulsah, Nicholas Fischer, Mi Namgung. 2013. “Bicycling choice and gender case study: The Ohio State University.” *International Journal of Sustainable Transportation* 7(5):347-65.

Allan, Andrew, Ali Soltani. 2019. “Servicing the Needs of Major Inner-urban Trip Generators.” Report, CRC for Low Carbon Living, Sydney, Australia.

An, Ran, Renee Zahnow, Dorina Pojani, Jonathan Corcoran. 2019. “Weather and cycling in New York: The case of Citibike.” *Journal of Transport Geography* 77:97-112.

Audikana, Ander, Emmanuel Ravalet, Virginie Baranger, Vincent Kaufmann. 2017. “Implementing bikesharing systems in small cities: Evidence from the Swiss experience.” *Transport Policy* 55:18-28.

Australian Automobile Association. 2018. “Road congestion in Australia.” Report, Australian Automobile Association, Canberra, Australia.

Australian Bureau of Statistics. “More than two in three drive to work, Census reveals.”, Accessed 11/05/2020 https://www.abs.gov.au/census. .

Bachand-Marleau, J., B. Lee, A. El-Geneidy. 2012. “Better understanding of factors influencing likelihood of using shared bicycle systems and frequency of use.” In *Transportation Research Record*, 66-71.

Barbour, Natalia, Yu Zhang, Fred Mannering. 2019. "A statistical analysis of bike sharing usage and its potential as an auto-trip substitute." *Journal of Transport & Health* 12:253-62.

Bauman, Adrian, Melanie Crane, Bradley Alan Drayton, Sylvia Titze. 2017. “The unrealised potential of bike share schemes to influence population physical activity levels – A narrative review.” *Preventive Medicine* 103:S7-S14.

BicycleNetwork. “Lower speeds to 30km/h and save lives.”, Accessed 11/01/2018.

Bonyun, Marissa, Andi Camden, Colin Macarthur, Andrew Howard. 2012. "Helmet use in BIXI cyclists in Toronto, Canada: an observational study." BMJ open 2 (3):1-5.

Bordagaray, Maria, Luigi Dell’Olio, Achille Fonzone, Ángel Ibeas. 2016. "Capturing the conditions that introduce systematic variation in bike-sharing travel behavior using data mining techniques." Transportation Research Part C: Emerging Technologies 71:231-48.

Buck, Darren, Ralph Buehler, Patricia Happ, Bradley Rawls, Payton Chung, Natalie J Borecki. 2013. “Are bikeshare users different from regular cyclists? A first look at short-term users, annual members, and area cyclists in the Washington, DC, region." Transportation Research Record 2387(1):112-9.

Butterworth, Elizabeth, Dorina Pojani. 2018. "Why isn't Australia a cycling mecca?" *European Transport* 69(4):1-22.

Campbell, Andrew A, Christopher R Cherry, Megan S Ryerson, Xinmiao Yang. 2016. "Factors influencing the choice of shared bicycles and shared electric bikes in Beijing." *Transportation Research Part C* 67:399-414.

Chandra, Shailesh, Jose Jimenez, Ramalingam Radhakrishnan. 2017. "Accessibility evaluations for nighttime walking and bicycling for low-income shift workers." *Journal of Transport Geography* 64:97-108.

Chen, Zheyan, Dea van Lierop, Dick Ettema. 2020. "Dockless bike-sharing systems: what are the implications?" *Transport reviews* 40 (3):333-53.

Dällenbach, Nathalie. 2020. "Low-carbon travel mode choices: The role of time perceptions and familiarity." *Transportation Research Part D* 86:102378.

de Chardon, Cyrille Médard, Geoffrey Caruso, Isabelle Thomas. 2017. "Bicycle sharing system 'success' determinants." *Transportation Research Part A: Policy and Practice* 100:202-14.

de Chardon, Cyrille Médard, Geoffrey Caruso, Isabelle Thomas. 2016. "Bike-share rebalancing strategies, patterns, and purpose." *Journal of Transport Geography* 55:22-39.

Department for Transport, Energy and Infrastructure (DTEI), South Australia. 2006. Safety in numbers: a cycling strategy for South Australia 2006-2010. Report, Adelaide.

Egset, Kaja Solland, Trond Nordfjærn. 2019. "The role of transport priorities, transport attitudes and situational factors for sustainable transport mode use in wintertime." *Transportation research part F: traffic psychology and behaviour* 62:473-482.

El-Assi, Wafic, Mohamed Salah Mahmoud, Khandker Nurul Habib. 2017. "Effects of built environment and weather on bike sharing demand: a station level analysis of commercial bike sharing in Toronto." *Transportation* 44 (3):589-613.

Eren, Ezgi, Volkan Emre Uz. 2020. "A review on bike-sharing: The factors affecting bike-sharing demand." *Sustainable Cities and Society* 54:101882.

Faghih-Imani, Ahmadreza, Naveen Eluru. 2016. "Incorporating the impact of spatio-temporal interactions on bicycle sharing system demand: A case study of New York CitiBike system." *Journal of Transport Geography* 54:218-27.

Faghih-Imani, Ahmadreza, Naveen Eluru, Ahmed M El-Geneidy, Michael Rabbat, Usama Haq. 2014. "How land-use and urban form impact bicycle flows: evidence from the bicycle-sharing system (BIXI) in Montreal." *Journal of Transport Geography* 41:306-14.

Fishman, Elliot, Simon Washington, N. Haworth. 2012. "Barriers and facilitators to public bicycle scheme use: A qualitative approach." *Transportation Research Part F* 15(6):686-98. doi: 10.1016/j.trf.2012.08.002.

Fishman, Elliot. 2013. "Bike share: a synthesis of the literature." *Transport Reviews* 33(2):148-65.

Fishman, Elliot, Simon Washington, Narelle Haworth. 2014. "Bike share's impact on car use: Evidence from the United States, Great Britain, and Australia." *Transportation Research Part D: Transport and Environment* 31:13-20.

Fishman, Elliot, Simon Washington, Narelle Haworth, Angela Watson. 2015. "Factors influencing bike share membership: An analysis of Melbourne and Brisbane." *Transportation Research Part A: Policy and Practice* 71:17-30.

Fishman, Elliot 2016. "Bikeshare: A review of recent literature." *Transport Reviews* 36(1):92-113.

Fishman, Elliot, Martin von Wyss. 2017. “Bike share in the Australian city: Assessing the feasibility of a future bike share program for Adelaide.” *Road & Transport Research: A Journal of Australian and New Zealand Research and Practice* 26(2):50.

Fuller, D., L. Gauvin, Y. Kestens, M. Daniel, M. Fournier, P. Morency, L. Drouin. 2011. “Use of a new public bicycle share program in Montreal, Canada.” *American Journal of Preventive Medicine* 41 (1):80-3.

Galatoulas, Nikolaos-Fivos, Konstantinos N Genikomsakis, Christos S Ioakimidis. 2020. “Spatio-Temporal Trends of E-Bike Sharing System Deployment: A Review in Europe, North America and Asia.” *Sustainability* 12(11):4611.

Garrard, Jan. 2003. "Healthy revolutions: promoting cycling among women." *Health Promotion Journal of Australia* 14 (3):213-5.

Gatersleben, Birgitta, Katherine M Appleton. 2007. “Contemplating cycling to work: Attitudes and perceptions in different stages of change.” *Transportation Research Part A: Policy and Practice* 41 (4):302-12.

Gebhart, Kyle, Robert B Noland. 2014. “The impact of weather conditions on bikeshare trips in Washington, DC.” *Transportation* 41 (6):1205-25.

Götschi, Thomas, Jan Garrard, Billie Giles-Corti. 2016. “Cycling as a Part of Daily Life: A Review of Health Perspectives.” *Transport Reviews* 36 (1):45-71.

Government of South Australia. 2017. “The 30-year plan for greater Adelaide: 2017 update.” Report, Department of Planning, Transport and Infrastructure, Adelaide, Australia.

Guo, Yuanyuan, Sylvia Y He. 2020. "Built environment effects on the integration of dockless bike-sharing and the metro." *Transportation Research Part D: Transport and Environment* 83:102335.

Hair, Joseph F, Rolph E Anderson, Ronald L Tatham, C William. 1998. “Multivariate data analysis.” In, 207-21. New Jersey: Upper Saddle River.

Hamilton, Timothy L, Casey J Wichman. 2018. “Bicycle infrastructure and traffic congestion: Evidence from DC's Capital Bikeshare.” *Journal of Environmental Economics and Management* 87:72-93.

Harms, L, L Bertolini, M Te Brömmelstroet. 2013. Social and spatial differentiation of bicycle use patterns in the Netherlands. Paper presented at the World Conference on Transport Research, Rio de Janerio Brazi.

Heinen, Eva, Kees Maat, Bert Van Wee. 2013. “The effect of work-related factors on the bicycle commute mode choice in the Netherlands.” *Transportation* 40(1):23-43.

Hensher, David A, John M Rose, William H Greene. 2005. *Applied choice analysis: a primer*. Cambridge: Cambridge University Press.

Heymes, Capucine. 2019. “Stationless in Sydney: The Rise and Decline of Bikesharing in Australia.” *Transport Findings*.

Hood, Jeffrey, Elizabeth Sall, Billy Charlton. 2011. "A GPS-based bicycle route choice model for San Francisco, California." *Transportation letters* 3 (1):63-75.

Jennings, Gail. 2011. "A challenge shared: is South African ready for a public bicycle system?" *SATC 2011*.

Jensen, Pablo, Jean-Baptiste Rouquier, Nicolas Ovtracht, Céline Robardet. 2010. "Characterizing the speed and paths of shared bicycle use in Lyon." *Transportation Research Part D: Transport and Environment* 15 (8):522-524.

Julsrud, Tom Erik, Eivind Farstad. 2020. “Car sharing and transformations in households travel patterns: Insights from emerging proto-practices in Norway.” *Energy Research & Social Science* 66:101497.

Kaplan, Sigal, Francesco Manca, Thomas Alexander Sick Nielsen, Carlo Giacomo Prato. 2015. "Intentions to use bike-sharing for holiday cycling: An application of the Theory of Planned Behavior." *Tourism Management* 47:34-46.

Kenworthy, Jeffrey R, Felix B Laube. 1999. “Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy.” *Transportation Research Part A* 33(7-8):691-723.

Kutela, Boniphace, Hualiang Teng. 2019. “The influence of campus characteristics, temporal factors, and weather events on campuses-related daily bike-share trips.” *Journal of Transport Geography* 78:160-9.

LDA Consulting. 2013. Capital Bikeshare member survey. Report, Washington, D.C.

Lee, Hwansoo. 2020. “Home IoT resistance: Extended privacy and vulnerability perspective.” *Telematics and Informatics* 49:101377.

Lee, Q.Y., Pojani, D. 2019. Making cycling irresistible in tropical climates? Views from Singapore. *Policy Design and Practice* 2(4):359-369.

Leister, Emily Hentz, Nicole Vairo, Dangaia Sims, Melissa Bopp. 2018. “Understanding bike share reach, use, access and function: An exploratory study.” *Sustainable Cities and Society* 43:191-6.

Lu, Wei, Darren Scott, Ron Dalumpines. 2018. "Understanding bike share cyclist route choice using GPS data: comparing dominant routes and shortest paths." *Journal of Transport Geography* 71:172-81.

Ma, Xinwei, Yufei Yuan, Niels Van Oort, Serge Hoogendoorn. 2020. “Bike-sharing systems’ impact on modal shift: A case study in Delft, the Netherlands.” *Journal of Cleaner Production* 259:120846.

Madhuwanthi, R.A.M, Ashu Marasinghe, R.P.C. Janaka Rajapakse, Asanka Dharmawansa, Shusaku Nomura. 2015. “Factors Influencing to Travel Behavior on Transport Mode Choice-A Case of Colombo Metropolitan Area in Sri Lanka.” *International Journal of Affective Engineering*.

Martens, Karel. 2004. “The bicycle as a feedering mode: experiences from three European countries.” *Transportation Research Part D* 9(4):281-94.

Martin, Elliot, Adam Cohen, Jan L Botha, Susan Shaheen. 2016. “Bikesharing and bicycle safety.” Working paper, San Jose State University.

Martin, Elliot W, Susan A Shaheen. 2014. “Evaluating public transit modal shift dynamics in response to bikesharing: a tale of two US cities.” *Journal of Transport Geography* 41:315-24.

Martinez, Mark. 2017. "The impact weather has on NYC Citi Bike share company activity." *Journal of Environmental and Resource Economics at Colby* 4 (1):1-10.

Mateo-Babiano, Iderlina, Richard Bean, Jonathan Corcoran, Dorina Pojani. 2016. “How does our natural and built environment affect the use of bicycle sharing?” *Transportation Research Part A* 94:295-307.

Mátrai, Tamás, János Tóth. 2016. “Comparative Assessment of Public Bike Sharing Systems.” *Transportation Research Procedia* 14:2344-51.

Mattson, Jeremy, Ranjit Godavarthy. 2017. “Bike share in Fargo, North Dakota: Keys to success and factors affecting ridership.” *Sustainable Cities and Society* 34:174-82.

Mehdizadeh, Milad, Mohsen Fallah Zavareh, Trond Nordfjaern. 2019. “School travel mode use: direct and indirect effects through parental attitudes and transport priorities.” *Transportmetrica A: Transport Science* 15(2):749-75.

Meyer, Gereon, and Susan Shaheen. 2017. *Disrupting Mobility Impacts of Sharing Economy and Innovative Transportation on Cities*. Berlin: Springer.

Molina-García, Javier, Isabel Castillo, Ana Queralt, James F Sallis. 2013. “Bicycling to university: evaluation of a bicycle-sharing program in Spain.” *Health Promotion International* 30(2):350-8.

Namgung, Mi, Hee-Jung Jun. 2018. “The influence of attitudes on university bicycle commuting: Considering bicycling experience levels.” *International Journal of Sustainable Transportation* 13(5):363-77.

Nguyen, Ha Anh, Ali Soltani, and Andrew Allan. 2018. “Adelaide’s east end tramline: effects on modal shift and carbon reduction.” *Travel Behaviour and Society* 11:21-30.

Nieuwenhuijsen, Mark J, David Rojas-Rueda. 2020. “Bike-sharing systems and health.” In *Advances in Transportation and Health*, edited by Mark J. Nieuwenhuijsen and Haneen Khreis, 239-50. Amsterdam: Elsevier.

Nikitas, Alexandros. 2018. "Understanding bike-sharing acceptability and expected usage patterns in the context of a small city novel to the concept: A story of ‘Greek Drama’." *Transportation research part F: traffic psychology and behaviour* 56:306-21.

Nikitas, Alexandros, Pontus Wallgren, Oskar Rexfelt. 2015. The paradox of public acceptance of bike sharing in Gothenburg. Paper presented at the Proceedings of the Institution of Civil Engineers-Engineering Sustainability.

Nkurunziza, Alphonse, Mark Zuidgeest, Mark Brussel, Martin Van Maarseveen. 2012. “Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dar-es-Salaam.” *Transport Policy* 24:249-59.

Noland, Robert B, Michael J Smart, Ziye Guo. 2016. “Bikeshare trip generation in New York city.” *Transportation Research Part A* 94:164-81.

Nordfjærn, Trond, Torbjørn Rundmo. 2015. “Environmental norms, transport priorities and resistance to change associated with acceptance of push measures in transport.” *Transport Policy* 44:1-8.

Ogilvie, F., A. Goodman. 2012. “Inequalities 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):40-5.

Parkes, Stephen D., Greg Marsden, Susan A. Shaheen, Adam P. Cohen. 2013. “Understanding the diffusion of public bikesharing systems: evidence from Europe and North America.” *Journal of Transport Geography* 31:94-103.

Piatkowski, Daniel, Rachael Bronson, Wesley Marshall, Kevin J Krizek. 2015. “Measuring the impacts of bike-to-work day events and identifying barriers to increased commuter cycling.” *Journal of Urban Planning and Development* 141(4):04014034.

Pojani, Dorina, Dukagjin Bakija, Entela Shkreli, Jonathan Corcoran, Iderlina Mateo-Babiano. 2017. “Do Northwestern and Southeastern Europe share a common “cycling mindset”? Comparative analysis of beliefs toward cycling in the Netherlands and the Balkans.” *European Journal of Transport And Infrastructure Research* 17 (1).

Pojani, Dorina, Jiashuo Chen, Iderlina Mateo-Babiano, Richard Bean, Jonathan Corcoran. 2020. “Docked and dockless public bike-sharing schemes: research, practice and discourse.” In *Handbook of Sustainable Transport*. Edward Elgar Publishing.

Prabhakar, Ranjani, R Alexander Rixey. 2017. “Impacts of level of traffic stress on bikeshare ridership in the case of Capital Bikeshare in Montgomery County, Maryland.” *Transportation Research Record* 2662 (1):168-78.

Pucher, J., R. Buehler, M. Seinen. 2011. “Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies.” *Transportation Research Part A* 45(6):451-75.

Pucher, John, Ralph Buehler. 2017. “Cycling towards a more sustainable transport future.” *Transport Reviews* 37(6):689-94.

Pucher, John, Lewis Dijkstra. 2003. “Promoting safe walking and cycling to improve public health: lessons from the Netherlands and Germany.” *American Journal of Public Health* 93 (9):1509-16.

Qian, Xiaodong, Miguel Jaller, Debbie Niemeier. 2020. “Enhancing equitable service level: Which can address better, dockless or dock-based Bikeshare systems?” *Journal of Transport Geography* 86:102784.

Rérat, Patrick. 2019. “Cycling to work: Meanings and experiences of a sustainable practice.” *Transportation Research Part A* 123:91-104.

Ricci, Miriam. 2015. “Bike sharing: A review of evidence on impacts and processes of implementation and operation.” *Research in Transportation Business & Management* 15:28-38.

Rundmo, T, J Foss Sigurdson, I Cerasi-Roche. 2011. "Travel mode use, transportation priorities, and risk perception." In *Perception of transport risk and urban travel mode use*, edited by T Rundmo, 9-29. Trondheim: Rotunde publication.

Sathishkumar, VE, Cho Yongyun. 2020. “A rule-based model for Seoul Bike sharing demand prediction using weather data.” *European Journal of Remote Sensing* 53(sup1):166-83.

Scheiner, Joachim, Christian Holz-Rau. 2007. “Travel mode choice: affected by objective or subjective determinants?” *Transportation* 34(4):487-511.

Schepers, Paul, Divera Twisk, Elliot Fishman, Aslak Fyhri, Anne Jensen. 2017. “The Dutch road to a high level of cycling safety.” *Safety Science* 92:264-73.

Sears, Justine, Brian S Flynn, Lisa Aultman-Hall, Greg S Dana. 2012. "To bike or not to bike: seasonal factors for bicycle commuting." *Transportation Research Record* 2314 (1):105-111.

Shaheen, Susan A., Stacey Guzman, Hua Zhang. 2010. “Bikesharing in Europe, the Americas, and Asia:Past, Present, and Future.” *Transportation Research Record* 2143 (1):159-67.

Shaheen, Susan, Stacey Guzman, Hua Zhang. 2012. “Bikesharing across the globe.” In *City Cycling*, edited by John Pucher and Ralph Buehler. Boston: MIT Press.

Shaheen, Susan A, Elliot W Martin, Adam P Cohen, and Rachel S Finson. 2012. "Public bikesharing In North America: early operator and user understanding." In.: Mineta Transportation Institute.

Shen, Yu, Xiaohu Zhang, Jinhua Zhao. 2018. "Understanding the usage of dockless bike sharing in Singapore." *International Journal of Sustainable Transportation* 12 (9):686-700.

Si, Hongyun, Jian-gang Shi, Guangdong Wu, Jindao Chen, Xianbo Zhao. 2019. “Mapping the bike sharing research published from 2010 to 2018: A scientometric review.” *Journal of Cleaner Production* 213:415-27.

Soltani, Ali, Andrew Allan, Fahimeh Khalaj, Dorina Pojani, Milad Mehdizadeh. 2021. "Ridesharing in Adelaide: Segmentation of users." *Journal of Transport Geography* 92: 103030.

Soltani, Ali, Andrew Allan, Ha Anh Nguyen, Stephen Berry. 2019. “Bikesharing experience in the city of Adelaide: Insight from a preliminary study.” *Case Studies on Transport Policy* 7(2):250-60.

Soltani, Ali, Frank Primerano, Andrew Allan, Sekhar Somenahalli. 2006. “Design for movement: linking non-work travel and activity level to local urban design dimensions.” *Urban Design International* 11(3-4):173-86.

Stead, Dominic, Dorina Pojani. 2017. “The urban transport crisis in emerging economies: A comparative overview.” *The Urban Transport Crisis in Emerging Economies,* pp. 283-95. Berlin: Springer.

Steinbach, Rebecca, Judith Green, Jessica Datta, Phil Edwards. 2011. "Cycling and the city: a case study of how gendered, ethnic and class identities can shape healthy transport choices." Social science & medicine 72 (7):1123-30.

Tao, Shuang, Jamol Pender. 2020. "The Impact of Smartphone Apps on Bike Sharing Systems." In.: School of Operations Research and Information Engineering Cornell University.

Train, Kenneth E. 2009. *Discrete choice methods with simulation*. Cambridge, UK: Cambridge University Press.

van Waes, Arnoud, Jacco Farla, Rob Raven. 2020. “Why do companies’ institutional strategies differ across cities? A cross-case analysis of bike sharing in Shanghai & Amsterdam.” *Environmental Innovation and Societal Transitions* 36:151-63.

Wang, Kailai, and Gulsah Akar. 2019. “Gender gap generators for bike share ridership: Evidence from Citi Bike system in New York City.” *Journal of Transport Geography* 76:1-9.

Wang, Kailai, Gulsah Akar, Yu-Jen Chen. 2018. “Bike sharing differences among millennials, Gen Xers, and baby boomers: Lessons learnt from New York City’s bike share.” *Transportation Research Part A* 116:1-14.

Wang, Mingshu, Xiaolu Zhou. 2017. “Bike-sharing systems and congestion: Evidence from US cities.” *Journal of Transport Geography* 65:147-54.

Wang, Wanying, Qiang Zhang, Zhanglin Peng, Zhen Shao, Xuefang Li. 2020. “An empirical evaluation of different usage pattern between car-sharing battery electric vehicles and private ones.” *Transportation Research Part A* 135:115-29.

Wardman, M., M. Tight, M. Page. 2007. “Factors influencing the propensity to cycle to work.” *Transportation Research Part A* 41(4):339-50.

Weinberg, Bruce D, George R Milne, Yana G Andonova, Fatima M Hajjat. 2015. “Internet of Things: Convenience vs. privacy and secrecy.” *Business Horizons* 58(6):615-24.

Winters, Meghan, Michael Brauer, Eleanor M Setton, Kay Teschke. 2010. "Built environment influences on healthy transportation choices: bicycling versus driving." *Journal of urban health* 87 (6):969-93.

Woodcock, James, Marko Tainio, James Cheshire, Oliver O’Brien, Anna Goodman. 2014. “Health effects of the London bicycle sharing system: health impact modelling study.” *British Medical Journal* 348:1-14.

Wu, Chunliang, Inhi Kim. 2020. “Analyzing the structural properties of bike-sharing networks: Evidence from the United States, Canada, and China.” *Transportation Research Part A* 140:52-71.

Xie, Xiao-Feng, Zunjing Jenipher Wang. 2018. “Examining travel patterns and characteristics in a bikesharing network and implications for data-driven decision supports: Case study in the Washington DC area.” *Journal of Transport Geography* 71:84-102.

Zhao, Jinbao, Jian Wang, Wei Deng. 2015. "Exploring bikesharing travel time and trip chain by gender and day of the week." *Transportation Research Part C: Emerging Technologies* 58:251-264.

# Notes

---

[1] Brisbane's CityCycle scheme recently folded.

[2] A limitation of a survey-based approach is a lack of detailed travel data for participants (such as a weekly travel diary) or big data obtained from bikesharing providers (such as Chicago's DIVVY open-source data).

[3] PCA with varimax rotation and iteration was applied to test the dimensional structure of the transport priorities. A factor loading above 0.40 was considered as the cut-off for retaining a dimension (Hair et al. 1998). The Scree plot and Kaiser criterion were used to determine the number of extracted components. An eigenvalue above 1.00 was regarded as significant.

[4] In other words, the factor loadings were less than 0.4.

[5] To check for collinearity between pairs of variables, the Variance Inflation Factor (VIF) test was performed:

$$\mathrm{VIF_j} = \frac{1}{1 - \mathrm{R_j^2}}$$

$R_j$ is the multiple correlation coefficient between a variable (j) and the other independent variables. Values over 10.0 indicate a collinearity problem. In this case, the results suggested no collinearity: Age = 1.334; Smart = 1.117; HHsize = 1.399; SepHouse = 1.277; FullTime = 1.082; *Ease* dimension = 1.043; *Safekeeping* dimension = 1.014; *Punctuality* dimension = 1.034; *Fitness* dimension = 1.020.

[6] We considered applying a MultiNomial Logistic (MNL) model instead of a two-level NL model. But when we compared the revealed behavioural responses, the goodness-of-fit, and the Inclusive Value (IV) criteria, the tree structure presented in Figure 2 was found to be superior over a MNL regression. In a two-level NL model, the IV parameters should fall between 0 and 1 to satisfy the global utility maximisation theory. The IV parameter for Users (U) was fixed to one as it has only one alternative in its nest. The IV parameter of Non-users, however, was estimated in the modelling process. As shown in Table 4, the IV parameter of the Non-user branch is 0.608, which is statistically positive and less than 1 (according to a Wald test). This means that in this case, a MNL model would cause misspecification and misrepresent the impact of explanatory variables.

[7] The utility that an individual n perceives from alternative $j$ in nest $B_k$ is defined as:

$$U_{nj} = V_{nj} + \varepsilon_{nj}$$

where:

$V_{nj}$ is the observable part

$\varepsilon_{nj}$ is the random component of utility

In an NL model, $V_{nj}$ can be split into two components: (1) component $W$ which is constant for all alternatives within a nest, and (2) component $Y$ which varies across alternatives within a nest (Train 2009). The utility is then expressed as:

$$U_{nj} = W_{nk} + Y_{nj} + \varepsilon_{nj}$$

for $j \in B_k$, where:

$W_{nk}$ depends only on variables that describe nest $k$. These variables differ over nests but not over alternatives within each nest.

$Y_{nj}$ depends on variables that describe alternative $j$. These variables vary over alternatives within nest k.

The probability that an alternative within nest $B_k$ is chosen and the probability that the alternative $i$ is chosen given that an alternative in $B_k$ is chosen are expressed as:

$$P_{ni} = P_{ni|B_k} P_{nB_k},$$

where:

$P_{ni|B_k}$ is the conditional probability of choosing alternative $i$ given that an alternative in nest $B_k$ is chosen

$P_{nB_k}$ is the marginal probability of choosing an alternative in nest $B_k$

The marginal and conditional probabilities are expressed as:

$$P_{nB_k} = \frac{e^{W_{nk} + \lambda_k I_{nk}}}{\sum_{l=1}^{K} e^{W_{nl} + \lambda_l I_{nl}}},$$

$$P_{ni|B_k} = \frac{e^{Y_{ni}/\lambda_k}}{\sum_{j \in B_k} e^{Y_{nj}/\lambda_k}},$$

where:

$$I_{nk} = \ln \sum_{j \in B_k} e^{Y_{nj}/\lambda_k}.$$

The parameter $\lambda_k$ is a measure of the degree of independence in unobserved utility among the alternatives in nest k. The quantity $I_{nk}$ (Inclusive Value) connects the upper and lower models (Train, 2009).

The 'Full Information Maximum Likelihood' (FIML) method was employed to estimate the NL model (Hensher, Rose, and Greene 2005). We included only variables that were significant at the 90% confidence interval according to the student's t-test statistic. The model had a McFadden pseudo-rho-squared of 44%, which is considered as an acceptable explanation power. The model specifications are listed below.

The utility function of choice I consisted of following parameters:

*I = I0+I1*SEPHOUSE+I2*FULLTIME+I3*EASE*

The utility function of choice H consisted of following parameters included:

*H=H0+H1*AGE+H2*AGE*SMART+H3*HHSIZE+H4*EASE+H5*SAFEKEEPING+H6*FITNESS*

U was considered as the reference.

Two alternative-specific constants for I and H were considered.