Appendix

Appendix A. A comparative analysis of University Sustainable Travel Plans – experience from Australia

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Abstract

Travel Demand Management (TDM) initiatives are widely applied by transport planners to establish and enable appropriate use of critical transport infrastructure. Less attention has been given to the specific case of TDM in an education precinct (university) context. Travel Plans have been promoted as a means for an organisation to encourage sustainable travel choices by their employees, visitors and customers. This paper offers an empirical contribution to the literature through a comparative qualitative evaluation of selected University Sustainable Travel Plans (USTPs) in Australia to identify the most important questions that a USTP should address explicitly. The evaluation comprised identification of a set of evaluation questions, completion of a template for each USTP considered and application of a simple scoring exercise. We also identify TDM measures that have been introduced as part of a USTP in response to the typical travel patterns exhibited in university settings. A contribution of this paper is to create a means of comparison of USTPs and to establish the components of a comprehensive travel plan.

Key words: sustainable travel plans; travel demand management; education precinct TDM; sustainable travel choices.

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1. Introduction

Universities, as large trip generators often located in central city locations, offer considerable scope for the implementation of policies to encourage sustainable travel choices. TDM initiatives within a university setting have the potential ability to influence tens of thousands of commuters (Mulley and Reedy 2016). This is strongly linked with the location of campuses (often for historical reasons) in different parts of the city (CBD, suburbs, fringe). These locational characteristics are important since campuses influence their surroundings, sometimes in ways that may be transformative. For example, the University of Sydney (one of the cases considered in this study) is on the fringe of the CBD and has approximately 44,000 students enrolled and 6,200 staff at its main inner west campus placing great pressure on the nearest railway station. Taking the case of a suburban university in Barcelona Miralles-Guasch and Domene (2010) found that the main barriers to use of more sustainable modes are a lack of adequate infrastructure, limited opportunities for walking and cycling and the longer journey times by public transport. Separate to the question of how accessible a campus is there is the issue of how mobility within the campus is managed, with early studies such as Dulken (1992) pointing out that a strength of the traditional campus is the concentration of a variety of functions within reach of pedestrians.

Travel Demand Management (TDM) initiatives are applied by transport planners to establish and enable appropriate use of critical transport infrastructure. Universities experience an ebb and flow of activity throughout the year but are seldom totally 'closed' for business. A crucial step in any university TDM programme is the development of a robust travel plan which can serve as an effective transport management tool. Travel plans have been increasingly implemented over the last two decades (see for example, Rye et al. 2011; De Gruyter et al. 2018). Rye (2002) describes a travel plan as a means for an organisation to reduce its transport impacts by influencing the travel behaviour of those attending its site(s), such as employees, suppliers, customers and visitors. More recently they have been linked to strategies to maximise staff (and others) health and wellbeing. A university's travel plan must ensure it covers the student body and all its segments, from full-time undergraduates to short and evening course participants, as well as staff and visitors. Aside from their sheer size, universities also commonly have a strong social good focus embedded in their obligations as thought leaders and, in many instances, as public institutions; however, many such institutions have been found to lag behind companies with respect to helping society become more sustainable (Lozano et al. 2013). While TDM initiatives are one way to achieve broader sustainability goals in a potential widespread way, the university environment represents a unique opportunity to target younger people in the formative stages of their adult travel patterns, as they vary their travel behaviour more often, and habits and routines are not yet fully established (Beige and Axhausen, 2017). Given these potential outcomes, a more detailed understanding of TDM initiatives for education precincts are of particular interest not just for universities, but cities and society more broadly as we seek to better understand viable pathways toward sustainability.

The objective of this paper is to evaluate the quality of a selection of University Sustainable Travel Plans (USTPs) in Australia to establish the most important questions that a USTP should address explicitly. The paper is structured as follows. We begin with a brief review of literature around the definition of TDM before moving to consider the case of TDM in an education precinct (university) context. Examples of TDM measures that have been introduced in university settings and their effectiveness are discussed. Acknowledging the important role of USTPs for the effective delivery of education precinct TDM, the main body of the paper comprises a comparative analysis of selected USTPs with reference to recent

experience from Australia. TDM measures that have been introduced as part of USTPs are discussed before conclusions from the study are drawn.

2. Literature context

2.1. Defining TDM

In a benchmark paper Meyer (1999) defined TDM initiatives as an 'action or set of actions aimed at influencing people's travel behaviour in such a way that alternative mobility options are presented and/or congestion is reduced' (p 576). Gifford and Stalebrink (2001) note that TDM had gained attention since the 1970s primarily because of significant increases in travel that have not been accompanied by increases in infrastructure capacity.

TDM strategies are normally applied as a package including measures as 'sticks' (or 'push' measures) to directly discourage private car use (e.g., parking restrictions or regulations), as well as 'carrots' (or 'pull' measures) to make sustainable modes more attractive.

Sammer and Saleh (2009) note that, when implemented effectively, TDM measures (which they categorise as including regulatory, pricing, planning or persuasive policies and which can be fiscal and non-fiscal) can contribute to the realisation of a more efficient transport system, improved environmental conditions and improvements in safety, as well as revenue generation to invest in alternative transport systems.

Examples of TDM measures that have been used in a university setting are discussed next.

2.2. Education precinct TDM

This section discusses travel patterns in a university setting, followed by examples of TDM measures and considers the role of University Sustainable Travel Plans (USTPs) in delivering TDM programmes.

2.2.1. Travel patterns in university settings

As regular travel surveys, often implemented as part of a travel plan (see Tables A.1 and A.2), have become more commonplace (although not necessarily implemented regularly), knowledge of the characteristics of staff and student travel behaviour has increased (see for example, Rybarczyk et al., 2014; Ribeiro et al., 2020; Duque et al., 2014). Moreover, it has been acknowledged that an understanding of campus-based travel behaviour is crucial for making the case for TDM (Hafezi, et al., 2018).

A detailed review of student and staff commuter behaviour is given in Logan et al. (2020). They note that students tend to have lower incomes (while recognising that there is a cohort of wealthy international students in most university communities), and so their travel choices may be constrained. Student travel patterns may also be influenced by part-time work to supplement their income. A recent analysis of a 10-year dataset of staff and student travel patterns[1] at the University of Aberdeen, UK (Logan et al., 2020) found that, compared to staff, students were more likely to use active modes such as walking or cycling, though they showed greater variation across the full range of options available for the journey to and from campus. By contrast, staff show greater consistency in choice of travel methods but with a much greater tendency to drive to work individually, reflecting the convenience of the car (Ribeiro et al.,

[1] The University of Aberdeen runs a biennial staff and student travel survey: https://www.abdn.ac.uk/about/documents/Travel2016.pdf

2020); an example is the need to teach at night. Similar findings were reported by Akar et al. (2012) from a study at Ohio State University who found that students were more likely to travel by alternative modes than faculty and staff members.

Klöckner and Friedrichsmeier (2011) suggested that university students travel choices were influenced by situational (e.g., accessibility to public transport; cost) and psychological factors (e.g., intentions and norms). Logan et al. (2020) note that while student residential options tend to be more constant (e.g. rental opportunities tend to be clustered in the same neighbourhoods and university halls and residences are often closer to the academic campus), staff generally have a greater choice of residential opportunities. Writing in a Sydney context, Mulley and Reedy (2016) point out that the socio-demographic profiles of students mean that they tend to be public transport users. Students also have more flexibility than most other groups to change their residential location to minimise travel time and cost. This echoes the findings of other campus-based studies, which have shown student mode choice to be strongly influenced by demographic and physical factors as well as perception of available choices (see for example, Zhou et al., 2018 and Sultana et al., 2018 in the United States; Moniruzzaman and Farber, 2018 in Canada). Hensher and King (2002) in a study at the University of Sydney found quality of public transport to/from campus, pedestrian routes through the campus and pedestrian safety within and near campus to be among the top 5 most important environmental issues.

Rissel et al. (2013) conducted a study at the University of Sydney of how staff and students' mode of travel can impact their physical activity level (sample size of 3,737 of which 60% were students). In their online survey 80% of respondents travelled to the University on the day of interest in November 2012 and the most frequent mode of use reported was: train (32%), car driver (22%), bus (17%), walking (17%) and cycling (6%). It was found that compared to students, staff were twice as likely to use car as driver and slightly more likely to use active transport. Results from the self-reported level of physical activity in the sample, showed that students were generally more active than staff, and females were more active than male. The study confirmed that the use of active modes to travel to university enabled a larger number of respondents to be classified as sufficiently active, suggesting that this should be a priority for university travel plans. Engelen et al. (2019) describe the outcome of a subsequent online survey of travel behaviour and physical activity conducted at the same university which also investigated travel on a specific day (in September 2017) using the same questions as Rissel et al. (2013). From a sample size of 4,359 (of which two thirds were students) Engelen et al. (2019) found an increase in use of active travel and public transport modes compared to 2017, although trip lengths had increased, with 68% of trips taking longer than 30 minutes.

It should be acknowledged that the COVID-19 pandemic has had a dramatic impact on travel patterns to and from places of employment and activity centres such as university campuses, hospitals and retail and leisure facilities. Caulfield et al. (2021) describe a case-study developed for the re-opening of Trinity College Dublin (TCD), Ireland in September 2020 after a prolonged period of lockdown. TCD is in the city centre and the University and city council worked together to develop interventions to enable a safe return to campus for staff and students. A survey was conducted in June and July 2020 (sample size of 2,653 respondents) to determine how respondents would like to travel to TCD, when the campus fully reopened. TCD reopened in late September 2020 with a "blended learning" approach of in-person laboratories and tutorials and larger lectures online. The results of the study demonstrated a willingness to embrace active modes – 55% of the sample said they would like to walk or cycle when the campus reopens, compared to 26.4% who said they had walked or cycled pre-pandemic, reflecting the perceived lower risk of contracting the virus when walking and cycling. Staff and students expressed concern about using public transport to arrive at the

campus and this is important due to the very high proportion using this mode pre-pandemic – only 27% said that this would be their preferred mode when the campus reopened compared to 68% who said they used public transport pre-pandemic.

In a recent commentary based on longitudinal data from a staff and student travel survey, Ho and Habib (2022) analyse the mode choice over a 10-year period for students and staff at Dalhousie University in Nova Scotia, Canada and explore changes in travel behaviour caused by COVID-19. Results showed that students were more likely to walk or use public transport, while staff were most likely to use private vehicles. Ho and Habib (2022) report that COVID-19 has resulted in most students reporting a shift to a new primary mode (mostly walking), despite a significant increase in travel distance to campus.

A study from Poland (Paradowska, 2021) explores whether the experience of remote study introduced because of the pandemic could form the trigger for implementing a sustainable mobility policy. The study investigates students' perceptions at two universities (sample size of 404 respondents) of daily travel before the start of online learning. Overall, commuting to the university was linked with more advantages than disadvantages and pedestrians and cyclists were most satisfied with their prior travel experiences. Most students did not expect to change their commuting modes.

Ceccato et al. (2021) report the outcome of a survey of 5,385 students and 1,213 staff members at the University of Padova in Italy which explored travel intentions in the "new normal" conditions in which it is expected that people have greater flexibility over whether to travel or not. As with other studies, perception of health risk plays a fundamental role in trip cancellation decisions, especially for public transport (see also Beck et al., 2021). Ceccato et al. (2021) found that the promotion of bicycle use, bike sharing, carpooling and micro-mobility among students can effectively foster sustainable mobility habits in the "new normal". They also investigated risk-mitigation interventions in work and study settings. Free hand sanitizing gel at entry points for students, and mandatory face mask usage and body heat checks for employees were found to reduce the probability of not making the trip. A study from Sicily surveyed 537 students from the Kore University of Enna in late 2021 (Campisi et al., 2022). Findings showed that most participants (66.1%) had moved to a new mode on their most regular trip compared to the start of the pandemic. They found that participants who mainly used public transport before the pandemic are more likely to retain the new transport mode as compared with those that were mostly using private cars. Encouragingly, those who switched to active modes are more likely to retain this new preference compared to those who switched to private car.

A study from Greece (Mouratidis and Papagiannakis, 2021) provides new evidence on changes in a range of online activities (telework, teleconferencing, e-learning, telehealth and e-shopping) due to COVID-19, which in turn have contributed to changes in urban mobility. Findings from a nationwide survey (April – May 2020) show that the incidence of daily online learners increased seven-fold, although this is not broken down by sector. An Indonesian study (Prasetyanto, et al., 2022) from mid-2021 found that the residential built environment of students influenced choices in relation to e-learning locations. Students who reside in well-developed and safe neighbourhoods tend to conduct e-learning at home. Good accessibility to public amenities, green spaces and pedestrian networks encouraged greater participation in online classes on campus.

2.2.2. TDM measures in university settings

Early contributions to the literature included a comprehensive review of TDM in a university context by Toor and Havlick (2004) and Bond and Steiner (2006) for the US; Hensher and

King (2002) and Curtis and Holling (2004) for Australia; and Watts and Stephenson (2000) for the UK.

Mulley and Reedy (2016) observe that universities generally encourage pedestrian-friendly, high amenity, sustainable campus environments which support access by public transport above car. Balsas (2003) takes this argument further suggesting that university campuses are privileged places to communicate sustainability. Bonham and Koth (2010) point out that transport is an area where universities can improve their environmental credentials, not just by focussing on reducing business travel but by concentrating on the routine daily journeys. However, as Mulley and Reedy (2016) note, travel plans and TDM for universities have traditionally been primarily around the communication of options (see Tables A.1 and A.2 for a selection of web links on sustainable transport guidance) which they consider is unlikely to be as successful as targeted measures to influence transport demand.

There are many well documented examples of TDM measures that have been introduced in university settings and several are briefly discussed below.

Measures to promote cycling – Stanford University in Palo Alto, California has been designated a Bicycle Friendly University and maintains bike-related programmes and resources[2]. The bike programme includes support for safe biking as well as making it easier to use public transport with bicycles. Staff and students can also rent or purchase a folding bicycle. Highlights of Stanford's Platinum bicycle programme initiatives include removal of car parking spaces and installation of new bike lanes between student residences and the core campus. The University also offers free and discounted travel on several bus and rail shuttle services. At the University of California, Los Angeles (UCLA) bike-share schemes have grown considerably in the past 10 years. In October 2017, UCLA launched Bruin Bike Share where cyclists could rent bikes for (then) $7 USD an hour. Membership was charged at $7 per month or $60 per year with a UCLA affiliation. Rates were slightly higher for visitors. The scheme was terminated in June 2020 citing the impact of COVID-19 and rising costs associated with the software required.

Free bus travel - In 2003, an experiment targeting 43 student drivers was carried out by the Tokyo Institute of Technology, in which a one-month free bus ticket was given to 23 car drivers (the experimental group), and nothing was given to the other 20 car drivers (control group). The goal was to shift their primary mode of travel from car to bus. The results showed that participants in the experimental group increased their frequency of bus use, while their car use habits decreased from before the intervention. Their travel behaviour was maintained a month after the intervention period. The increase was 20% higher than the frequency of bus use before the intervention. This study suggests that a temporary structural change, such as offering car drivers a temporary free bus ticket, may have an important influence on modal shift (Fujii and Kitamura, 2003).

[2] https://transportation.stanford.edu/maps-resources-access/sustainable-transportation/free-and-discounted-stanford-transportation-programs

Table A.1: University travel planning – selected universities in Sydney (at September 2021)

University	Sustainable Travel Plan (date)	Travel Survey	Community size[3] / location	Return to Campus Plan	Sustainable Transport Guidance for the university community (URL)
University of Sydney (USYD)	√ (2015)	√ (2012, 2017, 2021)	44,000 students & 6,200 staff at main inner-city campus, in Camperdown / Darlington. 10 campuses in total.	√	http://sydney.edu.au/campus-life/getting-to-campus.html
University of New South Wales (UNSW)	(√) (part of Environmental Sustainability Plan – 2019)	√ (2015, 2019)	62,000 students and more than 6,700 staff. Main campus (Kensington) located in eastern suburbs of Sydney.	√ (web summary)	http://www.facilities.unsw.edu.au/getting-uni
Western Sydney (WSU)	Unknown		48,458 students and 3,387 staff. Multi-campus (7), including edge of metropolitan area.	√ (web summary)	http://www.westernsydney.edu.au/campuses_structure/cas/campuses/getting_to_uni
University of Technology Sydney (UTS)	√ (2013)	√ (2008, 2018)	36,357 students & 3,068 staff at City campus. Centrally located main campus (City).	√ (web summary)	http://www.uts.edu.au/current-students/managing-your-course/your-student-info/student-id-cards/travel-concessions http://www.uts.edu.au/sites/default/files/uts-tag.pdf (brochure)
Macquarie University (MQU)	(√) (part of 2009 Concept Plan)	√ (2017, 2020, biennial)	30,000 students & 2,700 staff. Campus-based, adjacent to major business precinct, 15 kms from Sydney's city centre.	√	http://www.mq.edu.au/about/contacts-and-maps/getting-to-macquarie (includes link to 2020 Travel Survey Report)
University of Wollongong (UOW)	(√) (part of 2016 - 2036 Campus Master Plan) + separate Transport & Access Action Plan	√ (2015, 2019)	17,080 EFTSL & 2,170 FTE staff at main campus in Wollongong (5kms from city centre).	√ (web summary)	https://www.uow.edu.au/about/locations/wollongong/getting-to-campus/ (includes COVID-19 travel advice and a downloadable transport access guide)

Note: √ = Yes

[3] As reported in the USTP and / or web site.

Table A.2: University travel planning – Go8 universities (not including USYD and UNSW) (at September 2021)

University	Sustainable Travel Plan (date)	Travel Survey	Size[4] / location	Return to Campus Plan	Sustainable Transport Guidance for the university community (URL)
University of Melbourne (UoM)	√ (2020) (web summary only)	Unknown	3,668 staff & 48,157 students. Six campuses across the region, with the main campus located in the city-centre of Melbourne	√ (web summary)	https://about.unimelb.edu.au/news-resources/campus-services-and-facilities/transport-and-parking https://sustainablecampus.unimelb.edu.au/transport
Australian National University (ANU)	(√) * Only web summary with targets to satisfy by 2020	Unknown	Over 22,000 students & 4,000 staff. Five campuses distributed across three regions (ACT, NSW and NT). Main one located in the inner-city suburb in Canberra, ACT.	√	https://services.anu.edu.au/campus-environment/transport-parking https://services.anu.edu.au/campus-environment/transport-parking/catching-the-bus
University of Queensland (UQ)	(√) (2016 to 2020) part of Sustainability Action Plan	√ (2018)	56,278 students & 6,917 full-time staff. 3 campuses in QLD (the main St Lucia campus is 7 kms from the CBD).	√	https://my.uq.edu.au/information-and-services/maps-parking-and-transport/public-transport
University of Western Australia (UWA)	√ (2020) (also part of 2021 UWA Green Impact Program)	√ (2019)	23,510 students & 3,794 staff. Main campus (Crawley), 6km from CBD	√ (web summary)	https://www.transport.uwa.edu.au/
University of Adelaide (AU)	(√) Sustainability plan including transport (2016-2020)	√ (2011)	23,023 students & 3,457 staff. Four campuses in SA and VIC, the main one (North Terrace) is located in the city centre of Adelaide	√ (web summary)	https://www.adelaide.edu.au/infrastructure/services/transport
Monash University (MON)	(√) Part of Sustainability Strategy	√ (annual?)	85,924 students & 17,562 staff (9,950 full-time equivalent). Presence on three continents, with six Campuses in VIC (the largest one located 20 kms Southeast of Melbourne).	√ (web summary)	http://www.monash.edu/people/transport-parking

Note: √ = Yes

[4] As reported in the USTP and / or web site.

Shared Mobility Services - UC San Diego announced (July 2021) a new five-year exclusive agreement with Spin, a micro-mobility provider, and TransLoc, a transport software solutions company to deliver and integrate sustainable transport modes[5]. This initiative will deliver 600 shared e-bikes and e-scooters to use around campus, enhanced through a network of "Spin Hub" charging stations that include displays with real-time campus bus location data.

Packages of TDM initiatives at the University of Aberdeen - The University of Aberdeen has introduced various TDM initiatives over a 15-year period. Logan et al. (2020) describe the TDM initiatives which include 'pull' measures (improved cycling storage facilities, a lift sharing scheme, free inter-campus shuttle bus and several electric vehicle charging facilities). 'Push' measures include ending claims for taxi travel between campuses, the introduction of annual renewable parking permits, and a reduction in the overall number of parking spaces (the role of parking management on university campuses is discussed by Sweet and Ferguson, 2019). TDM initiatives were complemented with the council introducing paid non-residential on-road parking around both campuses. Although Logan et al. (2020) found that these measures had minimal impact on transport choices, the survey did provide useful insights into travel behaviour that could be used to inform future sustainable transport planning. This study confirmed that a top-down approach towards implementing TDM initiatives may miss the influence of societal indicators such as the interactions between family caring roles and gender on travel behaviour.

Finally, *working from home* (WFH) and *studying from home* (SFH) as a TDM tool should be acknowledged. The outbreak of the COVID-19 pandemic was associated with a rapid move to WFH and SFH. Significantly, it appears that COVID-19 may have broken the resistance of many employees and employers to working from home (Beck and Hensher, 2020a and b; Hensher et al. 2022). The significance of the impact of WFH means that it should now be recognised as a transport policy lever.

2.2.3. University Sustainable Travel Plans (USTPs)

Logan et al. (2020) in their evaluation of TDM measures introduced at the University of Aberdeen note that travel plans are suitable for environments like offices, schools, universities and hospitals which experience large daily flows of people. In an early university-focussed contribution Bond et al. (2006) observed that TDM policies at the University of Florida were distributed throughout the Campus Master Plan (in the absence of a formal travel plan). Rye et al. (2011) noted that travel plans had by then become an important part of policy statements in the UK with significant potential to solve transport problems and meet CO_2 reduction targets. Workplace travel plans are commonly seen as interventions designed to change employee travel behaviour and can be instrumental in reducing congestion and pollution during commuter travel (Vanoutrive, 2019). Ison and Rye (2008), commenting on the implementation and effectiveness of TDM emphasise the importance of addressing relevant site-specific issues such as congestion and parking as well as recruitment of relevant (implementation-related) staff.

A USTP should be developed based on clearly identified needs and a statement of context, identification of activities to be implemented, along with a statement of resourcing, and clearly articulated outcomes and impacts which should be evaluated on an on-going basis (see Table A.3). Anticipated benefits from a USTP will depend on the objectives established in the plan and may include reduced congestion on and around the site and precinct; improved transport

[5] https://www.prnewswire.com/news-releases/university-of-california-san-diego-launches-comprehensive-mobility-services-powered-by-ford-owned-spin-and-transloc-301408424.html

options for staff, students and visitors; better access for emergency vehicles; reduced demand for parking; and demonstrated commitment to environmental sustainability.

2.3. Overview

This review of the literature relating to education precinct TDM has considered the specific nature of travel patterns in university settings. Noting that TDM initiatives within a university setting have the potential ability to influence tens of thousands of commuters' examples of TDM measures that have been introduced in university settings have been considered. While there is a burgeoning literature on travel plans, particularly in a workplace context, the case of USTPs appears to have received less attention. The next section of the paper comprises a comparative analysis of selected USTPs with reference to recent experience from Australia.

3. A comparison of Australian University Sustainable Travel Plans (USTPs)

Acknowledging the important role of USTPs for the effective delivery of TDM and noting the relative paucity of the literature on USTPs, this section of the paper presents the outcome of a comparative evaluation of selected USTPs with reference to recent experience from Australia. The intention is to evaluate the quality of the plans to establish the most important questions that a USTP should address.

3.1. Method for the comparative evaluation

To evaluate the quality of USTPs and the extent to which TDM measures are implemented, a qualitative case study methodology was adopted, which is presented in Figure 1. The first step was to carry out a literature review, undertake stakeholder consultation with experts involved in sustainable transport planning, and obtain useful complementary material from industry partner TfNSW's Travel Choices programme[6]. Reference was also made to the literature on the evaluation of travel plans (e.g., Cairns et al., 2010; Wake et al. 2010). This information allowed us to develop a University Sustainable Travel Plan Evaluation template for use in the case study approach (an annotated version is included in the Appendix as Table A.A1[7]), which consisted of the most important questions to be answered when exploring and evaluating a USTP through a variety of lenses, defined as follows:

1. Is the USTP a freestanding document or is it part of a larger strategic University plan?
2. Does the Travel Plan address a clear statement of needs in a transportation and sustainability context?
3. Is the Travel Plan context clearly stated?
4. Is there a description of the current and / or future situation in terms of number of trips, modal share, public transport accessibility?
5. Is there a clear Travel Plan Management and Engagement strategy?
6. Are anticipated Travel Plan Outcomes clearly articulated?
7. Are Travel Plan Impacts identified?
8. Are Travel Plan Outputs identified?
9. Have Travel Plan Activities been identified?
10. Are Inputs and Travel Plan Resourcing adequately covered?
11. Is there a proposed Monitoring and Reporting process?

[6] https://www.mysydney.nsw.gov.au/travel-choices

[7] For example, question 2 "Is the Travel Plan context clearly stated?" requires the evaluator to consider both the *organisational context* and the *policy context* for the Travel Plan. This may include: how the Travel Plan fits with the broader, long term organisational goals and strategy; how the Travel Plan fits with Local and State Government goals and strategy; and how the Travel Plan fits with the goals and strategy of other nearby organisations or precinct partners (if applicable).

12. Does the University collect data through Travel Surveys? If so, how often?

A contrasting set of universities in Australia were then selected to ensure a variety of different size of community and locations of city centre, inner urban and outer metropolitan as well as single and multi-campus facilities (see Tables A.1 and A.2). We began with a selection of universities from across Greater Sydney (also taking advantage of the variety of community size and campus locations and configurations) and expanded the review to the Go8 (Group of 8 research intensive universities) to ensure good coverage across Australia. The review and evaluation of USTPs was determined by the attainability of publicly available materials. The individual universities were also contacted via their sustainability teams with requests for supplementary material and contact was facilitated via the existing network of sustainability officers within the Go8.

Five templates were completed for USTPs from Greater Sydney – the University of Sydney (USYD), University of New South Wales (UNSW), University of Technology Sydney (UTS), Macquarie University (MQU) and University of Wollongong (UOW); and two from Go8 universities from the rest of Australia – University of Queensland (UQ) and University of Western Australia (UWA). The evaluation comprised a full independent reading of the USTP by the first and second named authors, agreement of the template content and completion of a simple scoring exercise against each of the evaluation questions (again independently, followed by a discussion to reach consensus). A summary of the outcome is shown in Table A.3 which is supplemented by the more detailed findings presented in the Appendix (Table A.A2) which addresses each of the 12 questions in the evaluation. The final step of our approach is to report conclusions and recommendations based on the findings of the exploratory phase of the USTPs.

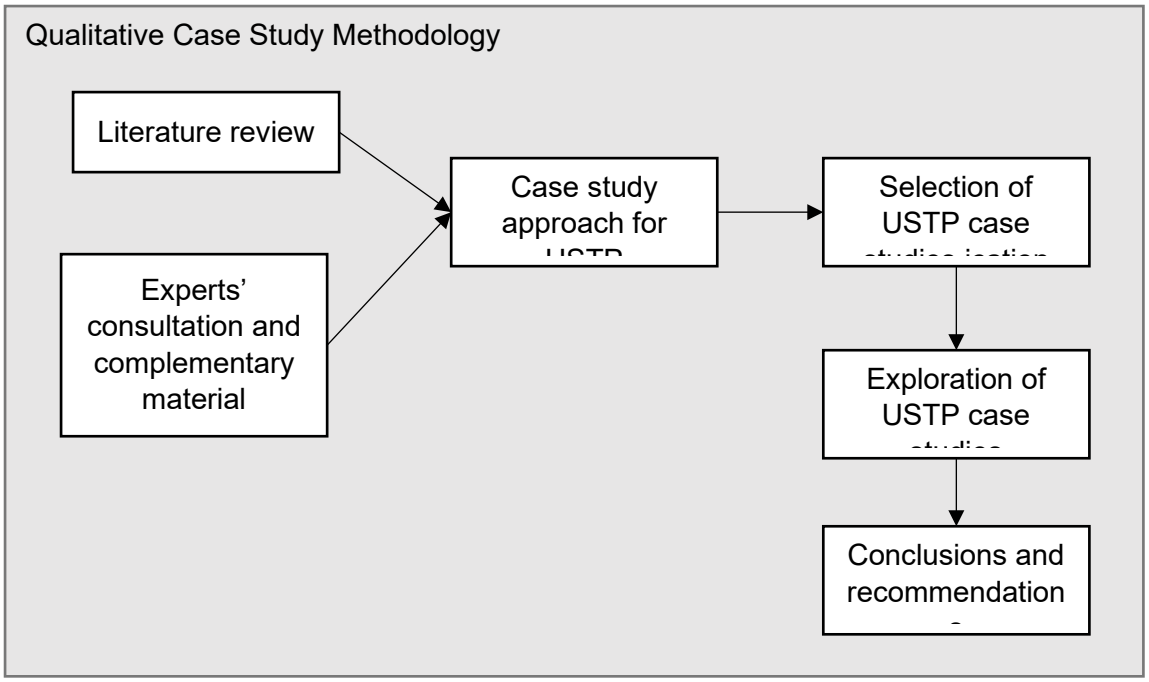

Figure A.1: Qualitative case study methodology used to evaluate USTPs

3.2. Comparative evaluation of USTPs

Table A.3 presents the summary of the outcomes of the review of USTPs and should be read in association with Table A.A2. Of the seven cases in Table A.3 only three institutions produce

a standalone USTP rather than a transport section within a wider Sustainability Plan (University of Sydney, 2015; University of Technology Sydney, 2013; and AECOM, 2020 for UWA)). Inspection confirms that a freestanding plan is likely to include a more detailed statement of needs and context and activities (see Table A.3, rows 1, 2 and 8). MQU employed external consultants to produce their campus Concept Plan (Macquarie University, 2019) which included a strategic treatment of transport and accessibility, as did UWA (AECOM, 2020). The period of refreshment for USTPs was generally unclear and often subject to resourcing constraints (confirmed by personal communications), although being part of a wider Sustainability Plan is likely to ensure more frequent updates.

Responsibility to produce an STP (in any environment) must be adequately resourced (Table A.3, row 10). In the case of MQU (2009) and UTS (2013) – both of whom had previously produced very comprehensive documentation – it was reported that staffing issues have impacted the revision of plans (personal communications).

More ambitious USTPs identify a range of strategies to improve transport accessibility, equity, connectivity and environmental sustainability (see Table A.4) and, especially in the light of COVID-19, telecommuting / flexible working should be considered as a standard TDM measure. From our examination of USTPs it is recommended that a manageable number of core activities be identified (not least because of the on-going resourcing issues identified – see Table A.3, row 9). The MQU Concept Plan is notable in specifically using the term TDM and itemising candidate measures where the strategy has been to prioritise active modes on campus, restrict car parking and improve the bus and rail service. Across the set of USTPs popular measures implemented include enhancing facilities for cyclists (UTS and MQU have worked closely with local government which can be a good way of realising “quick wins”). UNSW have found that over time people are living closer to campus and improvements to walking and cycling paths have provided further opportunity to use more sustainable modes of travel. Parking permits are widely used to manage demand (see Table A.4) and, while organised carpooling can be challenging to maintain, there is evidence to suggest a growth in informal carpooling (e.g., at UOW). Communication remains a strong feature of sustainable transport initiatives, although there was a surprising lack of travel pages being updated with COVID-10 advice (Table A.4).

Due attention should be given to the requirements of students and staff with disability or accessibility needs in terms of travel to and from campus. The Australian Disability Clearing House on Education and Training (ADCET) published guidelines in July 2020[8] updated in the context of COVID-19 return to campus planning.

One of the surest ways of developing an evidence base to inform the Sustainable Travel Plan is to organise a regular travel survey of staff and students (see Table A.3, row 11). Findings from this evaluation suggest that travel surveys are at best sporadic and that only a few are documented in detail (USYD being an exception). A 2-year travel survey cycle would be appropriate (as at MQU and proposed for UWA). It is strongly recommended that results are made publicly available (as in the case of UNSW, MQU and UWA).

[8] https://www.adcet.edu.au/resource/10382/guidelines-responding-to-the-needs-of-staff-and-students-with-disability-in-covid-19-return-to-campus-planning-for-australia-s-tertiary-institutions

Table A.3: Summary comparison of University Sustainable Travel Plans

University	University of Sydney (USYD)	University of New South Wales (UNSW)	University of Technology Sydney (UTS)	Macquarie University (MQU)	University of Wollongong (UOW)	University of Queensland (UQ)	University of Western Australia (UWA)
Does the Travel Plan address a clear statement of needs?	**	***	***	**	**	***	**
Is the Travel Plan context clearly stated?	***	*	***	*	**	NI	***
Is there a description of the current and / or future situation?	***	***	****	**	***	*	****
Is there a clear Travel Plan Management and Engagement strategy?	***	****	****	****	*	**	***
Are anticipated Travel Plan Outcomes clearly articulated?	*	***	***	*	*	NI	****
Are Travel Plan Impacts identified?	**	**	***	**	**	NI	***
Are Travel Plan Outputs identified?	***	**	**	*	**	NI	**
Have Travel Plan Activities been identified?	***	**	**	NI	***	**	***
Are Inputs and Travel Plan Resourcing adequately covered?	*	NI	NI	NI	NI	*	**
Is there a proposed Monitoring and Reporting process?	**	****	NI	NI	***	*	**
Travel Survey	****	****	****	****	****	NI	****
Score	27	28	28	17	23	10	32

Note: NI = not mentioned in plan* = mentioned but no details ** = mentioned in detail with some discussion of operationalisation (where applicable) *** = mentioned in detail with timeframe for operationalisation **** = in operation and plans for evaluation

A further observation is that delivery of sustainable transport initiatives should be supported by a strong governance framework. A good example is the UNSW Environmental Sustainability Plan (University of New South Wales, 2019) which has a clearly defined governance structure and reporting mechanism with a dedicated Reference Group to support the development and implementation of the Plan.

A common theme across the USTPs reviewed (whether free-standing or part of a wider document) is the relative paucity of detail related to resourcing the initiatives proposed (Table A.3, row 9). Similarly, most of the plans lacked a robust monitoring and evaluation process (Table A.3, row 10), with key exceptions being UOW who produce an annual progress report on their Transport and Access Action Plan and the UNSW Environmental Sustainability Plan which has an associated Annual Report.

Based on the simple scoring system, the most comprehensive USTP is shown to be that of UWA, a standalone plan which is produced by external consultants, and which has a strong focus on outcomes and impacts, gives due attention to engagement and is underpinned by a regular programme of data collection. The least high scoring USTP is from UQ which incorporates aspects of sustainable transport planning within its Sustainability Action Plan and does not produce a freestanding USTP. This may explain why key components of a USTP are not included (such as context, outcomes, impacts, and outputs). Whilst a travel plan can quite adequately be part of a wider University strategic plan (as demonstrated by UoW and UNSW) it is notable from this evaluation that issues of travel plan resourcing, while universally receiving less attention, are more adequately addressed in freestanding plans (e.g., at USYD and UWA). Similarly, the provision of a regular travel survey appears to be more likely where there is a freestanding USTP.

Although it is not our intention in this study to attempt to assess the effectiveness of the TDM measures implemented at any one university our findings imply that there is a relationship between the quality of a USTP and the resulting outcomes. A number of observations are offered here. Enhancing facilities for cyclists are amongst the most common measures implemented, often in association with local government initiatives, thus emphasising the importance of local context. UTS, a city centre located university, works closely with The City of Sydney Council and has a very clearly stated policy context (Table A.3, row 2). MQU, which is a campus-based university located adjacent to a large business park, benefits from being part of the Connect Macquarie Park & North Ryde Transport Management Association (TMA) and has closely aligned their USTP statement of needs with those of the TMA (Table A.3, row 1). UNSW, located in Sydney's eastern suburbs, has advocated for segregated cycleways in the local area for many years and has around 1,000 bike racks in the Kensington campus. UNSW has seen a growth in cycling to 6% of total daily trips in 2019 from less than 4% in 2016. UWA, located near the centre of Perth, has a stated objective of becoming a leading cycling campus and has aligned their USTP with the local policy context (Table A.3, row2).

Measures to improve wayfinding to / from and across campuses are frequently incorporated within STPs, although walking as a principal mode is influenced by the residential opportunities available locally. At UNSW a high number of staff and students walk to campus (over 20% of total trips in 2019 which has increased from 12% in 2016) and this has been encouraged by improvements to walking and cycling paths.

Parking permits and a reduction in parking spaces are widely used to manage demand. At MQU, car parking has been consolidated within four parking structures located adjacent to the primary entry roads to limit unnecessary vehicle movement through the campus. UOW has promoted convenient and affordable car parking based on need (e.g., service and contractor vehicles, disabled users and regional students).

UTS exhibits high public transport use by staff and students: the results of a 2018 travel survey show that 72% of staff and 84% of students use a form of public transport as their main mode, this is largely explained by the central location of the main campus and little onsite car parking. UTS takes part in the annual 'Ride to Work' day by running its own 'Ride to UTS' day. While organised carpooling (as at UTS) can be challenging to organise, there is evidence of a growth in informal carpooling, for example, UOW recorded a 6.5% increase in the number of vehicles entering the campus with 2 or more passengers between 2010 and 2016. Communication remains a strong feature of sustainable transport initiatives. UTS produces a Sustainable Transport Access Guide and UOW has a Transport Access Guide and a Living on Campus Transport handbook.

The literature confirms (e.g., Logan et al., 2020) that, where possible, packages of TDM measures should be introduced. From this study the standout case is MQU where results from the 2020 travel survey show that "drive alone" to campus has dropped from 45% (2017) to 37% (2020) while in the same 3-year period use of public transport to access campus has increased from 33% to 39%; and use of active modes has increased from 5% to 12% (i.e., public transport and active modes account for 51% of mode share). This is the outcome of a strategy to prioritise active modes on campus, restrict car parking and improve the bus and rail service (implemented as part of the Connect Macquarie Park Innovation District TDM programme). MQU is a special case though given that, uniquely amongst the set of cases considered, it is part of a local TMA.

Findings suggest that having a freestanding STP generally leads to a better result, but this is not a prerequisite to producing a comprehensive plan since sustainable transport policies can be part of a wider University strategic plan. However, it is crucial to have the needs clearly specified (which all USTPs evaluated managed to do – see Table A.3, row 1) and the management and engagement strategy explicitly stated (see Table A.3, row 4). The current description of situation tends to be a stronger aspect (Table A.3, row 3). The outcome of the comparative assessment suggests that USTPs are weaker on identifying outcomes, outputs, establishing a monitoring and reporting process (which is essential to ensure that USTPs are working properly) and conducting travel surveys, but those USTPs which pay attention to these aspects score better. Resourcing (Table A.3, row 9) seems to be an item which has not been adequately considered across all USTPs, even though we expect an appropriate strategy plan to include a comprehensive budget allocation which should be closely linked to the monitoring process.

Table A.4 provides a summary TDM measures implemented in the selected USTPs.

Table A.4: Comparison of TDM Measures implemented as part of University Sustainable Travel Plans

TDM measure	University of Sydney (USYD)	University of New South Wales (UNSW)	University of Technology Sydney (UTS)	Macquarie University (MQU)	University of Wollongong (UOW)	University of Queensland (UQ)	University of Western Australia (UWA)
Freestanding STP (date)	√ (2015)	X (2019)	√ (2013)	X (2009)	X (2016 & 2020)	X (2016)	√ (2020)
Enhanced facilities for cyclists	√	√	√		√	√	√
Promote 'Ride to Work Day'			√				
Inter-campus / campus to station shuttle service	√	√		√	√	√	√
Sustainable travel guidance	√	√	√	√	√	√	√
Organised lift sharing			√	√			√
Electric vehicle charging facilities			√				
Improved accessibility for community with disability			√		√		√
Improved wayfinding across campuses (including enhanced facilities for pedestrians)	√	√		√	√	√	√
Promote WFH	√		√	√			
Promote AV and VC facilities as an alternative to business travel	√	√				√	
Variety of parking permits	√			√	√		√
Reduced number of parking spaces	√		√	√			
Travel Survey (dates)	√ (2012, 2017, 2021)	√ (2015, 2019)	√ (2008, 2018)	√ (2017, 2020, biennial)	√ (2015, 2019)	X	√ (2019)
Travel pages updated with COVID-19 advice		√		√	√		

Note: √ = Yes. Blank cells = not implemented. This table is primarily compiled from information contained with the STPs. When there is no freestanding STP, the date refers to where the STP was included in a wider document (for more information refer to Table A2).

4. Discussion and Policy Implications

This paper has explored the concept of education precinct TDM. Evidence from a review of several University Sustainable Transport Plans in Australia demonstrates that a well-constructed travel plan can provide a useful framework for implementing TDM management tools. Our findings suggest that there has been little prior work which seeks to evaluate USTPs as policy instruments which may partly explain why many are so "vague". A contribution of this paper therefore has been to create a means of comparison, through completion of a template and application of a simple scoring system to work out what might be important criteria via which these policies can be assessed. The scoring system proposed in this study assumes equal weights across criteria. We recognise that given different contexts, some criteria might be more relevant than others and, as such, different weights could and should be assigned given different priorities. Additionally, we acknowledge that the emphasis is on what constitutes a comprehensive *plan* as opposed to an evaluation of how the plan is implemented and indeed how effective a plan may be in promoting more sustainable travel behaviours. There is scope for future research to explore if there are characteristics of transport plans that make them more likely to be formally operationalised, and equally if there are elements of plans that produce larger behavioural changes than others.

While having a freestanding USTP is not necessarily a prerequisite to a comprehensive travel plan (it can quite adequately be part of a wider University strategic plan), it is crucial to have the needs clearly specified and the management and engagement strategy explicitly stated. Prominent amongst findings is the need for a USTP to be adequately resourced and this seems to be an item which has not been considered across all USTPs. The plan should be supported by an ongoing programme of monitoring and evaluation (which itself requires a dedicated budget allocation). It is clear from this study that Universities in Australia acknowledge the importance of having a Sustainable Travel Plan but frequently the outcomes or impacts are not explicitly mentioned, the resourcing is not adequately covered, or the monitoring and reporting process in unclear. The comparative assessment in this study suggests that an adequate set up of activities and a monitoring and reporting process which includes regular follow-up surveys, will ensure the USTPs are working properly and raise any issues as the USTP is refreshed. These items are essential for the correct implementation, analysis and evaluation of TDM measures to strengthen the University's Sustainability plans and strategies. In some cases, it was also unclear how the USTP is communicated to university members, and in what manner is an appeal made to act more sustainability in order to motivate sustainable change.

As outlined in the introduction, TDM measures and their implementation via USTPs represent a unique opportunity to encourage large numbers of people to think about their travel choices through a more sustainable lens, and in many instances among people at a formative stage of their life course. Given the finding that resourcing and evaluation of such initiatives is haphazard, we argue that a more rigorous and implementation and appraisal process is needed in this domain, as the potential for insights and gains with respect to broader TDM initiatives is significant. On top of this the challenge remains to gain greater understanding of how work and study from home will influence travel behaviour and thus the USTP in the development of a university environment with potential for more flexible travel choices.

There are a number of limitations associated with this study. While the selection process of the USTPs was guided by advice from sustainability officers, there was arguably a bias towards locations where there was more activity in the sustainability arena. Access to relevant documentation was hampered by the extent to which materials were in the public domain and

universities should consider making a wider range of documentation public. Whilst this study adopted a qualitative evaluation methodology to evaluate the quality of USTPs a future study could assess the effectiveness of the measures implemented at different types of campus location through direct measurement and monitor the impact of such plans in a systematic way. This is an activity that appears to be largely missing at the university level.

Finally, one cannot ignore the impact that COVID-19 has had on travel patterns to and from university campuses and this is the focus of an on-going research project. There is unique opportunity to implement TDM measures catered to the more flexible work and study environments that have emerged and the valuable experience gained in return to campus planning (see Tables A.1 and A.2). It is important though that such initiatives are well-resourced and go well beyond the traditional response of only the communication of options rather than the implementation of targeted measures to influence and manage transport demand.

References

AECOM (2020). UWA Transport Strategy. Prepared by AECOM Australia, 22 July 2020.

Akar, G., Flynn, C., and Namgung, M., 2012. Travel choices and links to transportation demand management: Case study at Ohio State University. Transp Res Rec. 2319, 77-85.

Balsas, C. J. L., 2003. Sustainable transportation planning on college campuses. Transp. Policy. 10(1), 35-49.

Beck, M. and Hensher, D.A., 2020a. Insights into the Impact of Covid-19 on Household Travel, Work, Activities and Shopping in Australia – the early days under restrictions, Transp Policy. 96, 76-93.

Beck, M.J., Hensher, D.A., 2020b. Insights into the impact of COVID-19 on household travel and activities in Australia – The early days of easing restrictions. Transp Policy. 99, 95-119.

Beck, M., Hensher, D.A., Nelson, J.D., 2021. Public transport trends in Australia during the COVID-19 pandemic: an investigation of level of changing levels of use and concern. J. Transp Geogr. 96, 103167.

Beige, S., Axhausen, K.W. 2017. The dynamics of commuting over the life course: Swiss experiences, Transp. Res. Part A. Policy and Practice. 104, 179-194.

Bond, A., Steiner, R.L., 2006. Sustainable campus transportation through transit partnership and transportation demand management: A case study from the University of Florida. Berkeley Plan. J. 19, 125–142.

Bonham, J., Koth, B., 2010. Universities and the cycling culture. Transp. Res. Part D. 15(2), 94-102.

Cairns, S., Newson, C., Davis, A., 2010. Understanding successful workplace travel initiatives in the UK. Transp. Res. Part A. 44, 473–494.

Campisi, T.; Nahiduzzaman, K.M.; Nikiforiadis, A.; Stamatiadis, N.; Basbas, S., 2022. Will the Effects of COVID-19 on Commuting and Daily Activities of the University Students Be Maintained? Evidence from a Small Town in Sicily. Sustainability. 14, 5780.

Caulfield, B., Browne, S., Mullin, M., Bowman, S., Kelly, C., 2021. Re-open our city and campus post-Covid: A case study of Trinity college Dublin, the University of Dublin. Case Stud. Transp Policy. 9, 616-625.

Ceccato, R.; Rossi, R.; Gastaldi, M., 2021. Travel Demand Prediction during COVID-19 Pandemic: Educational and Working Trips at the University of Padova. Sustainability. 13, 6596.

Curtis, C., Holling, C., 2004. Just how (Travel) Smart are Universities when it comes to implementing sustainable travel. World Transp. Policy Pract. 10, 22–23.

De Gruyter, C., Rose, G., Currie, G., Rye., T., van de Graaff., E., 2018. Travel plans for new developments: a global review. Transp Reviews. 38(2), 142-161

Dulken, D., 1992. The very model of a suburban community, what we can learn from the university campus. Planning. 58(8), 24-25.

Duque, R.B., Gray D., Harrison, M., Davey E., 2014. Invisible commuters: assessing a university's eco-friendly transportation policies and commuting behaviours. J. Transp Geogr. 38, 122–36.

Engelen, L., Bohn-Goldbaum, E., Crane, M., Mackay, M., Rissel, C., 2019. Longer, more active commute, but still not very active: Five-year physical activity and travel behaviour change in a university population. Int. J. Environ. Res. Public Health. 16, 2420.

Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation. 30, 81–95.

Gifford, J.L., Stalebrink, O.J., 2001. Transportation Demand Management, In: Button, K.J., Hensher, D.A., (Eds.) Handbook of Transport Systems and Traffic Control (Vol. 3). Emerald Group Publishing Limited, Bingley, 199-208.

Hafezi, M.H., Daisy, N.S., Millward, H., Liu, L., 2018. Commuting to Campus: Findings from the Dalhousie EnACT Travel Survey. Technical Report 2018-002. Department of Civil and Resource Engineering, Dalhousie University.

Harms, L., Kansen, M., 2018, Cycling Facts: Netherlands Institute for Transport Policy Analysis | KiM, p.4, prepared by the Minister van Infrastructuur en Waterstaat, The Hague.

Hensher, D.A., King, J., 2002. Mapping Stakeholder Perceptions of the Importance of Environmental Issues and the Success in Delivery: A university case study, Environmental Education Research. 8(2), 199-224.

Hensher, D.A., Beck, M. J., Balbontin, C., 2022. Working from home and what it means for the future provision of transport services and infrastructure: a synthesis of key findings. Paper prepared for 17th International Conference on Competition and Ownership of Land Passenger Transport (Thredbo 17), Sydney, Australia, September 2022.

Ho, I., Habib, M.A., 2022. A Time-Series Investigation of University Transportation Mode Choice Trends and the Implications of the COVID-19 Pandemic. Paper for TRB.

Ison., S., Rye, T., 2008. The Implementation and Effectiveness of Transport Demand Management Measures: An International Perspective. Routledge, London.

Klöckner, C.A., Friedrichsmeier, T., 2011. A multi-level approach to travel mode choice – How person characteristics and situation specific aspects determine car use in a student sample. Transp. Res. Part F. 14, 261–277.

Logan, K., Nelson, J.D., Osbeck, C., Hastings, A., 2020. The Application of Travel Demand Management Initiatives within a University Setting. Case Stud. Transp Policy. 8(4), 1426-1439.

Lozano, R., Lukman, R., Lozano, F.J., Huisingh, D., Lambrechts, W. 2013. Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. Journal of Cleaner Production. 48, 10-19.

Meyer, M.D., 1999. Demand management as an element of transportation policy: using carrots and sticks to influence travel behavior. Transp. Res. Part A. 33, 575–599.

Macquarie University (2009). Consolidated Approved Concept Plan and Gazetted State Significant Site listing. https://staff.mq.edu.au/support/office-and-property-services/property-services/property-planning-and-management/concept-plan

Miralles-Guasch, C., Domene, E., 2010. Sustainable transport challenges in a suburban university: The case of the autonomous university of Barcelona. Transp. Policy. 17(6), 454-463.

Moniruzzaman, M., Farber S., 2018. What drives sustainable student travel? Mode choice determinants in the Greater Toronto Area. International Journal of Sustainable Transportation. 12, 367–79.

Mouratidis, K., Papagiannakis, A., 2021. COVID-19, internet, and mobility: The rise of telework, telehealth, e-learning, and e-shopping. Sustainable Cities and Society. 74, 103182.

Mulley, C., Reedy, L., 2016. Travel Demand Management Options for the Sydney CBD. A Literature Review. Institute of Transport and Logistics Studies. University of Sydney Business School.

Paradowska, M., 2021. Remote study and deconsumption – Sustainable mobility versus (un)necessary university commuting. Ekonomia I Srodowisko. 3 (78), 44-72.

Prasetyanto, D.; Rizki, M.; Sunitiyoso, Y., 2022. Online Learning Participation Intention after COVID-19 Pandemic in Indonesia: Do Students Still Make Trips for Online Class? Sustainability. 14, 1982.

Ribeiro P., Fonseca F., Meireles T., 2020. Sustainable mobility patterns to university campuses: Evaluation and constraints. Case Stud. Transp Policy. 8, 639–47.

Rybarczyk, G., Gallagher, L., 2014. Measuring the potential for bicycling and walking at a metropolitan commuter university. J. Transp Geogr. 39, 1–10.

Rissel, C., Mulley, C. Ding, D., 2013. Travel Mode and Physical Activity at Sydney University. Int J. Environ. Res. Public Health, 10(8), 3563-3577.

Rye, T., 2002. Travel Plans: do they work? Transp Policy. 9, 287-298.

Rye, T., Green, C., Young, E., Ison, S., 2011. Using the land-use planning process to secure travel plans: an assessment of progress in England to date. J. Transp. Geogr. 19, 235–243.

Sammer, G., Saleh, W., 2009. Travel Demand Management and Road User Pricing: Success, Failure and Feasibility. Routledge.

Sultana S., Kim, H., Pourebrahim, N., Karimi, F., 2018. Geographical Assessment of Low-Carbon Transportation Modes: A Case Study from a Commuter University. Sustainability. 10(8), 2696.

Sweet, M.N., Ferguson, M.R., 2019. Parking demand management in a relatively uncongested university setting. Case Stud. Transp. Policy. 7, 453–462.

Toor, W., Havlick, S., 2004. Transportation and sustainable campus communities: Issues, examples, solutions. Island Press.

University of New South Wales (2019). Environmental Sustainability Plan 2019-21. https://www.sustainability.unsw.edu.au/sites/default/files/documents/190925%20EnvironmentalSustainabilityPlan.pdf

University of Sydney (2015). Sustainable Transport and Mobility Plan. https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-7081%2120190227T095318.606%20GMT

University of Technology Sydney (2013). 2013-2020 Sustainable Travel Plan. https://www.uts.edu.au/sites/default/files/SUSTAINABLE_TRANSPORT_PLAN.140301.pdf

Vanoutrive, T., 2019. Commuting, spatial mismatch, and Transport Demand Management: The case of gateways. Case Stud. Transp. Policy. 7 (2), 489–496.

Wake, D., Thom, A., Cummings, R. 2010. Evaluating workplace travel plans. Proceedings Australasian Transport Research Forum 2010.

Watts, E., Stephenson, R. 2000. Evaluating an employer transport plan: effects on travel behaviour of parking charges and associated measures introduced at the University of Sheffield. Local Environment, 5, 435-450.

Zhou, J., Wang, Y., Wu, J., (2018) Mode Choice of Commuter Students in a College Town: An Exploratory Study from the United States. Sustainability. 10(9), 3316.

Appendix Paper

Table A.A1: University Sustainable Travel Plan Evaluation template

Institution / Title of plan / date of preparation
Does the Travel Plan address a clear statement of needs? These could include for example: • Minimise negative transport impacts of the site / organisation • Maintain and improve viability of existing or proposed site • Relocate with minimal impact on staff / student retention • Ensure people feel safe, secure and well informed about travel to and from the site • Give staff / students more flexibility to choose if, how and when they travel • Enable the organisation to sustainably expand
Is the Travel Plan context clearly stated? The *organisational context* and the *policy context* for the Travel Plan may include: • How the Travel Plan fits with the broader, long term organisational goals and strategy • How the Travel Plan fits with Local and State Government goals and strategy • How the Travel Plan fits with the goals and strategy of other nearby organisations or precinct partners (if applicable)
Is there a description of the current and / or future situation? This may include: • *location and facilities* (a description of the sites, facilities and business including: Number of staff / students; Number and type of persons accessing the site(s) other than staff / students (eg. visitors, contractors, delivery providers); Nature of key business activities affecting travel; Description of the site(s) including map showing locality, access roads and public transport; Plan of site showing car parks, access points and facilities such as cycle stands, end of trip facilities such as lockers and showers etc., Frequency of transport services to the site and any future changes expected to the transport network, Planned land use development, Access issues for those who may feel more vulnerable or who have mobility impairments, Description of current or future facilities that encourage sustainable travel, Description of current or future site barriers to sustainable travel). • *Current organisational policies affecting travel* (policies and procedures for staff and students related to travel including car use and parking, vehicle lease schemes, working / learning from home and business travel arrangements and any relevant salary packaging / loan arrangements or special circumstances (e.g., overseas students are not eligible for student concession Opal cards)).
Is there a clear Travel Plan Management and Engagement strategy? This could include: • Roles and responsibilities for Travel Plan development and monitoring • Decision making / governance framework • Steering committee details (if established) • Key internal and external stakeholders who helped develop the plan and how they will continue to be engaged • List roles of any organisations outside your organisation (eg bus operators, local government, state government, neighbours etc.)
Are anticipated Travel Plan Outcomes clearly articulated? These could include: • Travel accessibility for employees • Workplace productivity • Employee travel safety and personal security • Employee health and wellbeing • Business improvements • Corporate sustainability • Cost savings
Are Travel Plan Impacts identified? A Travel Plan should set realistic, quantifiable performance indicators to measure progress towards achieving the impacts of the Travel Plan within a certain timeframe; eg. “increase the use of public transport by 10% in 3 years or have working from home available one day a week for all staff by 2020”.
Are Travel Plan Outputs identified? • Is there a list of the key products and services that need to be delivered to achieve the impacts?

- Outputs could include: Plans / reports, brochures, articles and presentations, digital materials (websites, social media), events, works, marketing campaigns, policies, incentives, facilities, infrastructure etc.)

Have Travel Plan Activities been identified?

Who, What, When – Does the Travel Plan define what activities need to occur to deliver the outputs, who is responsible for delivering them and timeliness for delivery?

Are Inputs and Travel Plan Resourcing adequately covered?

- Is there a list of resources (time, people, budget) for Travel Plan development? These could include:
  - Implementation costs – construction of end of trip facilities, staff / student shuttles
  - Operating costs – security for accessing end of trip facilities, providing Opal cards for staff travel, or a new car park management system
  - Staff costs – people to coordinate, manage and monitor; developing communications material
  - Ongoing maintenance and renewal costs
  - Potential savings, if known

Is there a proposed Monitoring and Reporting process?

This could include:

- How the Travel Plan will be monitored (eg. by using an annual travel survey)
- How progress against the Travel Plan will be reported and to whom (eg. Board)
- Who is responsible for collecting data and reporting
- When the Travel Plan (in particular, activities and targets) will be reviewed and adjusted
- If the Travel Plan is a condition of consent, are the relevant planning authority requirements considered?

Table A.A2: Comparison of University Sustainable Travel Plans

University	University of Sydney (USYD)	University of New South Wales (UNSW)	University of Technology Sydney (UTS)	Macquarie University (MQU)	University of Wollongong (UOW)	University of Queensland (UQ)	University of Western Australia (UWA)
Freestanding STP (date)	√ (2015)	No, part of Environmental Sustainability Plan – 2019	√ (2013)	No, part of 2009 Concept Plan	No, part of 2016 - 2036 Campus Master Plan + separate Transport & Access Action Plan (2019-21)	No, part of Sustainability Action Plan (SAP) (2016 to 2020)	√ (2020) (Also, part of 2021 UWA Green Impact Program)
Does the Travel Plan address a clear statement of needs?	Yes, with a strong focus on social equity **	Yes, with very specific focus ***	Yes, detailed and builds on an evidence base of requirements ***	Yes, very specifically related to influencing modal split **	Yes, related to accessibility & sustainability **	Yes, three foci with actions and timeframe ***	Yes, clear guiding principles established **
Is the Travel Plan context clearly stated?	Very comprehensive (both internally and externally) ***	To an extent *	Very clearly stated ***	To an extent *	Yes (informed by 2019 travel survey) **	No NI	Yes, very detailed (sits within UWA Master Plan) ***
Is there a description of the current and / or future situation?	Yes, with reference to both planned growth & commuter demographics / travel patterns ***	Yes, with reference to local external initiatives ****	Yes (detailed) ****	Yes (with modal targets) **	Yes, thematic strategies and vision statements ***	Not in any detail *	Yes, very detailed (partly based on 2919 travel survey) ****
Is there a clear Travel Plan Management and Engagement strategy?	Yes, includes areas for improvement ***	Yes, this is a strong section ****	Yes, relationship with the City of Sydney is very strong ****	Yes, very detailed objectives and principles ****	Weak on engagement *	Yes, by thematic foci **	Very strong, with responsibilities identified ***
Are anticipated Travel Plan Outcomes clearly articulated?	Articulated but not detailed *	Yes (including specific targets) ***	Yes (with numeric outcomes) ***	Weak (only high level) *	Weak *	No NI	Yes, targeted outcomes are identified by strategy objectives ****
Are Travel Plan Impacts identified?	Yes, but only high level **	Limited **	Yes, clearly stated ***	Only with respect to modal split **	Only with respect to modal split **	No NI	Specific targets are identified for each objective ***

University	University of Sydney (USYD)	University of New South Wales (UNSW)	University of Technology Sydney (UTS)	Macquarie University (MQU)	University of Wollongong (UOW)	University of Queensland (UQ)	University of Western Australia (UWA)
Are Travel Plan Outputs identified?	Yes, but only for comms ***	Limited **	Yes, but limited **	Not obviously *	Yes, with detail **	No NI	Yes, but focussed on promotion **
Have Travel Plan Activities been identified?	Yes, very detailed ***	Yes, and responsibilities allocated **	Yes, and closely related to co-operation with City of Sydney **	No NI	Yes, very comprehensive; by theme with H/M/L priority ***	Yes (high level), embedded with SAP *	Yes, detailed by theme ***
Are Inputs and Travel Plan Resourcing adequately covered?	No specific detail *	No content NI	No content NI	No content NI	No content NI	Yes (high level) *	Yes (high level) **
Is there a proposed Monitoring and Reporting process?	Yes, but quite weak **	Yes, very detailed ****	No NI	No NI	Yes, very comprehensive with an annual status report against Actions ***	Yes (high level) *	Yes (but no detail) **
Travel Survey (dates)	√ (2012, 2017, 2021) ****	√ (2015, 2019) ****	√ (2008, 2018) ****	√ (2017, 2020, biennial) ****	√ (2015, 2019) ****	X NI	√ (2019) ****

Note: NI = not mentioned in the plan * = mentioned but no details ** = mentioned in detail with some discussion of operationalisation (where applicable) **** = in operation and plans for evaluation

Appendix B. The survey structure

The survey structure is presented in Figure B.1, and the colour legend in Figure B.2.

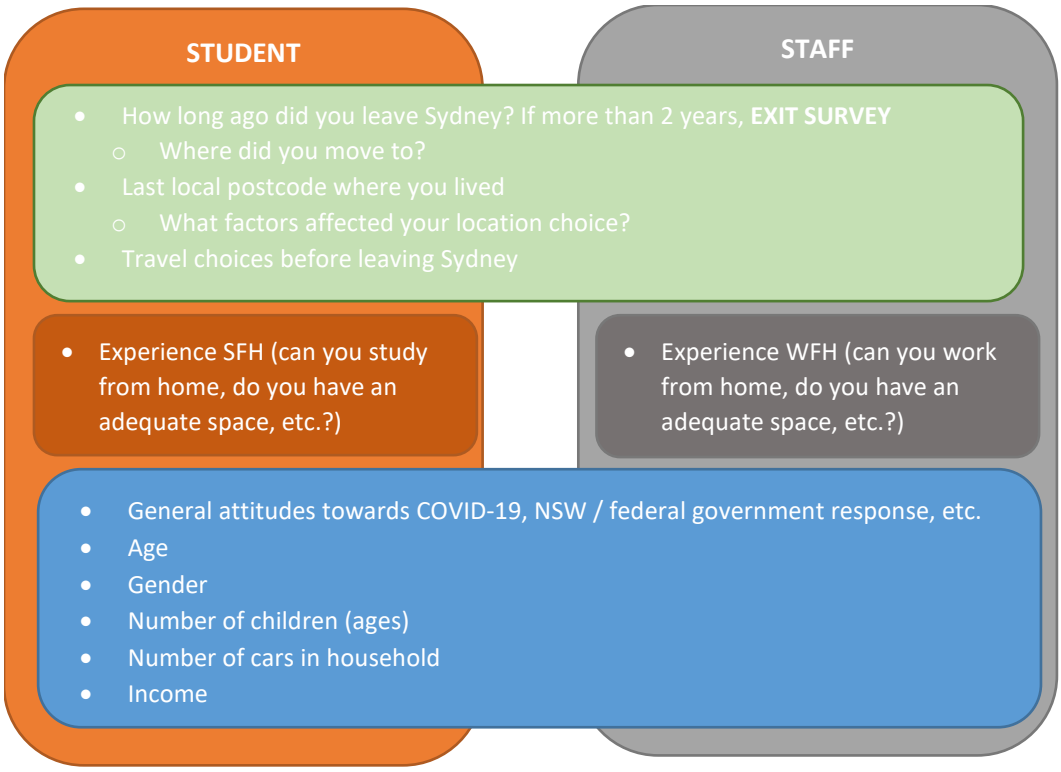

Figure E.1: Survey Structure

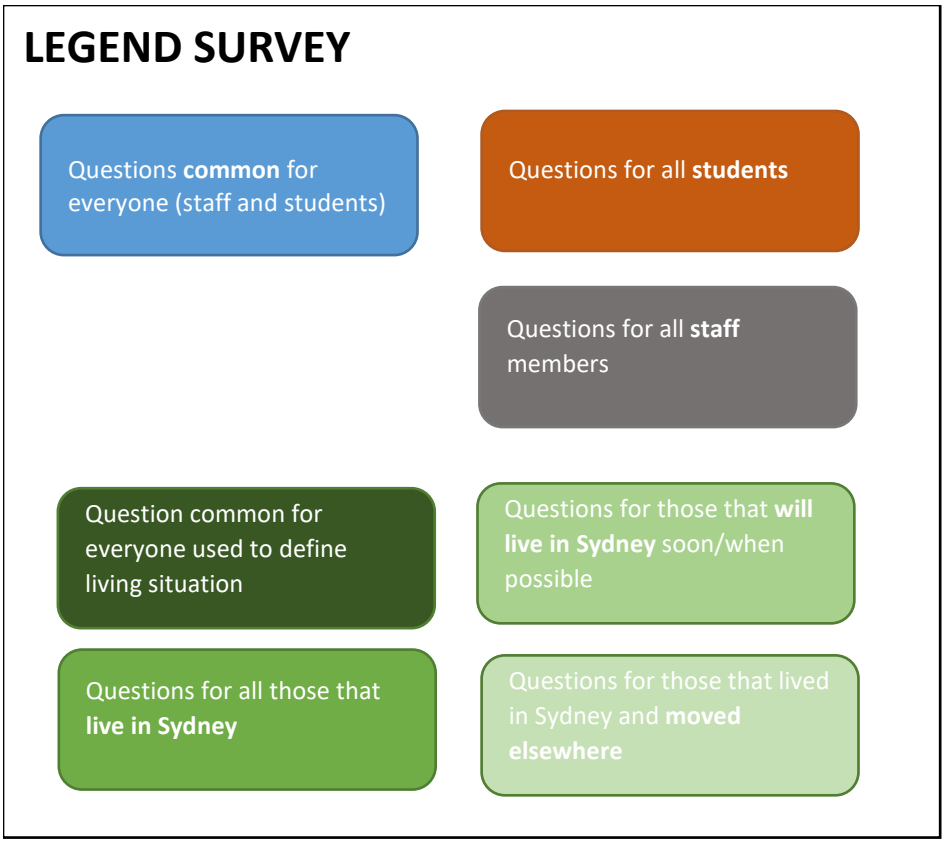

Figure E.2: Colour Survey Legend

Appendix C. Identifying main drivers for students and staff members' mode choice or to work/study from home or attend University campus: A case study in Australia

Identifying main drivers for students and staff members' mode choice or to work/study from home or attend University campus: A case study in Australia

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Abstract

Universities are major trip attractors and generators in large cities, and they have a significant influence on the transport network particularly in high-density areas. The trips to and from university campuses are made by staff, students, and visitors, with an important daily rotation of people (e.g., students who leave early, arrive later, etc.). In this study, we aim to improve our understanding of the trips made to the University of Sydney campuses, one of the largest universities in Australia, through investigation of how individuals (namely, staff and students) choose to study/work from home and their modes of transport used to go to campus on different days of the week. We have collected three sets of data: one in 2022 and two in 2023, using a survey answered by both staff and students. A hybrid logit model including latent variables is estimated to understand the motivations and main drivers to work/study from home and to choose different modes of transport when attending campus.

Keywords: University travel choices; sustainable modes of transport; work/study from home; staff and student behaviour; choice modelling

Acknowledgements

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1. Introduction

Universities are major trip attractors and generators, with many in large cities, and they have a significant influence on the transport network particularly in high-density areas. The trips to and from university campuses are made by staff, students, and visitors, with an important daily rotation (e.g., students that leave early, arrive later, etc.). Despite the significant influence that universities have in the transport network, there is limited information on how trips to and from university campuses are made, which modes of transport are preferred and why, and the effects that the possibility to work/study from home (WFH/SFH) – which have gained importance due to COVID-19 – has and will likely have in the medium to long-term on travel behaviour to campus. For three years, the University of Sydney, which is one of the largest universities in Australia with approximately 83,000 staff and students[9], offered a hybrid teaching model for a larger number of its courses, where students have face-to-face and online classes (in a mix of both synchronous and asynchronous learning). However, in the second half of 2023 (the second academic semester) there was move back to face-to-face classes exclusively, with no synchronous online learning component. The remote working model has also been implemented for staff members (both academic and professional), who are allowed to work from home for the whole or part of the week when their role allows for it. The recent enterprise bargain agreement between the University and its employees further strengthened the reasonable right to WFH on an ongoing basis. However, there is still limited knowledge about the preferences towards working from home and towards studying from home in particular, and how these have affected staff and students travel behaviour, principally in tertiary education.

In this study, we aim to improve our understanding of the trips made to the University of Sydney campuses, how often individuals (namely, staff and students) choose to study/work from home, and their preferred modes of transport to attend campus. We have collected three sets of data during 2022 and 2023 using an online survey completed by both staff and students. The hypothesis is that staff and students' travel behaviour is not only influenced by observed characteristics, such as travel time, costs, age, but also by underlying attitudes which represent their main motivation to attend campus. In this study, a hybrid choice model will be estimated to include both observed and unobserved characteristics. Namely, two latent variables representing underlying motivations to attend campus are considered: "face-to-face enthusiasts" and "social butterflies". The first underlying attitude represents those that are motivated and enjoy face-to-face activities, believe it is more effective for them to learn/work and enjoy campus facilities. The second underlying attitude represents those that are motivated by social interactions on campus, such as meeting new people, making friends, and building networks. Given staff and students are likely to have a different set of motivators, these latent variables will be estimated as specific to each role. Moreover, the utility functions of the mode choice model will include a scaling factor taking into account participants' role (i.e., staff or student) and the data collection wave. This methodological framework will allow us to gain a richer understanding of the main drivers to choose to WFH/SFH or to attend campus by different modes of transport for different days of the week: including traditionally considered variables such as travel time and costs; socio-economic characteristics, such as income, age, participants' role; and underlying variables that represent

[9] To put this in perspective, this figure would make the University of Sydney the 23rd largest city in Australia (behind Mackay whose population is 85,000 and above Rockhampton with a population of 80,200). It would be the 5th largest city in New South Wales behind Sydney, Newcastle, Wollongong, and Albury-Wodonga. It is larger than Wagga Wagga (57,000) and almost double the size of Orange (42,000).

participants' main motivation to attend campus. To the best of our knowledge, this has not been done before.

The next section presents an overview of the literature that has looked at travel behaviour given an increase in WFH/SFH, particularly in university contexts. Section 3 presents the three waves of data that will be used in this study. The following section (Section 4) presents the methodology, followed by the model results including elasticity estimates. Section 5 presents some simulated scenarios using the model results, which provides a better understanding on the implications of our findings. The last section presents the main conclusions and recommendations derived from this study.

2. Background

This study seeks to provide a better understanding of travel decisions made in a university context for different days of the week, including work from home (WFH) or study from home (SFH) as a travel alternative – both of which have significantly increased since the start of COVID-19 in 2020. This section will provide an overview of previous studies that have looked at travel behaviour given an increase in WFH/SFH, particularly in a university context. The first part of this section focuses on some illustrative survey-based studies, with papers that review the broader literature on work and study from home. The second part of this section is focused on studies that have looked at mode choices in trips made to and from universities across the world.

Hensher et al. (2021) used a survey collected in Australia to study WFH implications using an ordered logit model to explain the number of WFH days per week and a Poisson regression explaining the weekly one-way commuting trips by car and public transport. As expected, respondents who could WFH or were directed to do so reported more days WFH, and people that work in administration and services reported more days WFH relative to other occupations. Balbontin et al. (2022) study commuter mode choice and WFH during September-October 2020 in Australia, taking into consideration underlying attitudes towards WFH and the risk of infection in public transport. Their results show that these underlying attitudes have a significant influence on the probability to WFH.

Shibayama et al. (2021) compared the data from 14 countries (Austria, Brazil, Bulgaria, Czechia, Germany, Hungary, Iran, Italy, Japan, Malaysia, Slovakia, Slovenia, Thailand, and the UK). Their results suggest a significant increase in WFH and in the possibility to WFH, mainly in developed countries and for younger people with high educational levels. Studies indicate that people with lower incomes have less flexibility to WFH than people with medium and high-income levels (Astroza et al., 2020; Bonacini et al., 2021). Likewise, it is also found that unemployment affects more women, who are the ones who have the greatest number of unpaid work duties at home (Farré et al., 2020). Balbontin et al. (2021) compares the data collected in Australia, Latin America, and South Africa to identify the main drivers in WFH across different countries. The results show that, while the pandemic progression is different across countries this has an effect on the number of days WFH, employers' support towards WFH is an important driver as well as the employees' expectations as to the WFH support once COVID-19 restrictions are eased.

Barrero et al. (2021) surveyed over 30,000 people in the United States over multiple waves to investigate whether WFH will continue, and why. They use evidence from WFH experiences, investments that enable WFH, stigma associated with WFH, among others, to predict that people

will work 20 percent of their workdays from home after the pandemic ends, compared with just 5 percent before. This aligns with the Australian evidence (including a 4.6% WFH pre-COVID-19).

Research on teleworking (or telecommuting) prior to the pandemic, which is now referred to as work from home, suggests a relatively low degree of impact on the transport network and on commuting behaviour (Mokhtarian, 1991; Mokhtarian et al., 1995, 2004). Work from home during COVID-19 has been studied in several contexts; for example, in surveys undertaken in the United States (Brynjolfsson et al., 2020), Chile (Astroza et al., 2020), Spain (Farré et al., 2020), India (Bhaduri et al., 2020), among others. All the studies above agree that WFH has increased significantly due to COVID-19. Other relevant studies on WFH during the pandemic analysed mental health issues (Bouziri et al., 2020), enterprise management (Foss, 2020), employees' income (Bonacini et al., 2021), finding that with the proper digital tools, people can adequately complete their duties (Hiselius & Arnfalk, 2021).

Research on the effects of studying from home (SFH) and travel behaviour in a university setting is much more limited than the literature on WFH. Nguyen et al. (2020) study the impact of COVID-19 on perceptions and behaviour of university students in Vietnam. This brief qualitative study shows that students had a high concern towards the health crisis, which increased their reluctance to go to crowded places, using public transport, among others. Hermanto et al. (2021) study university students' opinions about studying from home during the COVID-19 pandemic in Indonesia, with a sample of 238 respondents. Their results show that more than half of the students in their sample were not enjoying SFH, and more than 90% felt they did not gain much knowledge compared to attending class on campus. Mouratidis & Papagiannakis (2021) study the importance and frequency of engaging in online activities before and during COVID-19 using a nationwide survey in Greece. Their findings report a 31% increase in telework and 34% increase in online learning. In terms of frequency, there were four times as many people engaging in teleworking and seven times more people engaging in online learning, as opposed to pre COVID-19. In their conclusions, the authors highlight the importance of looking at the longer-term effects of this shift towards online activities with the purpose of enhancing urban resilience and sustainability.

Caulfield et al. (2021) study the case of Trinity College Dublin (University of Dublin), Ireland in the period right when the lockdown restrictions were eased. This campus is located in the city centre, with only 1% of staff driving to work and students are not allowed to park on campus. The authors present the results of a travel survey of staff and students in June-July 2020 to determine how they would like to travel to campus when it fully reopened, with a focus on promoting the use of sustainable modes of transport. Their results highlight the importance of social distancing onboard public transport to reduce COVID-19 risk, particularly for those that are not able to use active modes (cycling or walking). A significant number of staff and students that cannot use active modes alone are willing to study and work from home. Their results highlight the importance of future research in travel behaviour and how our commuting mode choices will likely change as we move forward. Ceccato et al. (2021) conducted a survey of students and staff members at the University of Padova, Italy to understand the decision to travel for education or work purposes during COVID-19 (first semester of 2020). Their results suggest that the main drivers of travel decisions are different for staff members than students, and the available travel alternatives and risk mitigation measures on vehicles were statistically significant. Their results suggest that incentives towards the use of active modes (such as promoting their adoption and fostering of

bike sharing), car-pooling and micro-mobility, can have a significant influence in shifting students towards more sustainable travel modes.

Other studies have focused on understanding sustainable mobility patterns to university campuses in a period prior to COVID-19. Ribeiro et al. (2020) study the main drivers when choosing the mode of transport to the University of Minho, Portugal, where over 80% of staff members and over 40% of students use a private car. Their results suggest that 31% of car users are willing to switch to other modes if better service and conditions are provided, such as better cycling lanes, footpaths, and improved public transport frequency and routes. Logan et al. (2020) use biennial transport survey data to understand the influence of travel demand management (TDM) measures or initiatives on the commuting of staff and students at the University of Aberdeen, United Kingdom, over a 10-year period. Their results show that the university initiatives implemented, such as free inter-campus shuttle buses, charged parking permits and cycle infrastructure did not have, by themselves, a significant influence on a substantial change to sustainable modes of transport. Their results suggest that a wider societal infrastructure needs to be in place to have a significant influence on sustainable travel.

Danaf et al. (2014) study the difference in travel choice patterns between students at the University of Beirut, Lebanon in the year 2010, and the general population in the Greater Beirut Area in 2000. Their results show that a good strategy to encourage students to shift from private car to public transport would be increasing parking fees or decreasing bus travel times through the provision of shuttle services or taxi sharing. Akar et al. (2012) study travel choices of students and staff members from the Ohio State University, United States in 2011. Their findings show that cycling to campus could be encouraged by better proximity to bicycle lanes and trails, and the use of public transport could be encouraged by improving proximity to bus stops to increase the propensity to choose these modes. Their results suggested that students were more likely to travel by alternative modes than staff, and those concerned about travel time, flexibility, and safety were more likely to drive alone to campus.

Other studies trying to understand travel behaviour to a university campus have been carried out in the United States (Duque et al., 2014; Rybarczyk & Gallagher, 2014; Zhou et al., 2018; Sultana et al., 2018; Engelen et al., 2019), Canada (Moniruzzaman & Farber, 2018), Australia (Rissel et al., 2013); and Germany (Klöckner & Friedrichsmeier, 2011).

The research reported in this paper aims to fill a gap in the influence of studying and working from home, and attitudes towards attending campus after a significant increase in WFH/SFH, in staff and students' trips to university campus. The objective will be to identify and analyse the main behavioural drivers for staff and students, different profiles of transport users and what could encourage them to use more sustainable modes of transport. The University of Sydney, which is the case study, moved back to in-person delivery of courses only during the second semester of 2023, which is the case of many universities around the world, but agreed remote working remains an option for staff. The findings of this research will provide future guidelines for universities' travel plans, transport authorities and policymakers as we move forward and reach a "new normal".

3. Data

The data used in this study was collected using an online survey in three waves. The first one was collected in May-June 2022; the second one was collected during October-November 2022; and the third one between March-April 2023. During these periods there were no restrictions on

movement in Sydney, but the University still offered education within the hybrid format. Before wave 3 data collection, the University announced its plan to resume in-person delivery of courses for the second semester of 2023. The results discussed here only include students and staff members of the University of Sydney who lived in Sydney at the time of completing the survey. Different campuses of University of Sydney are included in the sample; however, 96% of the sample across waves attends the main campuses, which are located in the city centre. Table C.1 represents some general descriptive statistics of the sample for all waves, separated by staff and students. As expected, the income and age of staff are significantly higher than students. Results show that students tend to live in households with more members – but slightly fewer children. Around 70% of staff participants represented professional staff members (though professional staff members do comprise approximately 60% of staff). Unfortunately, this variable was not available for Wave 1 and only included from Wave 2 onwards – it will be included in the modelling as representing professional staff in Waves 2 and 3. Around 10% of the student sample across waves represents part-time students, and around 65% represents undergraduate students. While the gender variable exhibits some skew, it should be noted that 60% of staff and 58% of students are female. These results were relatively stable across waves. The descriptives show that in Wave 1, the total number of days per week studied from home last week was around 2.58, decreasing to 2.19 in Wave 3. For staff members it was around 2.31 days worked from home last week in Wave 1, decreasing to around 1.92 in Wave 3.

Table F.1: General descriptive statistics students and staff – mean (standard deviation)

	Student			Staff		
Variable	**Wave 1**	**Wave 2**	**Wave 3**	**Wave 1**	**Wave 2**	**Wave 3**
Age (years)	24.40 (7.36)	23.46 (5.96)	23.63 (6.45)	43.49 (11.45)	43.26 (11.53)	42.31 (10.98)
Gender female (1,0)	76%	64%	72%	70%	70%	72%
Personal annual income (000AUD$)	19.96 (25.54)	19.79 (30.29)	18.91 (26.05)	113.48 (70.36)	114.07 (67.10)	113.02 (65.57)
Number of cars available in household	1.57 (1.25)	1.35 (1.54)	1.46 (1.55)	1.34 (0.83)	1.36 (0.90)	1.41 (0.86)
Number of people living in same household	3.33 (1.51)	3.83 (11.83)	3.36 (1.90)	2.76 (1.29)	2.85 (1.32)	2.90 (1.33)
Number of children in household	0.53 (0.81)	0.44 (1.17)	0.43 (0.91)	0.58 (0.87)	0.65 (0.93)	0.60 (0.89)
Professional staff (1,0)	-	-	-	-	74%	72%
Part-time students (1,0)	11%	9%	9%	-	-	-
Undergraduate students (1,0)	66%	65%	65%	-	-	-
Distance between home and campus (kms)	18.01 (16.76)	15.89 (16.70)	19.31 (21.49)	17.58 (18.64)	16.76 (17.52)	16.22 (16.26)
Total number of weekly days worked/studied last week	5.50 (1.41)	5.59 (1.40)	5.55 (1.44)	4.97 (0.94)	4.98 (0.90)	4.91 (0.92)
Total number of weekly days worked/studied from home last week	2.58 (1.89)	2.60 (1.82)	2.19 (1.61)	2.31 (1.61)	2.14 (1.59)	1.92 (1.44)
Total number of weekly days worked/studied from campus last week	2.05 (1.71)	2.13 (1.61)	2.69 (1.59)	2.45 (1.63)	2.68 (1.55)	2.82 (1.54)
Total number of weekly days worked/studied partly from home and campus last week	0.86 (1.33)	0.86 (1.37)	0.68 (1.17)	0.21 (0.66)	0.16 (0.58)	0.17 (0.57)
Total number of respondents	**129**	**1,132**	**472**	**481**	**354**	**465**

Figure C.1 shows work/study behaviour for each day of the week, and Figure C.2 shows the mode chosen to go to the campus. Results indicate that students are more likely to study partly from campus and from home than staff members, and they are also more likely to do some study during the weekends than staff members – and these findings are stable across waves. These results are intuitive as students will often have classes timetabled for less than a full day, and have assignments that require time to complete. Regarding the modes used, staff members are much more likely to use their car to go to campus, and students are more likely to use public transport (particularly train and bus) and walk, while less likely to use the bicycle. Mode choices are relatively stable across waves. In the context of the University of Sydney, limited bicycle use is likely a function of the fact that the main campus is located in a very busy part of the city, surrounded by equally busy roads and bus routes with little to no bicycle infrastructure.

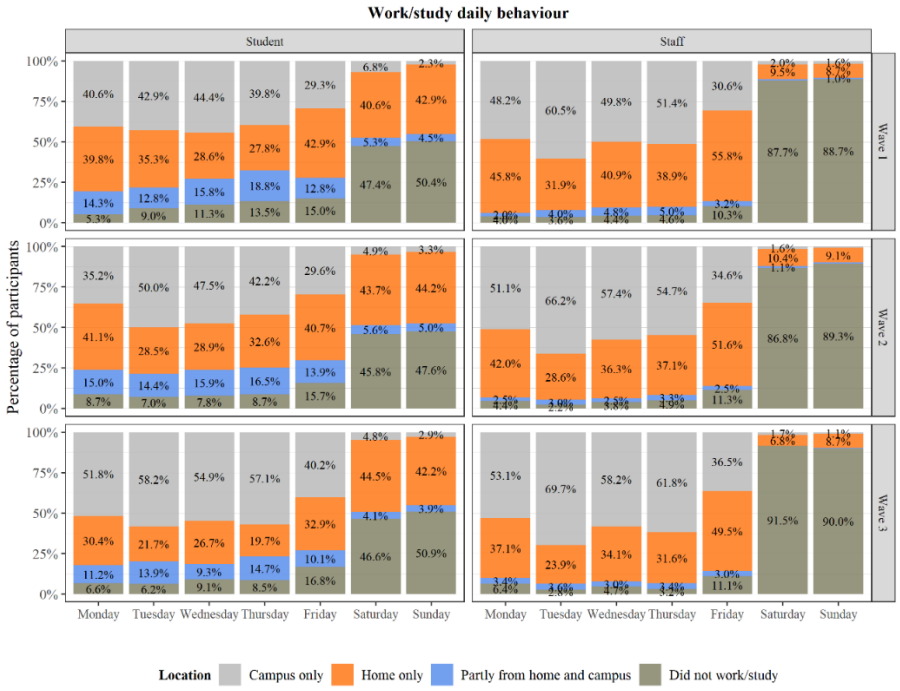

Figure F.1: Work/study daily behaviour

Figure F.2: Mode used to go to the university

In terms of activities that influence the decision to come into the university, Figure C**.3** shows that in all waves, students are motivated to come to campus to participate in face-to-face classes, attend a class, or feel that they learn more effectively when on campus relative to the start of the pandemic. They are also interested in building networks and meeting new people. Staff come to campus primarily to participate in face-to-face discussions, for a change from WFH, or they want to enjoy the social environment at work. In Wave 3, we also asked some questions regarding which factors would encourage participants use of public transport and bicycle. These results are presented in Figure C.4 and Figure C.5. The most important variable to encourage the use of public transport for both staff and students is having more frequent services, followed by more direct routes and a better connection from campus to/from the station. In terms of bicycle use, both staff and students selected as the most important variable having improved cycle paths on the journey to campus, followed by around 18% saying that they would never consider cycling. The importance of the other variables varies across staff and students; where the third most selected variable for staff is improved changing facilities and lockers on campus, and the second most selected variable by students is arrangements to buy a bicycle at a discount (which is followed closely by I would never consider cycling to campus). Even though these variables were only asked for in Wave 3, they are very relevant as they suggest measures that universities, policymakers and transport authorities could implement to encourage the use of more sustainable modes of transport such as cycling and public transport. These variables will be included in the modelling only for wave 3 and will be interpreted accordingly.

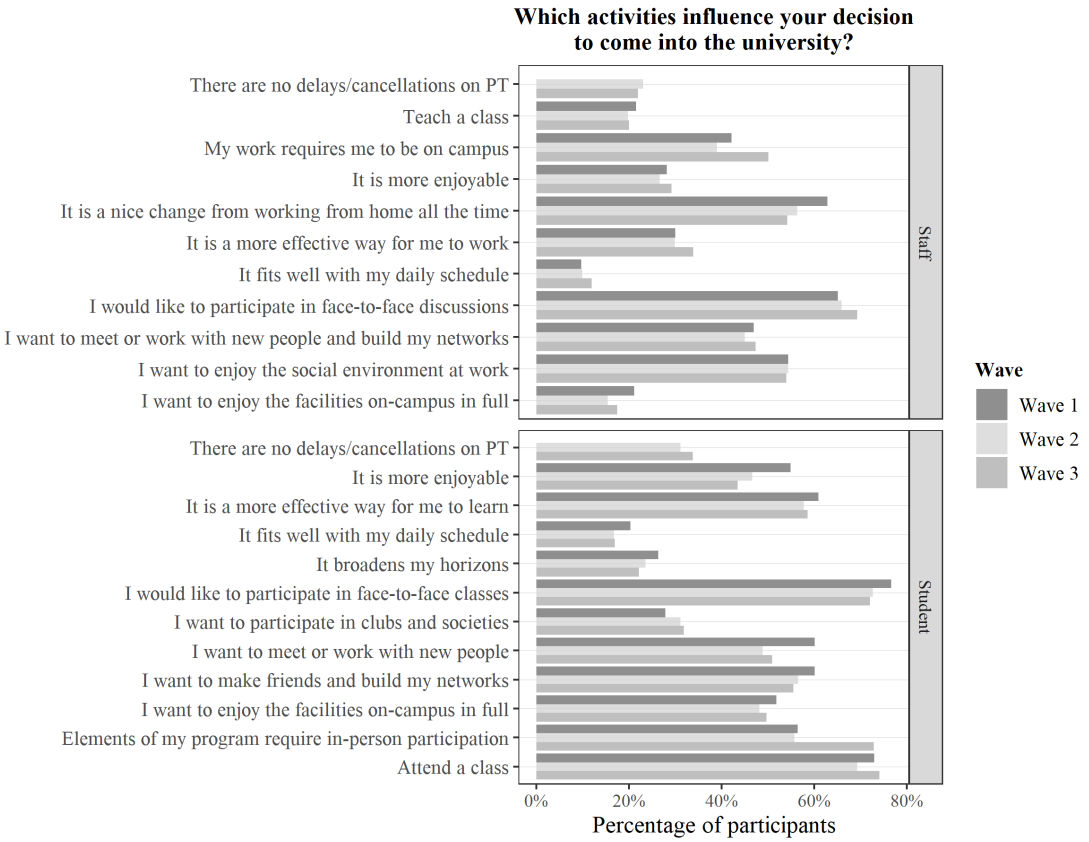

Figure F.3: Which activities influence your decision to come into the university?

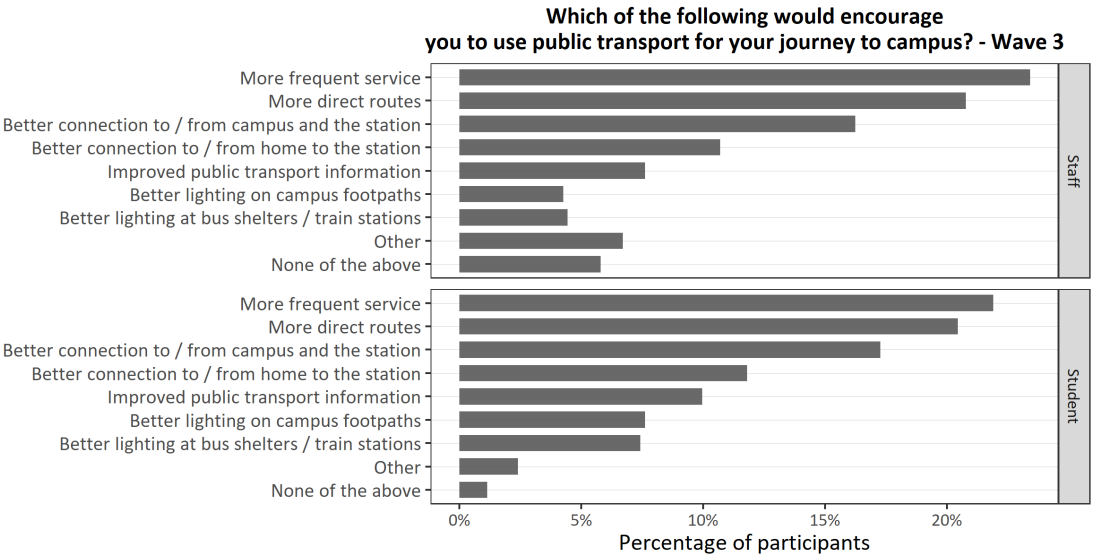

Figure F.4: Factors that would encourage use of public transport to campus – Wave 3

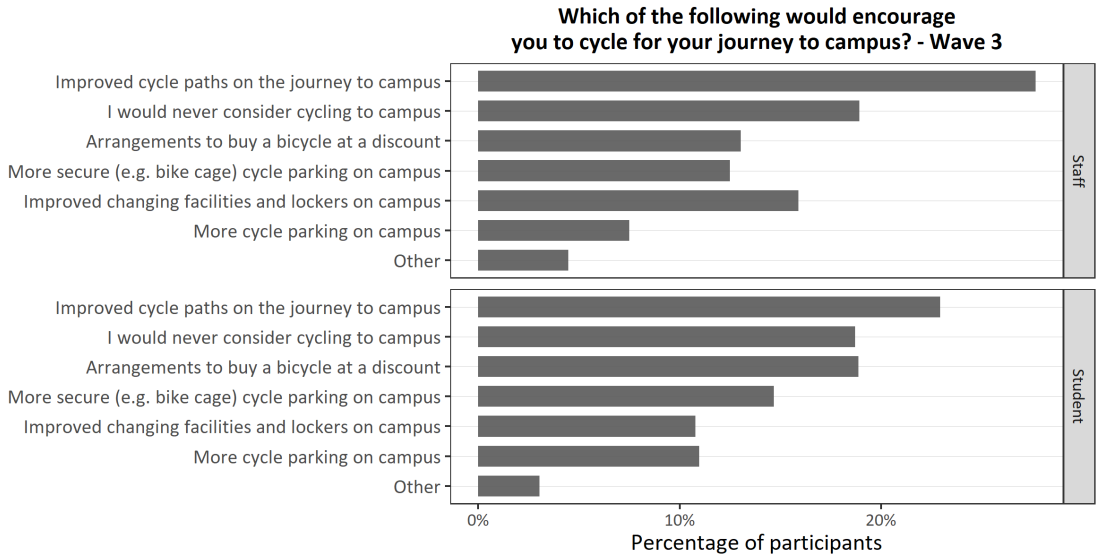

Figure F.5: Factors that would encourage use of bicycle to campus – Wave 3

4. Methodology

A hybrid choice model (MML) was estimated to identify the main drivers for students and staff members to decide where to work/study each day of the week, and if they decide to go to campus, by which mode of transport. The modelling framework is presented in Figure C.6. The hybrid choice model estimates three models simultaneously: four binary probit models representing each latent variable (face-to-face enthusiasts and social butterflies) specific for staff and students, and one mixed multinomial logit (MML) model that represents the daily decision to not work, WFH/SFH, or to attend campus and by which mode of transport.

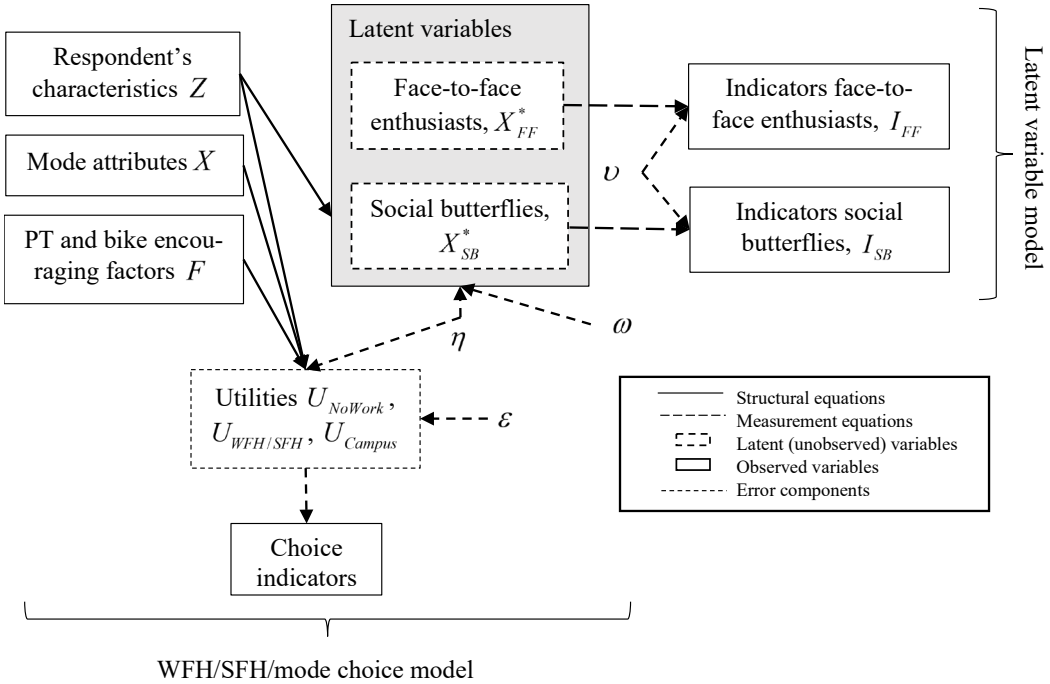

Figure F.6: Methodological framework for the hybrid choice model

The latent variables refer to variables that cannot be directly observed but are explained by some indicators. In this study, four latent variables (LV) will be considered that represent the main motivations to go to campus: two LVs representing face-to-face enthusiasts, $X^*_{FF/Staff}, X^*_{FF/Stud}$ and two LVs representing social butterflies, $X^*_{SB/Staff}, X^*_{SB/Stud}$; specific for staff and students, respectively. The structural equations for the latent variables are linear and expressed as follows:

$$X^*_{FF/Role} = \theta_{FF/Role} + \sum_j \theta_{FF/Role_j} \cdot Z_{qj} + \omega_{FF} + \eta_{FF} \quad (1)$$

$$X^*_{SB/Role} = \theta_{SB/Role} + \sum_j \theta_{SB/Role_j} \cdot Z_{qj} + \omega_{SB} + \eta_{SB} \quad (2)$$

Z_{qj} represents the *j*th characteristics of respondent *q* (e.g., age, gender, income); and θ are the estimated parameters associated with each attribute which are specific to each latent variable. The disturbances of the structural equations are defined by ω, which are the error terms associated to each latent variable*;* and η is an error term that takes into account serial correlation and is specific to each latent variable. The error terms ω and η are normally distributed with a mean of 0 and a standard deviation equal to 1, but they differ in that the second one will also be included in the WFH/SFH/mode choice model. This additional error component, η_n, takes into account the relationship between the structural equations and the WFH/commute mode choice model derived from using simultaneous estimation of the hybrid choice model, referred to as serial correlation (Bierlaire, 2016; Sottile et al., 2019). If this error term was not included, the simultaneous estimation would assume that the error terms involved in these models are independent. Serial correlation is taken into consideration by including an agent effect in the model specification, which is an error component in all the models involved (i.e., structural equations and mode choice).

The indicators used for the measurement equations of the latent variables represent whether a certain activity influences a participant to attend the campus (presented in Figure C**.3**). Each participant stated their main influences as binary variables (i.e., if they are or are not influenced by each activity). Given the complexity in defining the appropriate indicators for the latent variables and the differences between staff and students, the attitudinal questions were chosen based on the results from a factor analysis for staff and students separately[10]. It is also appropriate to analyse these responses separately as staff and students responded to slightly different sets of attendance motivators, and further as they are attending campus for different primary reasons (study versus work) the influence of these motivators should also be estimated separately.

Overall, the estimation of the latent component was an iterative process, where simple hybrid choice models were estimated to ensure that the results were not statistically different when removing/adding one attitudinal question as an indicator. For instance, including the same (equivalent) questions for both staff and students for each latent variable was tested, but including different ones as revealed by the factor analysis provided a better goodness-of-fit. The indicators used for each latent variable and participants' role (staff or student) are presented in Table C.2. The main difference between staff and students has to do with the attitudinal question stating that they like to participate in face-to-face discussions and classes, respectively. Results show that face-to-face classes seem to be preferred by students who are face-to-face enthusiasts, while face-to-face discussions are associated to staff members with the latent variable social butterflies. This is an interesting finding as it shows the different nature of classes and workplace discussions and how they are perceived differently and associated to different latent variables. Similarly, staff

[10] The factor analysis weights results are presented in Table C.6 in the Appendix.

members who are social butterflies like to change from working from home all the time, while students who are social butterflies rather attend campus to participate in university clubs and societies.

Table F.2: Indicators for latent variables representing motivations to attend campus

		Face-to-face enthusiasts	Social butterflies
Students	I would like to participate in face-to-face classes	X	
	It is a more effective way for me to learn	X	
	It is more enjoyable	X	
	I want to enjoy the facilities on-campus in full	X	
	I want to meet or work with new people		X
	I want to make friends and build my networks		X
	I want to participate in clubs and societies		X
Staff	I would like to participate in face-to-face discussions		X
	It is a more effective way for me to work	X	
	It is more enjoyable	X	
	I want to enjoy the facilities on-campus in full	X	
	I want to meet or work with new people and build my networks		X
	I want to enjoy the social environment at work		X
	It is a nice change from working from home all the time		X

The measurement equations for the latent variables are linear additive, as follows:

$$I_{no_n} = 0$$
$$I_{yes_n} = \alpha_n \cdot X_n^* + \upsilon_n \quad (3)$$

where I represents a binary response (0 = no, 1 = yes) if the participant is influenced to go to campus by activity *n* associated with each the latent variable X_n^* (presented in Table C.2); α are the parameters to be estimated; and υ_n the error term. This model is estimated as a binary probit model.

The left part of the modelling framework presented in Figure C.6 represents the WFH/SFH/mode choice model which is estimated as a mixed logit model. The alternatives' structure for the MML choice model is presented in Figure C.7, which has twelve possible alternatives given in Table C.3. The number of available alternatives for each participant will depend on whether they can work or study from home and their available modes of transport to go to campus. A utility function is defined for each alternative, and a scaling parameter is added to incorporate possible error variance between different waves of data and for staff and students. For these scaling parameters, wave 3 and students were considered to be the base, so a scale parameter was included for staff members, for wave 1 and wave 2 (Bhat & Castelar, 2002; Louviere & Swait, 1997).

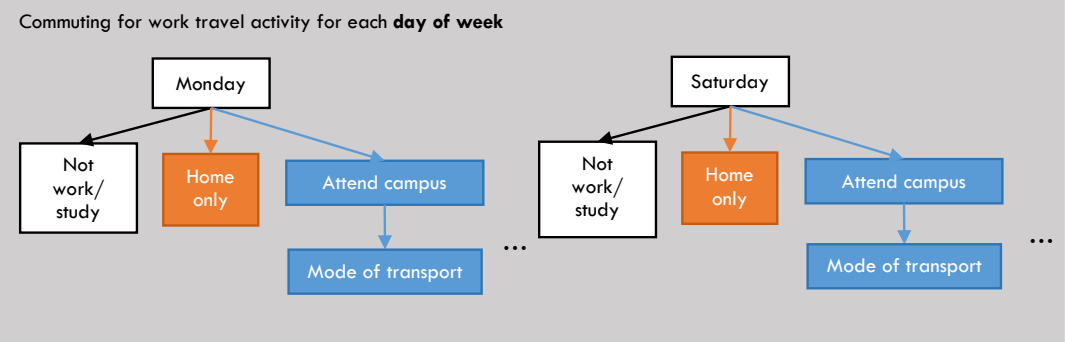

Figure F.7: Structure of daily alternatives

Table F.3: Alternative numbers per day of week Monday - Sunday

Alternative	Description
1	Not work/study
2	Work/study from home only
3	Attending campus - car driver
4	Attending campus - car passenger
5	Attending campus - taxi/rideshare
6	Attending campus - train
7	Attending campus - bus
8	Attending campus - light rail
9	Attending campus - ferry
10	Attending campus - walk
11	Attending campus - bicycle
12	Attending campus - motorcycle

The utility function of the work/study from home alternative is expressed as follows:

$$U_{Hm_q} = \left(1 + \lambda_{Staff_{Hm}} \cdot D_{Staff_q} + \lambda_{W1_{Hm}} \cdot D_{W1_q} + \lambda_{W2_{Hm}} \cdot D_{W2_q}\right) \cdot \left(\beta_{Hm} + \sum_i \beta_i \cdot Z_{qi} + \varepsilon_{Hm_q}\right) \quad (4)$$

D_{Staff_q} represents a dummy variable equal to 1 if participant *q* is a staff member, 0 otherwise; D_{Ww_q} a dummy variable equal to 1 if the observation of participant *q* belongs to wave *w*, 0 otherwise; λ the scaling parameters associated to staff, wave 1 and wave 2; β are the estimated parameters associated with each attribute (including the alternative specific constant, β_{Hm}); and ε represents an error component normally distributed with mean 0 and variance to be estimated that varies across individuals but it remains the same for individual *q*, which incorporates the correlation between the decisions made on different days of the week by the same individual

(panel data)[11]. The utility function for the alternatives to attend campus commuting by mode *m* for individual *q* is given by:

$$U_{Com_{mq}} = \left(1 + \lambda_{Staff_{Com_m}} \cdot D_{Staff} + \lambda_{W1_{Com_m}} \cdot D_{W1} + \lambda_{W2_{Com_m}} \cdot D_{W2}\right) \cdot \left(\beta_{Com_m} + \sum_i \beta_i \cdot Z_{qi} + \sum_i \beta_i \cdot X_{mqi} + \sum_i \beta_i \cdot E_{qi} + \sum_n \left(\beta_n \cdot X^*_{nq} + \eta_n\right) + \varepsilon_{Com_{mq}}\right) \quad (5)$$

X_{mqi} represents attribute *i* that describes mode *m* (e.g., travel time, fare/cost); and E_{qi} represents factor *i* that would encourage participant *q* to use public transport or cycling (as presented in Figure C**.4** and Figure C**.5**), only available for wave 3; and X^*_{nq} represent latent variable *i* for participant *q* and η_n its associated error term representing serial correlation. The error component ε_{CM_q} takes into consideration the correlation between the decision to commute made on different days of the week by the same individual *q* (i.e., it is specific for public transport alternatives and the same for all other commuting alternatives). These error terms create a hierarchical structure allowing for correlation between commuting alternatives.

The utility function of the *no work* alternative is given as equation (3):

$$U_{NW_q} = \left(1 + \lambda_{Staff_{NW}} \cdot D_{Staff} + \lambda_{W1_{NW}} \cdot D_{W1} + \lambda_{W2_{NW}} \cdot D_{W2}\right) \cdot \left(\beta_{NW} + \sum_i \beta_i \cdot Z_{qi} + \varepsilon_{NW_q}\right) \quad (6)$$

The hybrid model was estimated simultaneously using the Apollo Software (Hess & Palma, 2019) and using a high-speed computer at the University of Sydney with 6 nodes.

5. Hybrid choice model results

5.1. Latent variables results

Four different latent variables were estimated: two for students and two for staff representing face-to-face enthusiasts and social butterflies. The structural equation results are presented in Table C.4. Even though most of the socio-economic indicators were tested in these equations, only a few of them were statistically significant. This suggests that motivations to go to university can be explained by a few socio-economic variables, even though they do have a statistically significant influence on mode choices, as will be reported in the next subsection.

Results show that older students and professional staff members are less likely to be face-to-face enthusiasts, while staff members with higher income are more likely to be face-to-face enthusiasts. Given that the University of Sydney (and several Universities around the world) went back to pre-COVID operations soon after Wave 3 (second half of 2023), these results are informative in suggesting that the University's new policy will be most likely opposed by older students and professional staff, while supported by higher income and/or academic staff, which is aligned by informal observations and discussions with staff and students (e.g., discussed at many faculty teaching and learning committees). Academic staff have expressed a preference for face-to-face teaching, for an end to the hybrid approach (where classes are delivered by one

[11] Respondents provided responses on the choice made each day of the 7-day week, and hence there are 7 choice sets per respondent.

academic face-to-face and online simultaneously), and where collaborative research and problem-solving may be done more easily in a face-to-face environment. The results for the latent variable 'social butterfly' show that undergraduate students seem to be more motivated by social activities than postgraduate students; and staff members with more children in their household seem to be more motivated by social activities to attend campus.

Table F.4: Latent variables structural equations results

Description	Latent variable	Mean (t-value)
Alternative specific constant	Face-to-face enthusiast Staff	-1.545 (13.18)
Professional staff (1,0)	Face-to-face enthusiast Staff	-0.339 (3.35)
Personal income ('000$AUD)	Face-to-face enthusiast Staff	0.003 (3.61)
Alternative specific constant	Face-to-face enthusiast Students	0.881 (5.52)
Age (years)	Face-to-face enthusiast Students	-0.019 (3.08)
Alternative specific constant	Social-butterfly Staff	0.239 (4.11)
Number of children in household	Social-butterfly Staff	0.128 (2.56)
Alternative specific constant	Social-butterfly Students	-0.145 (2.15)
Undergraduate student (1,0)	Social-butterfly Students	0.191 (2.34)

5.2. Mode choice model results

The model results are presented in Table C.5, which combine the three waves. All the parameter estimates are statistically significant at the 90% confidence level, the majority being so at the 95% level. As explained in Section 4, scaling parameters were included to take into account possible error variance between the three waves of data and the participants' role (student or staff). Results show that the scaling parameter was only statistically significant for the waves' parameters (considering wave 3 as the base), suggesting that staff and students have statistically equivalent error variance. The scaling parameters for waves 1 and 2 are all negative and statistically significant (except wave 2 in active modes which was not statistically significant), suggesting a lower error variance in wave 2, followed by wave 1, relative to wave 3. This is likely associated with more freedom to WFH/SFH in wave 3 and a higher number of participants, meaning more heterogeneity in the data. The standard deviations of the error components are all statistically significant, suggesting that there is a correlation between public transport commuting alternatives, the other commuting alternatives (active modes and private modes), and no work alternatives which varies across respondents but not within the same respondent. The error component for the WFH/SFH alternative was not statistically significant and thus, excluded from the model results.

Table F.5: Mode choice model results

Description	Alternative	Mean (t-value)
Alternative specific constant	No work	-
Alternative specific constant	WFH/SFH	2.346 (18.05)
Alternative specific constant	Car driver	2.588 (16.84)
Alternative specific constant	Car pax	-0.282 (1.20)
Alternative specific constant	Taxi/Rideshare	-2.697 (5.45)
Alternative specific constant	Train	2.310 (14.32)
Alternative specific constant	Bus	1.440 (9.27)
Alternative specific constant	Light rail	1.744 (5.89)
Alternative specific constant	Ferry	1.997 (6.00)
Alternative specific constant	Walking	3.522 (17.06)
Alternative specific constant	Bicycle	2.065 (9.72)
Alternative specific constant	Motorcycle	2.356 (9.98)

Description	Alternative	Mean (t-value)
Weekend day for staff (1,0)	No work	11.185 (38.92)
Weekend day for students (1,0)	No work	6.511 (35.83)
Personal income staff ('000$AUD)	WFH/SFH	0.003 (3.85)
Part-time students (1,0)	WFH/SFH	0.407 (2.60)
Ln(Distance from home to campus for students (kms))	WFH/SFH	-0.203 (5.42)
Monday (1,0)	WFH/SFH	0.877 (11.13)
Wednesday (1,0)	WFH/SFH	0.368 (4.67)
Thursday (1,0)	WFH/SFH	0.349 (4.43)
Friday (1,0)	WFH/SFH	1.105 (13.45)
Weekends (1,0)	WFH/SFH	4.697 (30.08)
Travel time (mins)	All commuting alts	-0.004 (3.06)
Fuel cost or fare (AUD$)	Car driver, motorcycle, taxi/rideshare and PT	-0.031 (2.31)
Undergraduate student (1,0)	Car driver, pax and motorcycle	-2.419 (9.19)
Part-time students (1,0)	Car driver, pax and motorcycle	-1.605 (4.08)
Friday (1,0)	Car driver, pax and motorcycle	-0.659 (5.64)
Worked/studied partly from home and partly from campus (1,0)	PT modes	5.373 (23.73)
Undergraduate student (1,0)	Active modes	-0.772 (3.23)
Worked/studied partly from home and partly from campus (1,0)	Active modes	7.167 (22.26)
Incentives for PT use: More frequent services for students wave 3 (1,0)	PT modes	0.846 (4.97)
Incentives for bicycle use: More secure cycle parking on campus for students wave 3 (1,0)	Bicycle	-2.884 (3.65)
Incentives for bicycle use: Improved changing facilities and lockers on campus for students wave 3 (1,0)	Bicycle	-1.364 (1.95)
Incentives for bicycle use: Improved cycle paths on the journey to campus for staff wave 3 (1,0)	Bicycle	0.935 (3.80)
Incentives for bicycle use: Arrangements to buy a bicycle at a discount for staff wave 3 (1,0)	Bicycle	0.819 (2.23)
Factor face-to-face enthusiast students	Car driver, pax and motorcycle	-1.645 (10.23)
Factor social butterfly staff	Car driver, pax and motorcycle	-1.066 (10.56)
Factor face-to-face enthusiast staff	PT modes	-0.442 (6.45)
Factor social butterfly staff	PT modes	-0.609 (7.65)
Factor social butterfly students	PT modes	-0.620 (11.87)
Factor face-to-face enthusiast staff	Active modes	2.915 (9.93)
Factor social butterfly students	Active modes	-0.720 (6.77)
Scaling parameter for Wave 1 (1,0)	No work	-0.192 (6.57)
Scaling parameter for Wave 2 (1,0)	No work	-0.183 (7.42)
Scaling parameter for Wave 1 (1,0)	WFH/SFH	-0.203 (6.26)
Scaling parameter for Wave 2 (1,0)	WFH/SFH	-0.200 (7.77)
Scaling parameter for Wave 1 (1,0)	PT modes	-0.222 (5.60)
Scaling parameter for Wave 2 (1,0)	PT modes	-0.163 (4.94)
Scaling parameter for Wave 1 (1,0)	Active modes	-0.272 (5.86)
Standard deviation error component	No work	2.118 (26.49)

Description	Alternative	Mean (t-value)
Standard deviation error component	PT modes	-1.739 (20.02)
Standard deviation error component	All commuting alts except PT	2.641 (24.96)
Number of parameters		***71***
Log-likelihood equal shares L(0)		***-46,538.74***
Log-likelihood at convergence		***-32,703.15***
AIC/n		***3.087***
Sample size		***21,231***
Number of individuals		***3,033***

Results show that both students and staff are more likely to not work on weekends, with staff having a higher propensity to not work on weekends than students. In terms of WFH/SFH, staff members with a higher income are more likely to engage in WFH/SFH (unsurprising as they are more likely to be academic staff members, or senior members of the professional staff and thus have more discretion over where their work is completed), as is also seen for part-time students. Results show that students who live further away from campus are less likely to SFH, suggesting that living further away for students might have a more positive attitude towards attending campus – which is contrary to what has been found for workers in Sydney, Australia (Balbontin et al., 2023). This is an interesting difference suggesting that students' behaviour – specifically full-time students (since part-time are more likely to engage in SFH) – is different to workers in general and that students might gain and perceive more benefits by attending campus than staying home, particularly if they live further out from the city centre, where the main campuses of the University of Sydney are located (96% of our sample across all waves attends the main campuses). It may be that these students have inferior study facilities at home - smaller homes, and limited space. With respect to the day of the week, if a respondent is working/studying, they are more likely to do so from home on weekends followed by Fridays, Mondays, and finally by Wednesdays and Thursdays.

The attributes for the different commuting modes show that, as expected, travel time and cost have a negative influence on the probability of using them. Undergraduate students are less likely to use private modes, followed by active modes; while part-time students are less likely to use private modes. Staff and students that work partly from home and from campus on a given day are more likely to use active modes, followed by public transport, relative to private modes of transport. On Fridays, staff and students are less likely to use private modes of transport.

In terms of the factors that would encourage participants to use public transport or active modes, results show that students that stated they would be encouraged to use public transport with more frequent services, are more likely to use public transport – suggesting the need to improve frequency of services for public transport users. Students that said they would be encouraged by more secure cycle parking on campus, or by improved changing facilities and lockers on campus are less likely to cycle to campus. These results suggest two important factors that might be discouraging current students to cycle to the university. Staff members that said they would be encouraged to cycle to campus if there were improved cycle paths on the journey to campus or if there were arrangements to buy a bicycle at a discount are more likely to cycle to campus. These results show that staff members who currently cycle to campus believe cycle paths should be improved and would feel very positive towards bicycle purchase discounts. Including these factors is very interesting as it is suggesting that both public transport and bicycle users and non-users, as well as staff and students, have different priorities in terms of what would encourage them to use more sustainable modes of transport in their trip to the university. These findings advise which

factors are considered to be most relevant in terms of public transport and cycling use for both users and non-users, but they do not provide information on how mode choices would change if these attributes were improved as that would require hypothetical scenarios (stated preferences) and this research uses information on real travel behaviour only (revealed preferences).

The underlying attitudes represented by the factors have a statistically significant influence on all commuting alternatives, showing that the motivations to go to the university do play an important role in respondents' mode choice. Students who are face-to-face enthusiasts are less likely to use private modes of transport, while staff members who are face-to-face enthusiasts are less likely to use public transport and more likely to use active modes. Students who are social butterflies are less likely to use public transport, while staff members who are social butterflies are less likely to use private modes of transport, followed by public transport. The next section will present important outcomes of these results, which provide a better understanding of these findings and their implications separated by wave and participants' role.

6. Elasticities and simulation results

We estimated direct mean elasticities, which represent the percentage change in the probability to choose an alternative given a percentage change in the explanatory variable, *ceteris paribus*. The elasticities for the explanatory variables of each alternative were calculated for each individual and a weighted average calculated relative to the probability of choosing each alternative[12]. The elasticity estimates for the final model are presented in Figures 1 and 1 for students and staff, respectively (Table C.7 in the Appendix presents all the elasticity estimates with mean and standard deviation). The elasticity estimates for students show age plays a crucial role in the probability to drive to campus, a student who is 10% older than another is 6.50%, 6.64% and 7.35% more likely to drive to campus in Waves 1, 2, and 3, respectively. Age was not statistically significant for staff members.

The explanatory variable representing if they worked partly from home and partly from campus is a binary variable (either 1 or 0), same as the days dummy variables and should be interpreted slightly differently. Results show that participants who work part from home and part from campus are 2.37% more likely to use the train, 5.59% more likely to use the bus, 3.52% more likely to walk, and 16.08% more likely to cycle to campus in Wave 3 (the percentages were slightly lower for previous waves). In the case of staff members, they are 0.71% more likely to use the train, 2.55% more likely to use the bus, 21.2% more likely to walk, and 25.05% more likely to cycle in Wave 3. Interestingly, results show that staff and students who opt for blended work from home and campus tend to use more sustainable modes of transport – which could be somehow related to the distance from their home to campus. However, this variable was significant for students only, suggesting that those who live 10% further from campus are 0.18% less likely to SFH.

[12] Note that the variables that were not available in every wave, such as professional staff (available in wave 2 and 3) or the incentives to use public transport or bicycle (available in wave 3 only) were calculated as averages only for the waves where it was available.

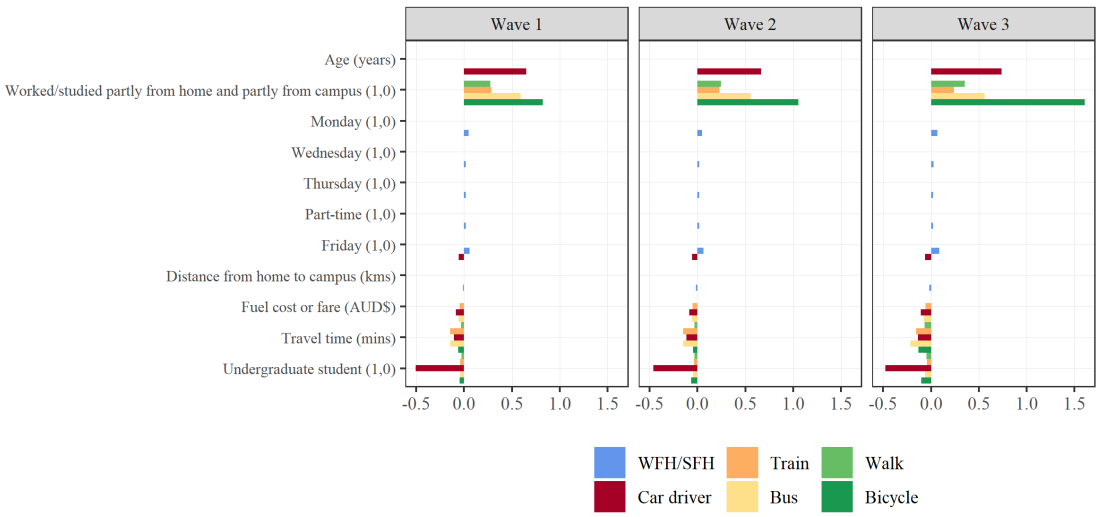

Figure F.8: Direct mean elasticity results for students

Elasticities' results show that staff members with an income 10% higher are 1.03%, 1.06% and 1.22% more likely to WFH, 0.69%, 0.75%, and 0.89% less likely to use the train, 0.71%, 0.83%, and 1.06% less likely to use the bus, 6.00%, 6.41% and 10.77% more likely to walk, and 5.68%, 9.35%, and 9.89% more likely to cycle to campus in Wave 1, 2, 3, respectively. For all modes, the elasticity increased across waves, suggesting that income's role in decision-making has gained relevance.

The travel times' elasticities show that if travel time decreases by 10%, staff and students, respectively, would be 1.05% and 1.35% more likely to drive, 1.99% and 1.56% more likely to use the train, 1.72% and 2.14% more likely to use the bus, 1.27% and 0.66% more likely to walk and 0.84% and 1.30% more likely to cycle in Wave 3. If the fuel cost would decrease by 10%, staff would be 0.73% more likely to drive and students 1.06%. If the public transport fare decreased by 10%, staff would be 1.09% more likely to use the train and 1.17% more likely to use the bus, while students would be 0.55% more likely to use the train and 0.79% more likely to use the bus. These elasticity results show that students are a bit less sensitive to travel time and a bit more sensitive to costs than staff members. However, these elasticities are quite low, which suggest that mode choice is relatively inelastic to changes in travel time and costs, showing a huge habitual behaviour when going to campus.

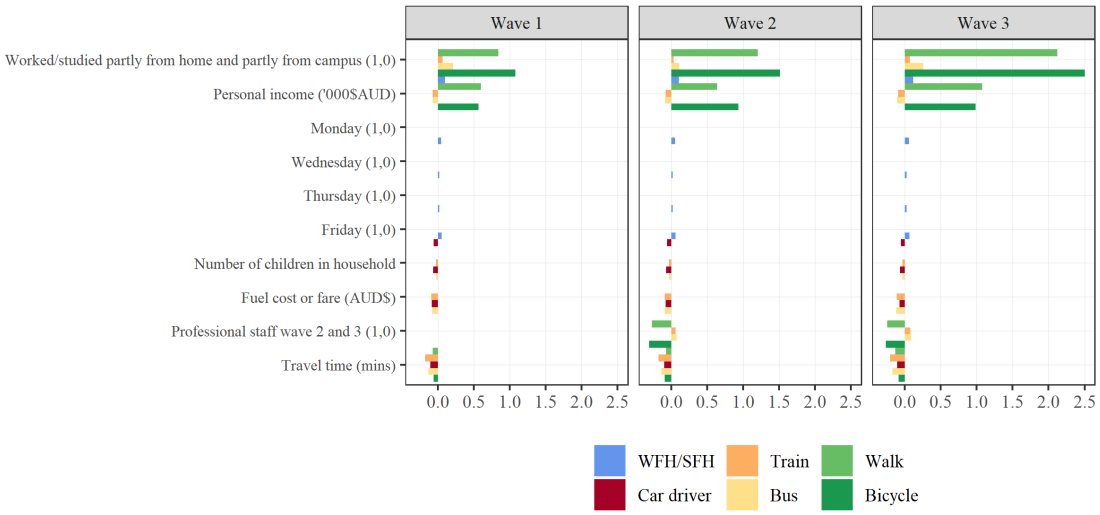

Figure F.9: Direct mean elasticity results for staff members

Most elasticities tend to increase across waves, suggesting that as we moved past the lockdowns and uncertainty associated with the pandemic and the University announced its plan to resume in-person delivery of courses, staff and students' characteristics and attitudes started playing a more relevant role in the probabilities to WFH/SFH or to attend campus by different modes of transport.

The explanatory variable distance from home to campus resulted to be statistically significant for students only and has a negative relationship with the probability to SFH. With respect to distance not being significant for staff, it is likely that staff operate with significantly less flexibility with respect to travel to campus, given that the University is a place of employment rather than a place of study. If a staff member needs to travel to campus (irrespective of how far away they live), they likely need to do so as a requirement of their job function.

Weekdays' choice probabilities[13] were simulated for different students' distances from home to campus, and its results are presented in Figure C.10. This explanatory variable was included with a natural logarithm transformation and that is why its influence on the probability to SFH is not linear. The probability to SFH for students on weekdays is around 36% in Wave 3 when living within 5 kms from campus, which decreases to around 31% when living within 20 kms, and to 27% when living within 50 kms. Results show that the main changes are for students living very close to campus (within 5 kms) relative to those living within 20 kms or more (where the influence in the probability to SFH decreases). Moreover, it seems that most students that decide to attend campus instead of SFH, mainly use public transport, followed by active modes.

[13] Only weekdays were included since the choices are very different to weekends (where students mainly study from home or not study).

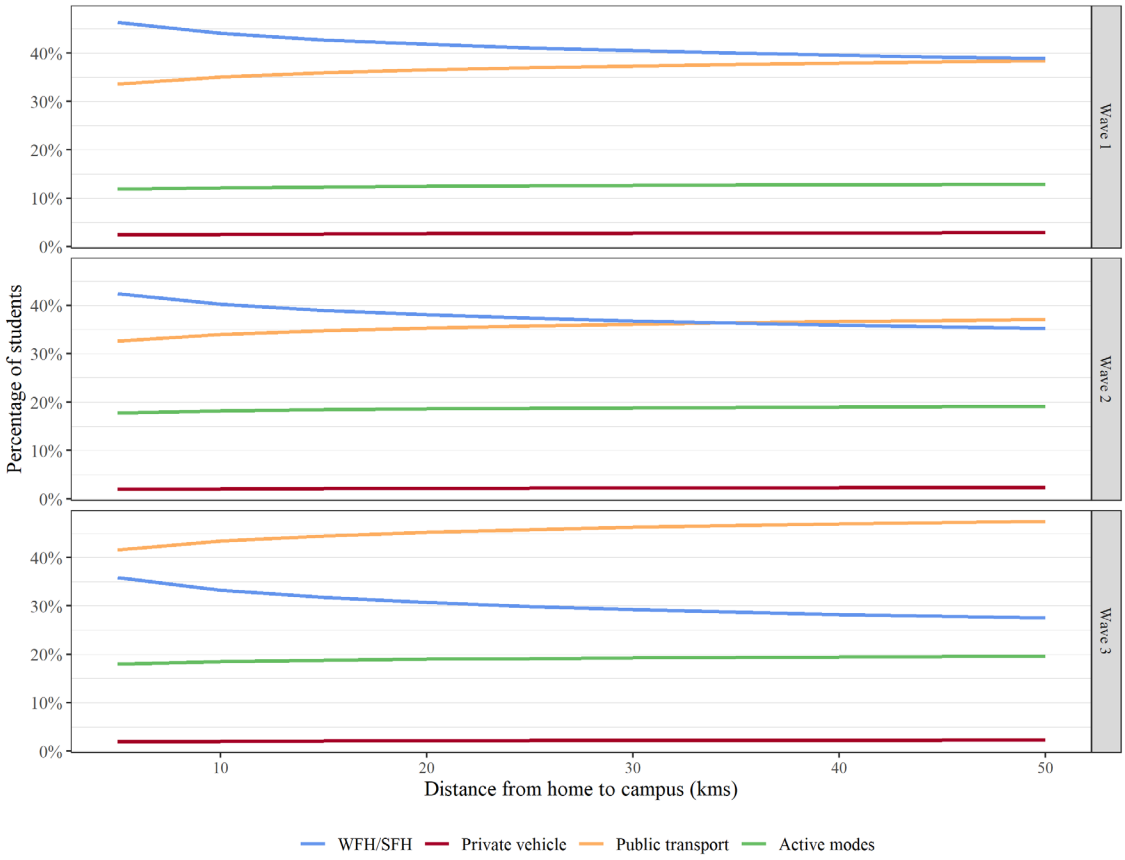

Figure F.10: Simulation distance from home to campus on weekdays for students

7. Conclusions

This study aims to understand staff and students' preferences to work (WFH)/study (SFH) from home or to attend university campus using different modes of transport. The data is collected in three waves of data for staff and students that work/study at the University of Sydney, Australia. A hybrid choice model is estimated to understand travel behaviour for each day of the week, including underlying attitudes that represent participants' motivations to go to campus: if they are mainly motivated by social or face-to-face activities (this latter includes enjoying facilities available on campus). This study comes at an interesting time, where the University of Sydney and many other universities around the world are moving to a completely in-person delivery of courses, which makes it more relevant to understand staff and students' main drivers to attend campus, particularly using more sustainable modes of transport.

Results show significant differences between staff and students, and between students who are undergraduate, postgraduate or are part-time students. Results show that part-time students are more likely to SFH or, if they attend campus, they are less likely to use car as their main mode of transport compared to postgraduate students but more likely than undergraduate students. This might be due to having to do more commuting trips than students, but some of them might work in the CBD or other business areas which usually have very limited parking. Undergraduate

students are less likely to use car as their main mode of transport, followed by active modes, relative to all other students.

Results show that students who live further away from campus are less likely to engage in SFH, somehow suggesting the need for more social interaction when they live further away. One other possible explanation is that, typically in Sydney, those from higher socio-economic backgrounds have the financial capacity to live close to the University (housing costs in and around the main campus are the most expensive in the country), whereas students further away from campus are more likely to be those from less advantaged socio-economic groups. There is evidence that in New South Wales, students from disadvantaged backgrounds outperform more advantaged students with the same academic ability and that, in large part, this is due to stronger internal motivation and a desire to ensure that they keep up (Manny et al., 2021). Perhaps we see this at play in these data, where students who are far away from campus, actually place a high value on on-campus participation and connection, which is linked to a stronger desire/need to succeed. In a post-COVID world, these equity considerations are still worth considering and that disadvantage can also be measured by distance from campus, and the time investment required by those determined to participate.

One of the variables that had one of the highest influences on modal choice was working partly from home and campus, which only occurred in 7.7% of the days in our sample amongst respondents who interestingly live closer to the campus (average of 12.8 kms) relative to the entire sample (average across waves of 16.9 kms). Results show that staff and students who work partly from home and campus on any given day are more likely to use active modes, followed by public transport. This is interesting as it is suggesting that people that live closer to campus are more likely to engage in working/studying from campus and home during the same day and, when they do, they are likely to use more sustainable modes of transport. This is an intuitive result, as these people are also likely to live closer to campus and thus have more flexibility in when they work at home or on campus, and how they get there.

The days of the week also have a significant influence on travel behaviour. On weekends, staff and students are less likely to work/study, but staff are even less likely to work than students are to study. If they do work/study, they are much more likely to do so from home than to attend campus. During the week, both staff and students are more likely to WFH/SFH on Fridays followed closely by Mondays. On Fridays, both staff and students are less likely to drive to campus – which might be related to engaging in social activities after work and not wanting to be dependent on their car and parking. In terms of the main motivations to attend campus, results show that staff who are mainly motivated by face-to-face activities are less likely to use public transport and more likely to use active modes, while those who are motivated by social activities are less likely to use their car and public transport. Students who are motivated by face-to-face activities are less likely to drive to campus, and those who are motivated by social activities are less likely to use active modes or public transport.

Overall, the elasticities estimated show that many of the policy levers for driving travel behaviour change are somewhat limited and likely a function of habitual behaviour. These elasticities should not be disregarded however, particularly given the volume of people that are employed or who study at the University of Sydney: a small change in behaviour can result in non-trivial changes in the volume of behaviour across this population. Perhaps the biggest policies a decision maker may employ to encourage more sustainable transport behaviour are those macro policies, such as informal peak spreading that already occurs in the student population via differentiated

timetabling (not all students start at 9am or finish at 5pm). A similar policy can be established among staff, where members can be encouraged to vary their time of departure on the days they do travel to work in order to avoid the peak. Perhaps encouraging staff to think of commuting time as an opportunity to complete administrative work might encourage the choice of public transport modes that enable such work to be completed (something that would be encouraged by the provision of Wi-Fi on buses and trains). As discussed in much of the COVID-19 literature, WFH has proven to be a significant lever for alleviating congestion and crowding on public transport. The ability to continue to WFH/SFH to some extent will likely continue to be the best option the University has for encouraging sustainable travel, by simply having staff and students continue to travel to campus less often during the week.

With respect to private modes of travel, particularly prevalent among staff, a more radical approach would be to consider the availability and cost of parking. There are a large number of parking spaces available on campus and the cost of parking for staff in particular is relatively modest, with a max cost of $5 per day (compared to anywhere between $5-10 per hour in other parts of the CBD). Higher parking costs would certainly be a controversial lever for the University to consider. Staff forums indicate that the predominant reasons for driving to campus do not relate to work itself, but rather outside constraints such as those associated with children (drop-offs and pickups) and that they live in areas poorly served by public transport. There could potentially be some scope for the university to consider a policy where revenue from higher parking charges is hypothecated to activities designed to support staff to eliminate those constraints; more flexible work, helping to link staff (via e-scooters, ridesharing, etc.) into areas where public transport access is better. This would require innovative thinking but could be seen as an investment in sustainability. An even more radical investment in sustainability would be establishment of satellite office spaces in areas spread strategically around the city, where staff could attend work at those spaces, and while not necessarily co-located with all their team, they still get that social interaction while working that many find to be important. Equally, if large enough these spaces could also be study hubs for students.

Our hybrid choice model also included dummy variables that represent what could encourage participants to use public transport or bicycle to attend campus. They were included as explanatory variables in the mode choices, under the assumption that what participants state would encourage them to use certain modes – as a proxy of what is missing or could be improved - influences their mode decision. Findings suggest that bicycle users who are staff members feel more strongly about improving cycle paths on their journey to campus (which the University could lobby for) and would appreciate arrangements to buy bicycles at a discount (which the University could facilitate). Indeed, the University now supports the purchase of e-bicycles (but not regular bikes) by salary sacrifice in the same way in which staff can salary sacrifice a motor vehicle. Despite the acknowledgement that the idea has merit, movement on this front has been slow. Students who are non-bicycle-users feel they could be encouraged by secure cycle parking, changing facilities and lockers on campus (all of which would be relatively low-cost interventions). The University owns several gyms on campus many of which have shower facilities – these might be able to be accessed by students who cycle to campus for a nominal fee. Students who are public transport users believe there should be more frequent services in public transport; in this regard, the University should be an active player in identifying areas where large segments of the student population are underserved and communicate them to the relevant public transport authorities. Likewise, with respect to bicycle infrastructure, there is scope for improved identification of feasible bicycle routes and communication of those routes to staff and students,

and the University can work with the local council to potentially invest in infrastructure to improve access by active modes to the campus. Perhaps it may also be an option to make it legal to use bicycles on footpaths, at a safe speed, within a certain proximity of the campus (and in future e-scooters, if they become legal in New South Wales). This may make cycling safer for those who are currently dissuaded from this mode.

Overall, these findings are diverse and are encouraging as they are suggesting important drivers that should be considered when creating university travel demand management programmes to incentivise return to campus by sustainable modes of transport.

References

Akar, G., Flynn, C., & Namgung, M. (2012). Travel choices and links to transportation demand management. *Transportation Research Record*, *2319*, 77–85. https://doi.org/10.3141/2319-09

Astroza, S., Tirachini, A., Hurtubia, R., Carrasco, J. A., Guevara, A., Munizaga, M., Figueroa, M., & Torres, V. (2020). Mobility Changes, Teleworking, and Remote Communication during the COVID-19 Pandemic in Chile. *Findings*. https://doi.org/10.32866/001c.13489

Balbontin, C., Hensher, D. A., & Beck, M. J. (2022). Advanced modelling of commuter choice model and work from home during COVID-19 restrictions in Australia. *Transportation Research Part E: Logistics and Transportation Review*, *162*. https://doi.org/10.1016/j.tre.2022.102718

Balbontin, C., Hensher, D. A., & Beck, M. J. (2023). Relationship between commuting and non-commuting travel activity under the growing incidence of working from home and people's attitudes towards COVID-19. *Transportation*. https://doi.org/10.1007/s11116-023-10403-2

Balbontin, C., Hensher, D. A., Beck, M. J., Giesen, R., Basnak, P., Vallejo-Borda, J. A., & Venter, C. (2021). Impact of COVID-19 on the number of days working from home and commuting travel: A cross-cultural comparison between Australia, South America and South Africa. *Journal of Transport Geography*, 103188. https://doi.org/10.1016/j.jtrangeo.2021.103188

Barrero, J. M., Bloom, N., & Davis, S. (2021). Why Working from Home Will Stick. In *National Bureau of Economic Research*. https://doi.org/10.3386/w28731

Bhaduri, E., Manoj, B. S., Wadud, Z., Goswami, A. K., & Choudhury, C. F. (2020). Modelling the effects of COVID-19 on travel mode choice behaviour in India. *Transportation Research Interdisciplinary Perspectives*, *8*, 100273. https://doi.org/10.1016/j.trip.2020.100273

Bhat, C. R., & Castelar, S. (2002). A unified mixed logit framework for modeling revealed and stated preferences: formulation and application to congestion pricing analysis in the San Francisco Bay area. *Transportation Research Part B: Methodological*, *36*(7), 593–616. https://doi.org/10.1016/S0191-2615(01)00020-0

Bierlaire, M. (2016). *Estimating Choice Models with Latent Variables with PythonBiogeme*. 68.

Bonacini, L., Gallo, G., & Scicchitano, S. (2021). Working from home and income inequality: risks of a 'new normal' with COVID-19. *Journal of Population Economics*, *34*(1), 303–360. https://doi.org/10.1007/s00148-020-00800-7

Bouziri, H., Smith, D. R. M., Smith, D. R. M., Descatha, A., Dab, W., & Jean, K. (2020). Working from home in the time of COVID-19: How to best preserve occupational health? In

Occupational and Environmental Medicine (Vol. 77, Issue 7, pp. 509–510). BMJ Publishing Group. https://doi.org/10.1136/oemed-2020-106599

Brynjolfsson, E., Horton, J. J., Ozimek, A., Rock, D., Sharma, G., Tuye, H.-Y., & Upwork, A. O. (2020). *COVID-19 and Remote Work: An Early Look at US Data*.

Caulfield, B., Browne, S., Mullin, M., Bowman, S., & Kelly, C. (2021). Re-open our city and campus post-Covid: A case study of Trinity college Dublin, the University of Dublin. *Case Studies on Transport Policy*, *9*(2), 616–625. https://doi.org/10.1016/j.cstp.2021.02.016

Ceccato, R., Rossi, R., & Gastaldi, M. (2021). Travel demand prediction during covid-19 pandemic: Educational and working trips at the university of padova. *Sustainability (Switzerland)*, *13*(12), 1–20. https://doi.org/10.3390/su13126596

Danaf, M., Abou-Zeid, M., & Kaysi, I. (2014). Modeling travel choices of students at a private, urban university: Insights and policy implications. *Case Studies on Transport Policy*, *2*(3), 142–152. https://doi.org/10.1016/j.cstp.2014.08.006

Duque, R. B., Gray, D., Harrison, M., & Davey, E. (2014). Invisible commuters: Assessing a university's eco-friendly transportation policies and commuting behaviours. *Journal of Transport Geography*, *38*, 122–136. https://doi.org/10.1016/j.jtrangeo.2014.05.010

Engelen, L., Bohn-Goldbaum, E., Crane, M., Mackey, M., & Rissel, C. (2019). Longer, more active commute, but still not very active: Five-year physical activity and travel behavior change in a university population. *International Journal of Environmental Research and Public Health*, *16*(13), 1–10. https://doi.org/10.3390/ijerph16132420

Farré, L., Fawaz, Y., Gonzalez, L., & Graves, J. (2020). How the COVID-19 Lockdown Affected Gender Inequality in Paid and Unpaid Work in Spain. *IZA Discussion Papers*.

Foss, N. J. (2020). Behavioral Strategy and the COVID-19 Disruption. *Journal of Management*, *46*(8), 1322–1329. https://doi.org/10.1177/0149206320945015

Hensher, D. A., Beck, M. J., & Wei, E. (2021). Working from home and its implications for strategic transport modelling based on the early days of the COVID-19 pandemic. *Transportation Research Part A: Policy and Practice*, *148*, 64–78. https://doi.org/10.1016/j.tra.2021.03.027

Hermanto, H., Rai, N. G. M., & Fahmi, A. (2021). Students' opinions about studying from home during the COVID-19 pandemic in Indonesia. *Cypriot Journal of Educational Sciences*, *16*(2), 499–510. https://doi.org/10.18844/cjes.v16i2.5627

Hess, S., & Palma, D. (2019). Apollo: A flexible, powerful and customisable freeware package for choice model estimation and application. *Journal of Choice Modelling*, *32*(February). https://doi.org/10.1016/j.jocm.2019.100170

Hiselius, L. W., & Arnfalk, P. (2021). When the impossible becomes possible: COVID-19's impact on work and travel patterns in Swedish public agencies. *European Transport Research Review*, *13*(1). https://doi.org/10.1186/s12544-021-00471-9

Klöckner, C. A., & Friedrichsmeier, T. (2011). A multi-level approach to travel mode choice - How person characteristics and situation specific aspects determine car use in a student sample.

Transportation Research Part F: Traffic Psychology and Behaviour, *14*(4), 261–277. https://doi.org/10.1016/j.trf.2011.01.006

Logan, K. G., Nelson, J. D., Osbeck, C., Chapman, J. D., & Hastings, A. (2020). The application of travel demand management initiatives within a university setting. *Case Studies on Transport Policy*, *8*(4), 1426–1439. https://doi.org/10.1016/j.cstp.2020.10.007

Louviere, J., & Swait, J. (1997). *Separating Weights And Scale Values In Conjoint Tasks Using Choices Of Best And Worst Attribute Levels*.

Manny, A., Yin, Z., Tam, H., Lipka, R., Dickins, P., & Sciberras, G. (2021). *Data analysis: Student disadvantage and success at university*. https://www.uac.edu.au/assets/documents/submissions/student-disadvantage-and-success-at-university.pdf

Mokhtarian, P. L. (1991). Telecommuting and Travel: State of the Practice, State of the Art. *Transportation*, *18*(4), 319–342.

Mokhtarian, P. L., Collantes, G. O., & Gertz, C. (2004). Telecommuting, Residential Location, and Commute-Distance Traveled: Evidence from State of California Employees. *Environment and Planning A: Economy and Space*, *36*(10), 1877–1897. https://doi.org/10.1068/a36218

Mokhtarian, P. L., Handy, S., & Salomon, I. (1995). Methodological Issues in the Estimation of the Travel, Energy, and Air Quality Impacts of Telecommuting Permalink https://escholarship.org/uc/item/44n3k2jp Publication Date. *Transportation Research Record A*, *29A*(4), 283–302.

Moniruzzaman, M., & Farber, S. (2018). What drives sustainable student travel? Mode choice determinants in the Greater Toronto Area. *International Journal of Sustainable Transportation*, *12*(5), 367–379. https://doi.org/10.1080/15568318.2017.1377326

Mouratidis, K., & Papagiannakis, A. (2021). COVID-19, internet, and mobility: The rise of telework, telehealth, e-learning, and e-shopping. *Sustainable Cities and Society*, *74*(July), 103182. https://doi.org/10.1016/j.scs.2021.103182

Nguyen, D. Van, Pham, G. H., & Nguyen, D. N. (2020). Impact of the Covid-19 pandemic on perceptions and behaviors of university students in Vietnam. *Data in Brief*, *31*, 105880. https://doi.org/10.1016/j.dib.2020.105880

Ribeiro, P., Fonseca, F., & Meireles, T. (2020). Sustainable mobility patterns to university campuses: Evaluation and constraints. *Case Studies on Transport Policy*, *8*(2), 639–647. https://doi.org/10.1016/j.cstp.2020.02.005

Rissel, C., Mulley, C., & Ding, D. (2013). Travel mode and physical activity at Sydney University. *International Journal of Environmental Research and Public Health*, *10*(8), 3563–3577. https://doi.org/10.3390/ijerph10083563

Rybarczyk, G., & Gallagher, L. (2014). Measuring the potential for bicycling and walking at a metropolitan commuter university. *Journal of Transport Geography*, *39*, 1–10. https://doi.org/10.1016/j.jtrangeo.2014.06.009

Shibayama, T., Sandholzer, F., Laa, B., & Brezina, T. (2021). Impact of COVID-19 lockdown on commuting: a multi-country perspective. *European Journal of Transport and Infrastructure Research*, *21*(1). https://doi.org/10.18757/ejtir.2021.21.1.5135

Sottile, E., Sanjust di Teulada, B., Meloni, I., & Cherchi, E. (2019). Estimation and validation of hybrid choice models to identify the role of perception in the choice to cycle. *International Journal of Sustainable Transportation*, *13*(8), 543–552. https://doi.org/10.1080/15568318.2018.1490465

Sultana, S., Kim, H., Pourebrahim, N., & Karimi, F. (2018). Geographical assessment of low-carbon transportation modes: A case study from a commuter university. *Sustainability (Switzerland)*, *10*(8), 10–13. https://doi.org/10.3390/su10082696

Zhou, J., Wang, Y., & Wu, J. (2018). Mode choice of commuter students in a college town: An exploratory study from the United States. *Sustainability (Switzerland)*, *10*(9), 1–18. https://doi.org/10.3390/su10093316

Table F.6: Factor analysis weights results

		Face-to-face enthusiasts	Social butterflies
Students	I would like to participate in face-to-face classes	0.619	
	Attend a class		
	Elements of my program require in-person participation		
	It is a more effective way for me to learn	0.811	
	It is more enjoyable	0.752	
	I want to enjoy the facilities on-campus in full	0.431	
	I want to meet or work with new people		0.733
	I want to make friends and build my networks		0.961
	It broadens my horizons	0.459	
	I want to participate in clubs and societies		0.444
	It fits well with my daily schedule (e.g., childcare in or close to campus; my gym is close to campus)		
	There are no delays/cancellations on public transport		
Staff	I would like to participate in face-to-face discussions		0.753
	Teach a class		
	My work requires me to be on campus		-0.555
	It is a more effective way for me to work	0.818	
	It is more enjoyable	0.852	
	I want to enjoy the facilities on-campus in full	0.425	
	I want to meet or work with new people and build my networks		0.678
	I want to enjoy the social environment at work		0.632
	It is a nice change from working from home all the time		0.606
	It fits well with my daily schedule (e.g., childcare in or close to campus; my gym is close to campus)		
	There are no delays/cancellations on public transport		

Note: The attitudinal questions “It broadens my horizons” and “My work requires me to be on campus” were not included as indicators for the latent variables students’ face-to-face enthusiasts and staff social butterflies, respectively. The models were tested with and without them and it made no difference in the model results, so it was decided to remove them to simplify the model estimation.

Table F.7: Estimated elasticities mean (standard deviation)

Explanatory variables	Alternative	Staff W1	Staff W2	Staff W3	Student W1	Student W2	Student W3
Personal income ('000$AUD)	WFH/SFH	0.103 (0.006)	0.106 (0.005)	0.122 (0.006)	-	-	-
Part-time (1,0)	WFH/SFH	-	-	-	0.017 (0.002)	0.015 (0.002)	0.020 (0.004)
Distance from home to campus (kms)	WFH/SFH	-	-	-	-0.011 (1.9e-4)	-0.016 (3.4e-4)	-0.018 (4.9e-4)
Monday (1,0)	WFH/SFH	0.051 (0.011)	0.053 (0.012)	0.062 (0.015)	0.046 (0.012)	0.048 (0.014)	0.068 (0.029)

Explanatory variables	Alternative	Staff			Student		
		W1	W2	W3	W1	W2	W3
Wednesday (1,0)	WFH/SFH	0.022	0.023	0.029	0.019	0.020	0.026
		(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.006)
Thursday (1,0)	WFH/SFH	0.021	0.022	0.027	0.017	0.019	0.023
		(0.002)	(0.002)	(0.004)	(0.002)	(0.003)	(0.005)
Friday (1,0)	WFH/SFH	0.056	0.060	0.066	0.057	0.060	0.088
		(0.011)	(0.013)	(0.015)	(0.017)	(0.019)	(0.042)
Weekends (1,0)	WFH/SFH	0.100	0.095	0.069	0.582	0.612	0.858
		(0.349)	(0.333)	(0.310)	(0.789)	(0.826)	(1.257)
Number of children in household	Car driver	-0.063	-0.073	-0.064			
		(0.008)	(0.010)	(0.010)	-	-	-
Undergraduate student (1,0)	Car driver				-0.507	-0.460	-0.476
		-	-	-	(0.980)	(0.867)	(0.926)
Age (years)	Car driver				0.650	0.664	0.735
		-	-	-	(0.030)	(0.044)	(0.045)
Friday (1,0)	Car driver	-0.055	-0.056	-0.050	-0.058	-0.057	-0.060
		(0.028)	(0.029)	(0.028)	(0.032)	(0.030)	(0.035)
Travel time (mins)	Car driver	-0.102	-0.098	-0.105	-0.106	-0.116	-0.135
		(0.005)	(0.005)	(0.005)	(0.003)	(0.008)	(0.005)
Fuel cost or fare (AUD$)	Car driver	-0.080	-0.077	-0.073	-0.087	-0.087	-0.106
		(0.007)	(0.006)	(0.005)	(0.008)	(0.007)	(0.006)
Number of children in household	Train	-0.021	-0.029	-0.033			
		(0.001)	(0.002)	(0.003)	-	-	-
Undergraduate student (1,0)	Train				-0.041	-0.038	-0.042
		-	-	-	(0.001)	(0.001)	(0.001)
Personal income ('000$AUD)	Train	-0.069	-0.075	-0.089			
		(0.003)	(0.003)	(0.003)	-	-	-
Professional staff wave 2 and 3 (1,0)	Train		0.062	0.079			
		-	(0.002)	(0.002)	-	-	-
Worked/studied partly from home and partly from campus (1,0)	Train	0.066	0.035	0.071	0.283	0.230	0.237
		(0.072)	(0.056)	(0.117)	(0.395)	(0.340)	(0.515)
Travel time (mins)	Train	-0.172	-0.172	-0.199	-0.143	-0.150	-0.156
		(0.012)	(0.010)	(0.016)	(0.007)	(0.010)	(0.010)
Fuel cost or fare (AUD$)	Train	-0.089	-0.090	-0.109	-0.047	-0.052	-0.055
		(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)
Number of children in household	Bus	-0.023	-0.029	-0.030			
		(0.002)	(0.002)	(0.003)	-	-	-
Undergraduate student (1,0)	Bus				-0.043	-0.049	-0.061
		-	-	-	(0.001)	(0.002)	(0.002)
Personal income ('000$AUD)	Bus	-0.071	-0.083	-0.106			
		(0.003)	(0.003)	(0.004)	-	-	-
Professional staff wave 2 and 3 (1,0)	Bus		0.077	0.095			
		-	(0.002)	(0.003)	-	-	-
Worked/studied partly from home and partly from campus (1,0)	Bus	0.212	0.116	0.255	0.591	0.557	0.559
		(0.369)	(0.220)	(0.714)	(1.396)	(1.486)	(1.948)
Travel time (mins)	Bus	-0.128	-0.134	-0.172	-0.147	-0.151	-0.214
		(0.009)	(0.008)	(0.010)	(0.010)	(0.014)	(0.011)
Fuel cost or fare (AUD$)	Bus	-0.077	-0.087	-0.117	-0.057	-0.058	-0.079
		(0.001)	(0.001)	(0.003)	(0.001)	(0.002)	(0.002)
Undergraduate student (1,0)	Walk				-0.027	-0.032	-0.046
		-	-	-	(0.002)	(0.002)	(0.004)
Personal income ('000$AUD)	Walk	0.600	0.641	1.077			
		(0.151)	(0.239)	(0.633)	-	-	-
Professional staff wave 2 and 3 (1,0)	Walk		-0.270	-0.238			
		-	(0.099)	(0.166)	-	-	-
Worked/studied partly from home and partly from campus (1,0)	Walk	0.845	1.202	2.124	0.273	0.245	0.352
		(1.725)	(2.137)	(5.155)	(0.180)	(0.170)	(0.437)
Travel time (mins)	Walk	-0.067	-0.070	-0.127	-0.033	-0.029	-0.066
		(0.002)	(0.003)	(0.012)	(0.001)	(0.001)	(0.004)
Undergraduate student (1,0)	Bicycle				-0.049	-0.065	-0.103
		-	-	-	(0.003)	(0.004)	(0.009)

Explanatory variables	Alternative	Staff			Student		
		W1	W2	W3	W1	W2	W3
Personal income ('000$AUD)	Bicycle	0.568 (0.264)	0.935 (0.377)	0.989 (0.520)	-	-	-
Professional staff wave 2 and 3 (1,0)	Bicycle	-	-0.308 (0.173)	-0.264 (0.172)	-	-	-
Worked/studied partly from home and partly from campus (1,0)	Bicycle	1.082 (1.899)	1.509 (6.444)	2.505 (6.425)	0.821 (1.182)	1.054 (2.616)	1.608 (6.409)
Travel time (mins)	Bicycle	-0.055 (0.003)	-0.088 (0.014)	-0.084 (0.007)	-0.063 (0.003)	-0.046 (0.002)	-0.130 (0.012)

Appendix D. Parameter estimates for multiple discrete continuous model weekly number of trips by purpose and mode.

Table G.1: Parameter estimates for multiple discrete continues model weekly number of trips by purpose and mode

Description	Purpose	Mode	Mean (t-value)
Alternative specific constant	Work-related	Private car	-1.571 (17.61)
Alternative specific constant	Work-related	Public transport	-2.073 (21.77)
Alternative specific constant	Work-related	Active modes	-2.136 (17.50)
Alternative specific constant	Attend Uni students	Private car	-0.775 (4.83)
Alternative specific constant	Attend Uni students	Public transport	2.650 (13.90)
Alternative specific constant	Attend Uni students	Active modes	2.184 (9.02)
Alternative specific constant	Care	Private car	-0.474 (5.97)
Alternative specific constant	Care	Public transport	-1.501 (16.45)
Alternative specific constant	Care	Active modes	-1.045 (9.93)
Alternative specific constant	Shopping	Private car	0.482 (7.54)
Alternative specific constant	Shopping	Active modes	1.068 (8.78)
Alternative specific constant	Social recreation	Private car	0.590 (5.80)
Alternative specific constant	Social recreation	Public transport	0.515 (4.31)
Male (1,0)	Commuting	Private car	-0.436 (5.14)
Staff (1,0)	Commuting	Private car	0.448 (5.08)
Number of children in household	Commuting	Private car	0.110 (3.07)
Distance from home to campus (kms)	Commuting	Private car	0.006 (3.57)
Male (1,0)	Commuting	Public transport	-0.345 (4.30)
Staff (1,0)	Commuting	Public transport	1.073 (10.43)
Age (years)	Commuting	Public transport	-0.009 (3.79)
Number of children in household	Commuting	Public transport	-0.167 (4.04)
Distance from home to campus (kms)	Commuting	Public transport	0.009 (4.95)
Staff (1,0)	Commuting	Active modes	0.864 (5.69)
Age (years)	Commuting	Active modes	-0.022 (7.34)
Personal income ('000$AUD)	Commuting	Active modes	0.002 (2.87)
Personal income ('000$AUD)	Attend Uni students	Private car	-0.007 (2.88)
Distance from home to campus (kms)	Attend Uni students	Private car	0.009 (2.40)
Wave 1 (1,0)	Attend Uni students	Private car	0.499 (2.09)
Wave 2 (1,0)	Attend Uni students	Private car	0.446 (3.00)
Male (1,0)	Attend Uni students	Public transport	-0.234 (2.79)
Age (years)	Attend Uni students	Public transport	-0.059 (7.94)
Personal income ('000$AUD)	Attend Uni students	Public transport	-0.010 (5.69)

Description	Purpose	Mode	Mean (t-value)
Distance from home to campus (kms)	Attend Uni students	Public transport	0.019 (9.25)
Wave 1 (1,0)	Attend Uni students	Public transport	-0.484 (3.35)
Wave 2 (1,0)	Attend Uni students	Public transport	-0.505 (6.34)
Age (years)	Attend Uni students	Active modes	-0.050 (5.09)
Personal income ('000$AUD)	Attend Uni students	Active modes	-0.012 (4.35)
Distance from home to campus (kms)	Attend Uni students	Active modes	-0.020 (4.25)
Male (1,0)	Care	Private car	-0.554 (5.86)
Staff (1,0)	Care	Private car	1.007 (10.24)
Number of children in household	Care	Private car	0.335 (9.99)
Male (1,0)	Care	Public transport	-0.474 (2.96)
Male (1,0)	Care	Active modes	-0.300 (2.42)
Staff (1,0)	Care	Active modes	0.933 (7.26)
Number of children in household	Care	Active modes	0.260 (5.90)
Male (1,0)	Shopping	Private car	-0.297 (3.81)
Staff (1,0)	Shopping	Private car	0.850 (9.83)
Male (1,0)	Shopping	Public transport	-0.213 (1.92)
Age (years)	Shopping	Public transport	-0.015 (5.00)
Personal income ('000$AUD)	Shopping	Public transport	-0.006 (4.60)
Number of children in household	Shopping	Public transport	-0.257 (3.73)
Staff (1,0)	Shopping	Active modes	0.334 (2.44)
Age (years)	Shopping	Active modes	-0.010 (2.28)
Personal income ('000$AUD)	Shopping	Active modes	-0.002 (2.17)
Number of children in household	Shopping	Active modes	-0.233 (4.53)
Male (1,0)	Social recreation	Private car	-0.325 (4.03)
Staff (1,0)	Social recreation	Private car	0.826 (7.72)
Age (years)	Social recreation	Private car	-0.008 (2.35)
Number of children in household	Social recreation	Private car	0.107 (3.15)
Male (1,0)	Social recreation	Public transport	-0.165 (1.80)
Age (years)	Social recreation	Public transport	-0.022 (5.57)
Number of children in household	Social recreation	Public transport	-0.266 (4.86)
Staff (1,0)	Social recreation	Active modes	0.426 (4.40)
Number of parameters			***82***
Log-likelihood			***-37,567.95***
AIC/n			***25.957***
Sample size			***2,901***