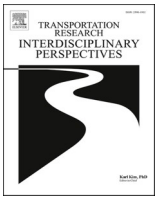
Transportation Research Interdisciplinary Perspectives 12 (2021) 100490

Contents lists available at ScienceDirect

Transportation Research Interdisciplinary Perspectives

journal homepage: www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives



A campus on the move: Modal choices of students and staff at the University of Lausanne, Switzerland

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ARTICLE INFO

Keywords:
University
Campus
Modal choice
Sustainable mobility
Policy

ABSTRACT

Universities generate significant transport flows on a daily basis. Transport represents a core challenge for the attractiveness of universities but also for their ecological footprint. This paper addresses the mobility practices of students and staff at the University of Lausanne, Switzerland, through a series of 13 annual surveys. The majority of the university community use public transport, which is explained by investments in infrastructures, the development of their carrying capacity (frequency and size of vehicles) and also the staggering of the start time of classes that has flattened peak hours. The efficiency of public transport and a parking policy have more than halved the modal share of the car. Cycling has experienced a notable growth unlike motorized two-wheelers and walking. The paper then addresses how mobility practices diverge within the university community. Modal choices can be explained when the effects of gender, age, income, territorial context (distance and mobility offer) but also values (as reflected by several differences between faculties) are looked at together. Overall, the paper brings knowledge to the issue of mobility on university campuses and the levers that could turn them into sustainable communities.

Introduction

Transport represents a central challenge for universities. It is their main source of greenhouse gas emissions due to commuting, as discussed in this paper, (air) travel to conferences, seminars, thesis panels, field work, etc., and goods delivery and logistics to a lesser extent. Thus universities need to develop accessibility and attractiveness while also reducing their ecological footprint. The transition to sustainable mobility represents a major challenge for the increasing number of institutions that aim to become models of sustainability and that can become key sites to implement and test climate and environmental policies (Balsas, 2003; Cattaneo et al., 2018; Cuesta-Claros et al., 2021; Delmelle and Delmelle, 2012; Genta et al., 2019; Miralles-Guasch and Domene, 2010).

This paper focuses on the University of Lausanne in Switzerland, which has several characteristics which make it an interesting case. It has 20,000 students and employees, and this figure is growing and covers most scientific fields. Its campus is located in the suburban outskirts of Lausanne, a medium-sized city (140,000 inhabitants for the core city, 425,000 for the urban region), rather than in the central zone (where it would have benefited from existing infrastructure). Continuous public policies have aimed to improve the campus accessibility with public transport services.

The analysis is structured around the following research questions: What are the modal shares of the various means of transport used to commute to the campus? How have these shares evolved over time and why? How modal choices vary within the university community? A series of 13 questionnaire surveys and official documents in the field of transport and urban planning make it possible to study the daily mobility induced by this institution. In regard to the existing literature, the paper's originality lies in its simultaneous consideration of both transport demand and policies over a long period. It partakes in the scientific and political debates on the levers for transforming campuses into sustainable communities.

The paper begins with an overview of the study of modal choices and mobility policies on university campuses, before presenting the case study and the methodology. Next, the results relating to the modal shares and their evolution as well as the way they vary within the university community are presented. Finally, the conclusion discusses the key findings and the challenges facing universities in terms of mobility.

Analysing mobility on a university campus

In recent years, a body of research has been developed on mobility

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https://doi.org/10.1016/j.trip.2021.100490
Received 12 July 2021; Received in revised form 14 October 2021; Accepted 17 October 2021

within universities. In addition to the ease of access to research sites, there are multiple reasons for researchers' interest in this field: universities are among the largest generators and attractors of commuters (Rotaris and Danielis, 2015); their often suburban location makes mobility issues more acute (Miralles-Guasch and Domene, 2010); campuses welcome a diverse population in terms of age and socio-economic status (even if this does not reflect the general population); they emerge as privileged places to communicate and implement sustainability, and can as such serve as living labs for testing and implementing various alternative transportation strategies (Balsas, 2003). The trends observed in universities may also prove to be relevant for other types of campus (business parks, office complexes, hospitals, etc.) (Tolley, 1996).

Furthermore, university provides a context in which students learn a variety of different practices. Students can be regarded as "resident apprentices" in the area of household energy consumption (Alamel, 2021). A parallel can be drawn with the learning of sustainable mobility practices which, if developed under favourable conditions, could last into later life (Delmelle and Delmelle, 2012). University campuses represent a microcosm of society, places where norms and behaviours are shaped, and are hence an ideal setting for exploring policy initiatives targeted at reducing automobile dependence (Balsas, 2003). This potential effect could be all the more significant as the students "progress to occupy influential roles in governments, companies and other organizations" (Tolley, 1996, 214).

This paper draws on the literature on modal choices for travelling to campuses (2.1) and policies on campuses that influence these modal choices (2.2.) mainly in the Global North though.

Modal choices for travelling to campuses

A modal choice is defined as the decision to use a particular means of transport to complete a journey. It is often the result of a very compound choice process that can take place consciously or unconsciously and which may be constrained by objective and subjective determinants (De Witte et al., 2013, 329).

Based on a review of the literature, De Witte et al. (2013) identify a non-exhaustive list of 26 determinants that can be divided into four categories: (1) socio-demographic indicators (age, gender, education, income, household composition, etc.); (2) spatial indicators (density, diversity, proximity to infrastructure and services, frequency of public transport, parking, etc.); (3) journey characteristic indicators (reason for travel, distance, travel time, cost, etc.) and (4) socio-psychological indicators (experiences, habits, perceptions, etc.). Socio-demographic and spatial factors determine the possibilities with respect to mobility, while the socio-psychological factors influence how these possibilities are acted upon (ibid. 331).

The research often identifies a strong dependence on cars within campuses (Cattaneo et al., 2018; dell'Olio et al., 2019; Melia and Clark, 2018; Tolley, 1996). The modal share of the car is higher in campuses located at quite some distance from the city centre. In Lisbon (Portugal) for example between 55% and 86% of members of staff (19% and 52% among students) drive to the campus depending on its location (Vale et al., 2018). Disparities also appear within university communities; students, due to their age and limited financial means, are less likely to have a driver's licence or a car, and therefore use automobiles less than employees. At the University of Cantabria (Spain) 50% of the students commute by car vs about 75% of the employees (dell'Olio et al. 2019). Among staff, lecturers and researchers use cars less than members of the administration, primarily because they live in more urban areas (Miralles-Guasch and Domene, 2010). Students are more likely to use public transport, but also to cycle, because of the low cost and their physical fitness (Shannon et al., 2006). A few papers noted differences between faculties. Students attending different faculties are known to have different attitudes and personalities, which can affect their mobility patterns (Cattaneo et al., 2018; Kim et al., 2016). For example, among civil engineering students, attending classes on environmental issues increases awareness of environmental problems and influences attitudes to transportation (Kim et al., 2016).

The research also focuses on the potential for modal shift from individual motorised transport to public transport and active mobility, such as walking and cycling (Rotaris and Danielis, 2015) or shared electric bikes (Eccarius et al., 2021). Some studies show that behaviours do not always correspond to users' preferences, who may be frustrated or satisfied in various ways and to varying extents in their mobility practices (Miralles-Guasch and Domene, 2010). Studies focus on the motivations for and barriers to adopting cycling and walking (Shannon et al., 2006). Commuters also differ in their attitudes towards alternatives to cars and to measures that could encourage them to change their practices (Fürst, 2014). This last point opens up a discussion around campuses' transport offers.

Mobility policies on campus

Based on the literature on university campuses and more generally on mobility and transport I propose to discuss four main mobility policies: the development of transport infrastructures, mobility management, urban planning and the use of digitalization.[1] These various policies will be used as a reading grid to interpret the evolution of modal shares for travelling to the University of Lausanne. It has to be noted that they are not the sole responsibility of the universities. While they are sometimes compared to small towns, their powers are limited, and various public authorities are often the major actors.

The first policy is the development of transport infrastructure (roads, cycle tracks, railways, etc.) in order to meet demand of mobility. The need for infrastructure depends, in particular, on the location of the campus. Many campuses, due to their suburban location, the proximity of highways and the abundant presence of parking, are characterised by a predominance of automobiles (Cattaneo et al., 2018; dell'Olio et al., 2019; Melia and Clark, 2018; Tolley, 1996). Promoting alternative means of transport is complicated by the lack of dedicated infrastructure, the lack of recognition of active mobility and the longer duration of journeys by public transport (Miralles-Guasch and Domene, 2010).

The second policy is to implement travel demand or mobility management and so-called soft measures (i.e. not infrastructural). Mobility management can be defined as a package of planning strategies (e.g. traffic calming measures) and (dis)incentives, which aims to change individual behaviours and to foster the modal shift from single occupant vehicles to alternative modes (Balsas, 2003; Miralles-Guasch and Domene, 2010). Several studies have for example shown the importance of parking regulation in the case of campus. Under-priced parking is seen as subsidising students and staff who drive to campus, while those who walk, bike or ride transit to campus rarely receive any subsidy (Brown et al., 2001). Free or low-cost parking permits make the use of the car attractive in general, but also for shorter-distance car commutes, especially in the winter season (Delmelle and Delmelle, 2012). The research has analysed the behavioural changes induced by introducing parking charges or restrictions (dell'Olio et al., 2019; Melia and Clark, 2018). Other measures relate to the subsidisation of public transport

[1] The limits of these categories are not always clear-cut. The development of mobility as a service (MAAS) offers include the access to transport services (requiring infrastructures) and digitalization (through apps).

passes (Brown et al., 2001), the implementation of carpooling and car-sharing services, the purchase of less polluting vehicles for the university fleet, flexible working hours and awareness-raising campaigns (Balsas, 2003; Miralles-Guasch and Domene, 2010).

The third policy refer to urban planning. Transport policy is only one way of influencing mobility and there is considerable potential to influence travel through non-transport policies, such as land-use planning (Stead and Banister, 2001). As seen above the location of a campus has a great influence on mobility practices (Vale et al., 2018). For universities located in the heart of urban areas, housing, shops, services and amenities are often located nearby and easily accessed by means other than the car (Delmelle and Delmelle, 2012). Satellite campuses, however, often prioritise accessibility by car. The North-American campus model, which follows the principles of the neotraditional town, combines a variety of functions within reach of pedestrians (Balsas, 2003).

In addition to the location of a campus, the debate focuses on urban forms and their compatibility with the principles of sustainability (Rérat, 2012; Stead and Banister, 2001). The compact city model is intended to reduce dependence on cars, make public transport more efficient and offer pedestrian and bicycle friendly environments. This model relates to principles such as coordination of land use and transport policy, increased densities and a mix of functions (housing, shops, various other economic activities, etc.). It also relates to the different roles that universities can take on in urban production (constructor, promoter, etc.) (Coulson et al., 2015; König, 2013).

A fourth policy is linked to digitalisation, which opens up new perspectives in the area of teleworking and distance education. These practices could help desynchronise or even reduce flows. A key issue here is the degree to which teleworking and travel are substitutes or complements (Lachapelle et al., 2018). Part of the time saved could be converted into new or longer trips for non-commuting trips. Teleworking could also influence residential and employment location choices and increase the tolerance of long commuting distances (Ravalet and Rérat, 2019). Teleworking was practiced before the pandemic mainly informally by teachers and lecturers in the case study analysed in this paper. Due to the lack of data, teleworking will not be addressed in the empirical part but the potential impacts of digitalisation on mobilities towards the campus will be discussed in the conclusion.

The university of Lausanne campus

In the 1960s, the University of Lausanne (UNIL), then established in the heart of the city, experienced a major boom that prompted the authorities to seek a new site to develop it. They opted for Dorigny, to the west of Lausanne, a site which was still essentially rural, and which welcomed the first building in 1970. Since then, around twenty buildings have been constructed for academic activities, but no housing. These buildings are dispersed in places, and concentrated in others, with passages through vast green spaces according to a "pavilions in a park" concept (Maillard, 2013) (Fig. 1). UNIL has 20,000 students and employees (90% of whom are active on the Dorigny campus) and covers all major scientific fields, with the exception of the engineering sciences. The campus's internal traffic concept is based on the elimination of roads – the car parks are located on the margins – so that people travel on foot.

The campus is located 5 km from the centre of Lausanne and 2 km from Renens (Fig. 2). The train stations of Lausanne and Renens are the busiest ones in French-speaking Switzerland after Geneva. While the patronage of Lausanne train station corresponds to its population (Lausanne is the second-largest French-speaking city with 140,000 inhabitants), that of Renens (21,000 inhabitants) is explained by the proximity of UNIL and the Swiss Federal Institute of Technology Lausanne. Lausanne has direct rail connections (at least one per hour) to all large Swiss cities and to most medium-sized Swiss French-speaking cities, while Renens is very well connected to the whole of the Lake Geneva region[2]. A metro serves these stations and the campus since 1991, as well as several bus lines. Lausanne is also characterised by steep slopes and is one of the cities which is rated lowest by cyclists in terms of safety (Rérat, 2021a).

The context in which the campus is situated has evolved considerably and has become progressively urbanised with housing, industries, offices and shopping malls (Widmer, 2013). This suburban region is experiencing some of the strongest demographic and economic growth in Switzerland, and thus the once isolated campus is now surrounded by urbanisation, although many physical disruptions persist on a smaller scale, due in particular to the transport infrastructure.

Methodology

Mobility practices was addressed through a survey, carried out in the spring each year between 2005 and 2017 by the Intermodality and Transport Planning Lab of the Swiss Federal Institute for Technology. It was sent electronically to all UNIL students and staff, whose numbers increased from 12,000 to 18,000 during the period under study. The UNIL provided the raw data used in this paper which is based on a secondary analysis.

The questionnaire focuses on journeys to the campus on a typical day. It addresses their spatial (municipality of origin and building of destination), temporal (usual arrival and departure times on campus, frequencies of journeys) and modal (means of transport[3]) characteristics. The survey thus relates to factual elements and does not ask individuals about the reasons for their choices (aspirations, constraints, etc.). Information relating to the respondents' profile (see below for the list) is obtained by cross-referencing the questionnaire and the UNIL database, while guaranteeing anonymity.

The response rate hovered around 23% (from 17.5% in 2015 to 26.8% in 2009). An adjustment of the sample corrects the variable response rates according to user groups. The weighting criteria are age, gender and status (with regard to status, participants state whether they are academic staff, administrative and technical staff, or students). The questionnaire remained almost the same between 2005 and 2017, and was redesigned in 2018. Comparability is ensured for most indicators, without being perfect, which explains why the 2018 and 2019 editions are not included in the analysis. The 2020 and 2021 surveys were cancelled due to the sanitary crisis and the obligation of teleworking and online teaching.

The first part of the analysis relates to the use of different means of transport at an aggregated level (modal shares) over 13 years. The evolution of the modal shares is interpreted with the main measures that have influenced practices for travelling to the campus. These measures can be identified with planning documents and the history of the campus from the point of view of urban planning and transport.

[2] The quality of the rail network in general should be noted, as Switzerland is the world leader in terms of distance travelled by train per capita (LITRA, 2015).

[3] Respondents had to select one of these options: foot, bike, motorized two-wheeler, car, public transport, other means, several means. Details were asked for the last three modalities.

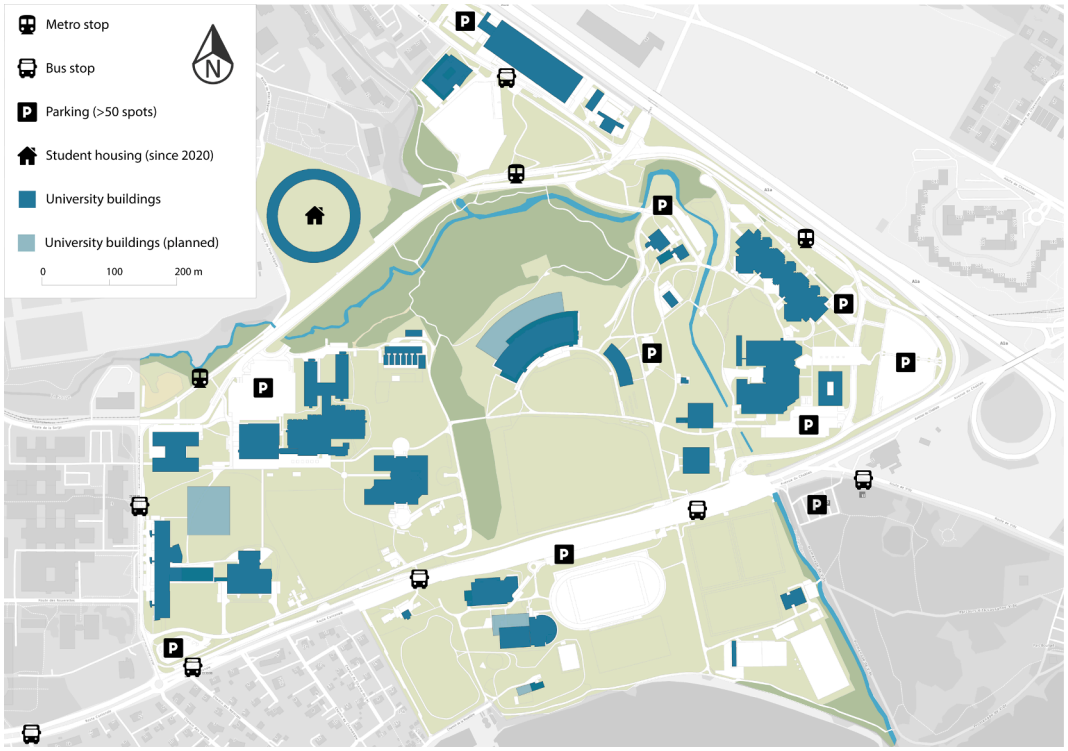

Fig. 1. Campus plan (Source: University of Lausanne; designed by Dimitri Marincek).

The second part of the analysis focuses on the characteristics that are likely to influence modal choices among the university community. The variable to be explained (dependent variable) in this stage is the use of one of these three categories: public transport, active mobility (walking, cycling and other means) and individual motorised vehicles (two or four wheels). The explanatory or independent variables tested were either asked in the survey or obtained through the UNIL database. They refer to:

- Gender (male/female);
- Age (25 and under[4], 26–35, 36–50, 51 and above);
- As-the-crow-flies distance between home and campus[5];
- Number of journeys per week;
- Type of municipality in which the individual lives. The typology is based on morphological (density) and functional (commuting flows) criteria (SFO, 2014). It distinguishes between large, medium and small urban centres, suburbs (either of large or medium centres) and secondary centres (of large urban centres). Three types complete the list: rural peri-urban, agricultural and touristic municipalities;
- Faculty. This variable includes in addition to the central administration Theology and Religious Studies; Law, Criminal Sciences and Public Administration; Arts; Social and Political Sciences; Higher Commercial Studies; Biology and Medicine; Geosciences and Environment; and Associated Institutions;
- Status that distinguishes between students (73.7% of the university community in 2017), administrative and technical staff (11.8%) and academic staff, including teachers and researchers (professors, doctoral assistants, post-docs, etc.);
- The survey year is entered into the model as a continuous variable given the regularity of the trend between 2005 and 2017. The same general model, tested separately for each year, shows a very similar influence of the different parameters explaining modal choices among the university community.

Multivariate binary logistic regressions measure the association between the use of a means of transport and the factors which are likely to influence it. They take all explanatory variables into account simultaneously and thus measure the specific effect of each of them ("all things being equal" or *ceteris paribus*). This effect is expressed in terms of probability ratio (*odd ratio*). If it is greater (or less) than 1, the modality increases (or decreases) the likelihood of using a transportation mode compared to the reference modality[6]. Tests determine whether this effect is statistically significant.

While this survey makes it possible to grasp the main characteristics of the demand for mobility to the campus, it has certain limitations. Firstly, it takes into account intermodality (combining several modes during a single trip to the campus even if shorter walking journeys from the metro station to the final destination are not considered) but not multimodality (changing modes of transport to get to the campus depending on the day, the season, etc.). Secondly, the results relate to a theoretical day because not all people go to the campus on a daily basis, including during the course period (part-time, teleworking, etc.). Thirdly, the survey addresses factual elements and does not ask

[4] This age group matches only partially with students. Some students are older while some employees (specifically among the administrative and technical staff but also PhD researchers) belong to this age group.

[5] As-the-crow-flies distances were used to compare all respondents. They have some limits notably in suburban spaces where actual distances can be longer because of physical barriers such as motorways or railways. As far as places of residence are concerned, it should be noted that half of UNIL students (48%) live with their parents, a tenth in a student residence and a third in independent accommodation (Fischer, 2015).

[6] The further the result is from 1, the greater the impact of the variable. It is therefore possible to determine a hierarchy between the different effects. However, it is not possible to define an order of magnitude for this effect (these are not simple probabilities). Thus a probability ratio of 2 does not mean that the variable under study doubles the probability of being mobile.

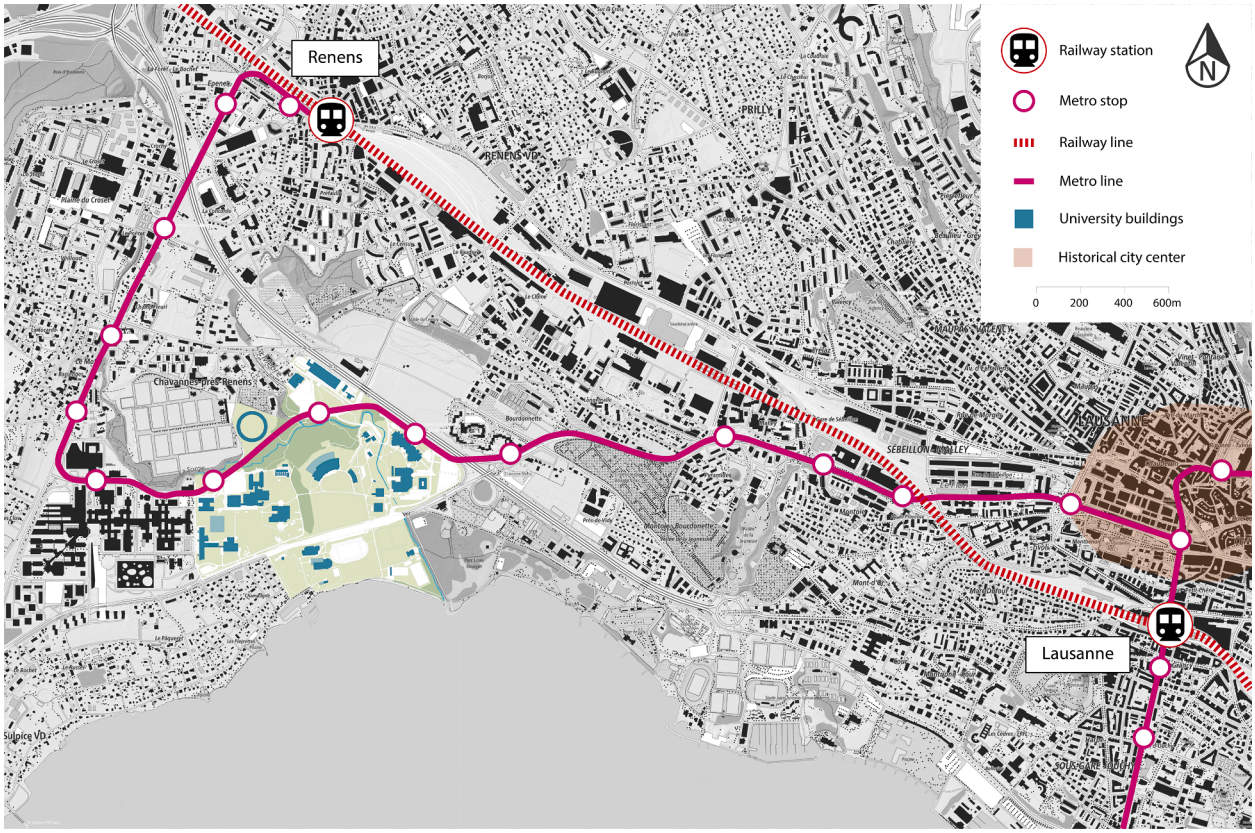

Fig. 2. Map of the western part of the urban region of Lausanne (Source: swisstopo; designed by Dimitri Marincek).

individuals about the reasons for their modal choice. Finally, the UNIL database does not include some variables usually used in mobility studies, such as type of household (or family structure), access to transport means and income. In our study, the level of income is imperfectly measured by status.[7] It was not possible to distinguish between undergraduate and postgraduate students.

Evolution of modal shares towards the campus

The modal split between means of transport is expressed in percentages (Fig. 3) and in absolute values (Fig. 4). In 2017, 60.3% of respondents travelled only by public transport, 15.8% by individual car, 8.9% by combining at least two modes (e.g. bike and train) and 8.5% by bicycle. Walking (2.9%) and motorised two-wheelers (3.3%) recorded very low shares, as did other means (0.2%), such as scooters.[8]

Public transport

The share of public transport increased from 2005 to 2009, then stabilised before falling slightly. The theoretical number of daily users of public transport increased sharply from 6000 to 10,000 in 13 years.[9] In 68% of journeys completed by public transport, at least two modes are combined (train and metro, for example), while 26.2% are completed exclusively by metro and 4.8% by bus. Three quarters of combined journeys involve at least one train journey, and almost 90% of all public transport journeys are completed either fully or partially by metro. To this category can be added the share of people who use more than one mode of transport to reach the campus, the number of which has doubled in 12 years. Intermodality (using more than one mode for a single trip) most often corresponds to the use of a two-wheeled vehicle (motorised or not) to get to a train station (the "first kilometre") and then to the use of the metro.

Mobility has been a major challenge since the inauguration of the campus, as it is necessary not only to ensure accessibility to this suburban site but also to cope with the growth in the number of users. The main strategy consisted in developing the public transport offer. It first took the form of classic school transport in the 1970s: shuttles connected the campus to Lausanne with six daily buses running morning, noon and evening. This offer quickly proved to be unsuitable and regular bus lines were put into operation. It became clear that a high-capacity public transportation infrastructure was required to connect the campus. A light metro was opened in 1991 with three stations on the campus (Fig. 1), and its success was immediate; the line increased the modal share of public transport from 43% in 1990 to 50% in 1992 (Bovy and Demierre, 2001).

During the period covered by the surveys the capacity of the metro was gradually improved with an increase in the length of metros and in their frequency. A study on the doubling of the line (to make the passing of two metros possible even outside stations) was launched in 2020. The connection of the campus has also benefited from broader urbanization trends and the global transport policy. Since the early 2000 s, significant investments in the Lausanne region (a second metro line, transformation of the main stations, etc.) have reinforced the general attractiveness of public transport.

These measures managed to curb the growth in demand but required

[7] It has to be noted that salary does not vary between faculties for a given status.

[8] As a point of comparison, the Swiss labour force (FSO 2017) use less public transport (31%) than the academic and administrative staff (54% and 37%). Motorized transports are underrepresented among academic staff (26% vs 53%) unlike among other employees (55%). Walking is less present at UNIL (9% in Switzerland), but cycling is more frequent among researchers (14.2% vs 8% in the whole country).

[9] This is theoretical because not all people travel to the campus every day (part-time working/study, telecommuting, exam and leave periods, etc.).

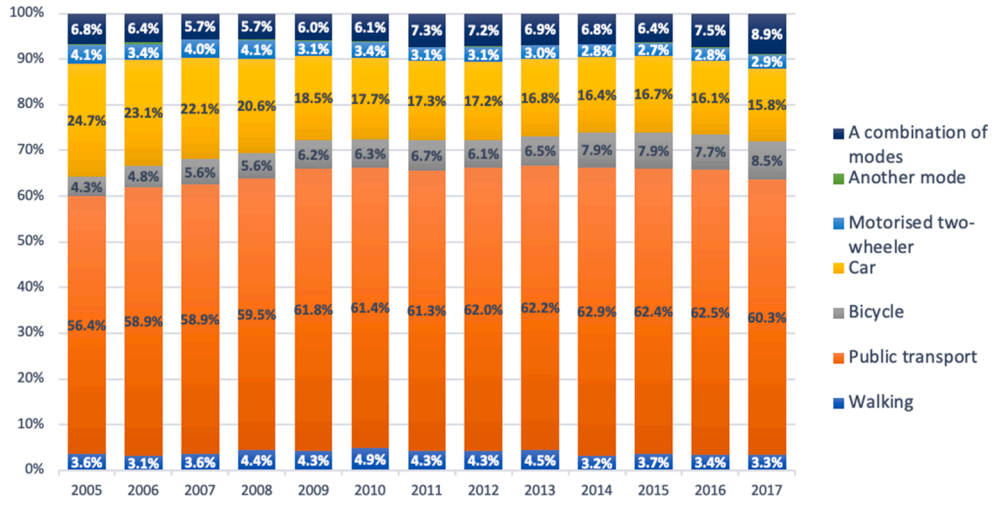

Fig. 3. Share of each mode of transport (2005–2017).

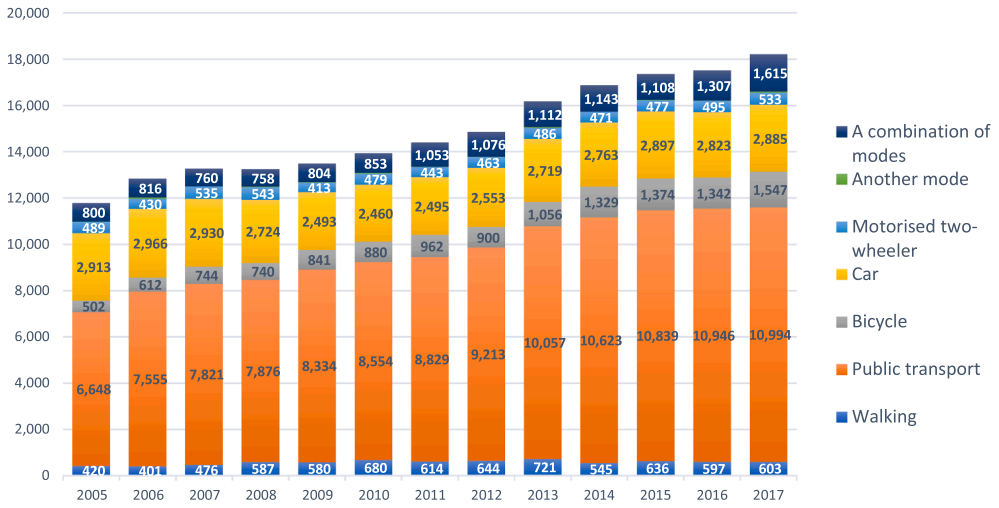

Fig. 4. Theoretical daily number of users of each mode of transport (2005–2017).

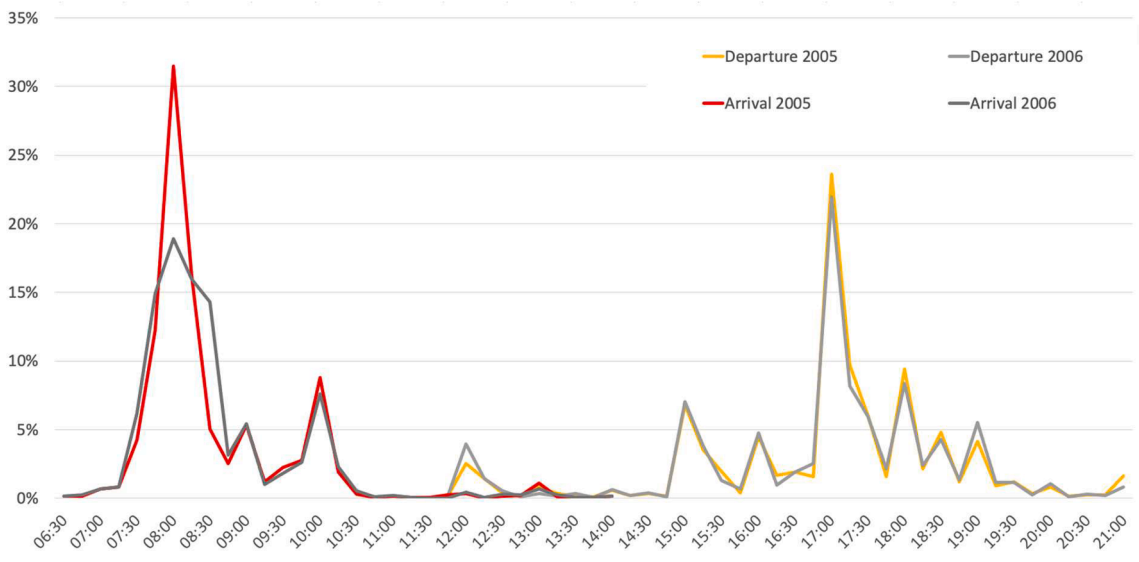

Fig. 5. Usual arrival and departure time on campus in 2005 and 2006.

substantial investment. Improved infrastructure can also be a source of induced traffic, due to making travel easier. Between 2005 and 2017, the average home–campus distance increased from 13.8 to 16.2 km and the share of people commuting over 30 km increased from 15.8 to 20.3%. Improved infrastructure, combined with the housing shortage in the Lausanne region, may have encouraged longer commuting journeys.

The increase in the carrying capacity also referred to mobility management measures concerning class timetables. In 2005, a third of the university community usually entered the campus at 8:00am (Fig. 5). In 2006, class start times were phased across two time slots (8:00 am and 8:30 am),[10] making it possible to stagger arrivals. As a result, less than 20% of people arrived at 8:00 am. This measure, which mainly affected students, helped to flatten peak hours and increase the capacity of the metro in the morning. Timetables are then standardized after the lunch break.[11]

Cars

The share of the car has dropped significantly from 25% to 16%. In absolute values, the figure stabilises around 2500 people, which is to be viewed in the light of the parking policy (see below). Nine out of ten users are individual drivers, and the remaining 10% is shared equally between people who are dropped off on campus and members of the university community who carpool. Carpooling is more frequent among students (15%), but remains stable during the period under study.

At its inauguration, the campus benefited from excellent road accessibility, thanks in part to Switzerland's first motorway. The predominance of cars was reflected in the development of large parking areas on the campus and until the 1990s parking was free and unlimited. The modal share of individual motorized transport accounted for 45% in 1990[12] (Bovy and Demierre, 2001). A parking policy was then gradually put in place, including permits according to type of user (e.g. passes exclusively for members of the university community), charges and ticket/permit checks. This is an example of a measure of mobility management aimed at modifying demand.

Moreover, UNIL has decided not to increase the number of parking spaces (1600 for the whole campus), in order to promote forms of sustainable mobility and preserve green spaces (parking spaces outside the campus are located too far away to be attractive; Fig. 1). However, the number of parking permits available remains higher than demand, which suggests that these measures have been sufficient to dissuade certain motorists all the more in the context of a smaller motorization of young adults that has been observed in many countries (Bayart et al., 2020). In Switzerland, the share of young adults (18–24 years old) holding a driving licence has decreased from more than 70% in 2000 to about 60% in the 2010s) (Rérat, 2021b).

Cycling and walking

Significant growth has been observed in the share of cycling (from 4.3% in 2005 to 8.5% in 2017), representing a tripling in terms of the university community (from 500 to 1500). 91.2% of cyclists use a mechanical bicycle and 8.8% use an electrically assisted bicycle. In contrast, the share and number of walkers (as well as users of motorised two-wheelers) varies very little.

The increase in cycling is not the consequence of a change in residential locations among the university community. The proportion of people living within 2 km of the campus has increased only slightly (from 10 to 11%), and that of people living between 2 and 5 km away has decreased significantly (from 41 to 33%). The University has launched promotion campaigns and introduced various bicycle services (parking, workshops, bicycle share schemes) but the cycling routes to the campus are not well developed for cycling. Its growing modal share illustrates the general renewed attractiveness of cycling in Swiss urban regions (Rérat, 2021a).

The trend regarding cycling is likely to strengthen as well as a new increase in walking with the building of housing on the campus and its transformation into a multifunctional district. The campus was originally conceived as a monofunctional district due, in part, to the refusal of surrounding municipalities to build student accommodation, but also to the principle of separating functions (zoning) promoted by functionalist planning. Dedicated exclusively to university activities, the campus filled up in the morning and empties at the end of the day. This has started to change in Autumn 2020 with the inauguration of a building containing 830 student bedrooms and 75 staff accommodation units (catering for a total of around 1000 people). Students (and some employees) are now residents of the campus and encouraged to favour active mobility due to the proximity of the university buildings. One of the university challenges will be to ensure interconnection with the surrounding neighbourhoods (via bridges/subways, footpaths, etc.) and the organisation of internal circulation. The original campus planning provided for arrival at the campus by car or public transport and anticipated internal travel on foot but did not consider cycling. The creation of safe and enjoyable cycling routes is crucial in order to take advantage of the densification of the campus.

Differentiated mobility practices within the university community

Behind the aggregated figures, significant variations can be observed within the university community in the use of public transport, active mobilities (cycling, walking and other modes such as scooters) and individual motorised vehicles (two or four wheels). Three logistic regressions were applied to explain the use of each of these three modes according to various characteristics provided by the database (gender, age, status, faculty, municipality, distance and frequency of the commute). The population is composed of the respondents of the 13 surveys (N = 38,866). While a table in the appendix presents the frequencies variable by variable for two years (2005 and 2017), Table 1 presents the influence of each variable all other things being equal and considering the 13 surveys.

The share of men and women using individual motorised transport – cars in particular – is similar all other things being equal. It is less common among young people and increases over the life course. This differentiated access to cars is explained by an income effect (which offers greater latitude in modal choices) and also by a double effect of age (young people do not necessarily have their driving licence yet) and generation (young people having potentially been less socialised to cars than previous generations). The economics and law faculties, and to a lesser extent social and political sciences, use cars more extensively. These differences, which appear despite these faculties sharing the same campus and being located next to each other, reveal the importance of the image of the various means of transport and the values associated with them.

The territorial context has a significant effect: the use of the car increases with distance from the urban centre and reaches its peak in agricultural and peri-urban municipalities. The distances for which individual motorised transport is particularly competitive are between 5 and 15 km. A final point is that the share of the car decreases, all other things being equal. As the methods controls for structure effect, this decline is not explained by changes in the structure of the university community (e.g. a greater share of students) but by general changes in modal choices.

The use of public transport increases over time, is more frequent

[10] A third time slot (8:15am) was adopted at the neighbouring the Swiss Federal Institute of Technology Lausanne.

[11] This room management may be more complicated in campuses where use rate of teaching rooms is very high.

[12] This survey gathered cars and motorcycles (but not mopeds) in the same category (the first ones were much more numerous however).

Table 1
Use of different modes of transport according to the profile of the respondents (binary logistic regressions on the 13 annual surveys).

Variables	Modalities	Public transport		Active mobilities		Individual motorised transport	
		Exp(B)	Sig.	Exp(B)	Sig.	Exp(B)	Sig.
Gender	Female (ref)						
	Male	0.798	***	1.725	***	1.000	ns
Age	25 years old and under (ref)						
	26–35 years old	0.526	***	1.389	***	1.986	***
	36–50 years old	0.285	***	1.202	*	4.106	***
	51 years old and above	0.196	***	0.973	ns	6.253	***
Status	Student (ref)						
	Administrative and technical staff	0.430	***	0.535	***	3.354	***
	Academic staff	0.737	***	1.217	**	1.364	***
Faculty	Central administration (ref)						
	Higher Commercial Studies	0.593	***	0.503	***	2.696	***
	Biology and Medicine	0.856	ns	1.101	ns	1.034	ns
	Law, Criminal Sciences and Public Administration	0.719	***	0.537	***	2.027	***
	Theology and Religious Studies	1.375	*	0.725	ns	0.780	ns
	Geosciences and Environment	0.710	***	1.671	***	0.887	ns
	Arts	1.184	***	0.751	ns	0.893	ns
	Social and Political Sciences	0.857	ns	0.821	ns	1.304	***
	Associated Institutions	1.420	***	0.974	ns	0.713	***
Type of municipality	Large urban centres (ref)						
	Secondary centres of large urban centres	0.339	***	3.310	***	1.606	***
	Suburbs of large urban centres	0.276	***	2.314	***	3.106	***
	Medium urban centres	0.622	***	0.940	ns	1.412	***
	Suburbs of medium urban centres	0.261	***	0.952	ns	3.347	***
	Small urban centres	0.176	***	1.146	ns	5.238	***
	Rural/peri-urban municipalities	0.144	***	1.175	ns	6.379	***
	Agricultural municipalities	0.107	***	0.956	ns	8.920	***
	Touristic municipalities	0.273	***	1.499	ns	3.528	***
Distance	Less than 5 km (ref)						
	5–15 km	1.102	*	0.167	***	2.588	***
	More than 15 km	3.149	***	0.040	***	1.039	ns
Frequency	1–7 days per week	1.066	***	0.967	ns	0.938	***
Survey year	From 2005 to 2017	1.035	***	1.060	***	0.925	***

Notes: ns = not significant; * = $p < .05$; ** = $p < .01$; *** = $p < .001$
Model fit indicator – Nagelkerke R Square: 0.233; 0.257; 0.306.

among women and, unlike individual motorised transport, is higher among those aged less 25 and decreases with age. Status also plays a huge role: students are the most likely to use public transport, followed by academic staff, with administrative and technical staff the least likely to use it. This difference within the university community could be explained by the possibility of using time spent on public transport to work, which is likely to be of most relevance to lecturers and researchers. The theology and arts faculties, and the institutions associated with UNIL, are notable for their above-average use of public transport (although there are no differences in the distances between faculties and public transport stops).

Large centres like Lausanne are characterised by very intensive use, but so too are other cities connected with Lausanne and Renens train stations. The distance from home to campus also increases use of public transport, as trains are very competitive over long distances in terms of speed, comfort and the ability to make use of travel time. Those who travel more frequently per week are also more likely to use of public transport (and less likely to use motorised vehicles).

Active mobilities – dominated by cycling – are more common among men, a frequent observation in contexts where cycling occupies a low modal share (Rérat, 2021a). Age does not have a linear effect: active mobility is the domain of the 26–35 age group and, to a lesser extent, the 36–50 age group, while the oldest and youngest age groups engage in it less. Several hypotheses can be put forward: poorer physical fitness among older employees; problems with bicycle parking at home for students, who are more likely to live in older buildings; lack of habit or a less favourable image of active mobility within the oldest and youngest age groups; greater awareness of middle-aged people regarding the need to exercise and the health benefits (ibid.), etc. The economics and law faculties are distinguished by a much lower than average use of active forms of mobility. Conversely, geosciences make much more use of them, which can likely be explained by increased environmental awareness.

Distance greatly reduces active mobility, due to the physical effort required. The types of municipalities where the share of active mobility is highest reflect the territorial context of the campus (a suburb of a large urban centre near to the secondary centre of Renens). Finally, taking the survey year into account in the model shows an increasing trend.

Overall, mobility practices diverge within the university community even when the destination, i.e. the campus, is the same. The use of different means of transport can be explained when the effects of gender, age, income, territorial context (distance and mobility offer) and values (as reflected, in particular, by the differences between faculties) are looked at together.

Discussion and conclusion

Mobility is a major challenge for universities, which experience significant flows of people every day. This article has analysed the evolution of modal shares over 13 years in the case of the University of Lausanne, a medium-size university (20,000 students and employees). Its main campus is located in the suburbs of Lausanne (a medium-size city of 140,000 inhabitants) and has become well connected with public transport services over the past 30 years. The main results provide elements to the debates on how to foster sustainable mobility in university campuses.

About 60% of UNIL members exclusively use public transport, and a further 10% combine several means of transport (mostly a two-wheeler and public transport) while the modal share of public transport accounted for 43% in 1990. Cycling is experiencing notable growth with the doubling of share and tripling of number between 2005 and 2017. Cars have been in decline on the UNIL campus since 1990 (modal share of 45% but that included motorbikes). It reached 15.8% in 2017, which is a low level in an international comparison for campuses in medium-size cities or in suburban locations (Cattaneo et al., 2018; dell'Olio et al., 2019; Melia and Clark, 2018; Tolley, 1996).

The explanation for these trends can be found in mobility measures that have shaped the campus but also in regional and national policies as well as wider in social trends (such as the decline in youth licensing and the return of the bike). A first policy refers to infrastructures and the development of a public transport offer (buses and metro at the urban scale, trains at the regional and national scale) that provided efficient alternatives to individual motorized transport. A second range of measures relate to mobility management and have been taken by the university administration. It involves regulating parking. Parking conditions have a significant influence on the use of cars and are considered, in general, to be one of the main levers to promote a modal shift, provided alternatives are available and measures are in place to prevent people parking in the surrounding neighbourhoods. Another measure was the staggering of the start time of classes which flattened peak hours for public transport. It reveals the marked temporality of university activities and, more generally, the importance of the organisation of urban routines as a regional planning issue. However, its potential is limited by the growth in demand for public transport in the UNIL sector.

The paper has also shown that mobility practices diverge within the university community even when the destination, i.e., the campus, is the same. Some differences are quite well-known. They refer to socio-demographic characteristics (gender, age, professional status), territorial context (degree of urbanity of the municipality in which the individual lives) and journey characteristics (distance, frequency). Part of these differences could be (re)interpreted with more empirical material through the new lens of "worthwile travel time". This concept introduces the idea that travel can be pleasant, meaningful or worthwhile (Cornet et al., 2021). It could explain why academic staff are more prone to take the train (using the time to work during longer commute). It could also shed light on the fact that middle-aged people cycle more than young people (the opposite is found regularly in the literature). Commuting by bike is a way of getting exercise that can be more appealing to people with tighter time–space constraints (work, family, etc.) (Rérat, 2021a)

Some other differences had not been observed at the scale of a whole university at the best of our knowledge. This is the case of the varying modal choice between faculties. Members of the economics and law faculties in Lausanne drive much more than the others (along social and political sciences) and use less public transport and active mobilities even when control variables are considered (age, place of residence, distance, etc.). Staff in geosciences cycle more than the others while in arts and theology they rely more than average on public transport. These differences refer to socio-psychological characteristics, to perceptions and image of the various modes, to values and attitudes. They highlight the fact that modal choice cannot be reduced to a purely economically rational one (De Witte et al., 2013).

Overall, the results confirm the importance of transport infrastructure (as shown by the sharp decline of the modal share of the car to low standards in international comparison), highlight the role of mobility management measures that universities can apply (e.g. parking policy, staggering of the start time of classes) and identify the varying use of the different means of transport with a university. This last observation could be more considered in marketing and awareness campaigns.

Several elements will have impacts on the future mobility practice of the UNIL community. The first one is the construction of housing in an area where there had previously been only buildings intended for teaching and research. The importance of territorial variables (type of municipality and distance) clearly features in the rationale for modal choices. Proximity of student accommodation to learning spaces appears to be a way of encouraging active mobility. This trend can also be compared with the evolution of suburban municipalities and their maturation into real pieces of city (Dunham-Jones and Williamson, 2011).

Then, the COVID-19 crisis may have some long-lasting effects. An open question for future research is whether (or when) public transport will return to the level of use prior to the pandemic and if parts of their customers will turn to individual modes (motorized or active) to avoid crowding and to guarantee physical distancing. Another challenge is the digitalization of teaching, research and administration that has been accelerated during the (partial) lockdowns. Digitalisation can limit the need for face-to-face contact and thus there may be less need to travel. It could also distribute journeys in a more balanced manner. Employees have experienced teleworking during the crisis and many (although not all of them) have enjoyed the greater freedom regarding where they perform their duties. Teaching has returned to classes in autumn 2021 but on the long-term new forms of teaching could focus less on large lectures and more on personal and group work. They would highlight the importance of third places which can function simultaneously as a library, a coworking space and a common room. As a digitally connected campus, the university thus appears increasingly to be nomadic, a physical place augmented by the fluidity of virtual networks. The UNIL site is both a campus and a website (unil.ch); it is simultaneously territorialised and delocalised.

There are, however, limits to digitalisation. These are largely due to the advantages of face-to-face contact, especially for teaching, but also to questions of feasibility and desirability (development of interpersonal contacts, for example). From the point of view of mobility management, teleworking reduces the number of commuting journeys, but may nevertheless be concentrated on certain days of the week and accompanied by rebound effects (Ravalet and Rérat, 2019). Being able to telework could represent a boost for residential remoteness, making long commuting journeys more acceptable because they are less frequent and facilitating multiresidentiality among researchers and teachers, thus diminishing the environmental benefits of teleworking. This is all the more likely given the decrease in interregional migration in Switzerland over the last 50 years, in favour of long-distance commuting (Rérat, 2014)

The various measures and policies related to mobility identified in the paper also highlight certain specificities of a university as a generator of mobility. While it is similar to a small city due to the number of students and employees (the city in the sense of *urbs*), it does not have the political responsibility and powers (the city in the sense of *civitas*) at least in the Swiss context, and therefore depends on the local authorities that surround it. It must also respond to a demand which is distinguished by specific temporalities (on a daily, weekly or seasonal scale) and by a population of which a subset (students) faces different constraints (limited financial resources, living with parents, etc.).

This study has certain limitations: the questions asked regarding modal choice were largely factual in nature and, while cross-referencing against individual profiles partially lifts the veil on the differences within the university community, other types of questions would be of benefit to complement this approach. This is true of questions regarding the reasons behind modal choice (motivations and constraints, perceptions, experiences), those regarding residential choice and those regarding teleworking. A longer observation period and a more detailed approach than the "typical" day appear necessary to understand the growing complexity of work arrangements over time and space.

Another limitation, from the perspective of reducing the ecological footprint of universities is the fact that professional mobility is not taken into account (seminars, conferences, thesis panels, field work, etc.) despite the academic environment being a major consumer of this type

of mobility, often involving long distances and air travel (Glover et al., 2017). Failure to take action in respect of this mobility could destroy the environmental benefits of home–campus flow management. Academic long-distance travels also highlight the role of values and social norms that shape mobility practices (Kreil, 2021). They need to be addressed so that universities can become key sites to implement climate policies.

A final, crucial, issue – in terms of both policy and research – relates to the fact that campuses could increasingly be used as *living labs* in the transition to sustainable mobility (König, 2013). University campuses could be seen as ecosystems gathering researchers, commuters, and inhabitants where the impacts of infrastructures, mobility management measures (incentive or disincentive), new mobility services or campaigns aiming to change values and behaviours could be designed, tested and discussed. This is especially true when student accommodation is located on campus. The policies implemented could take greater account of the fact that the student years constitute a crucial phase in the learning of sustainable mobility, the effects of which could last into the later stages of the life course.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The paper is taken from a research project funded by the University of Lausanne ("MobCampus"). The author is grateful to his colleagues who took part in the project: Gianluigi Giacomel, Antonio Martin, Laura Scaperrotta and Boris Wernli.

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