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ABSTRACT

Millennials are increasingly reported to behave, and travel, differently from previous generations at the same stage in life. Among the observed changes, they postpone the time they obtain a driver's license, often live in urban locations and do not own a car, drive less if they own one, and use alternative travel modes more often. However, the reasons behind these trends, and their long-term impacts on travel demand and the future growth of cities, are still largely unclear. This study investigates millennials' mobility through the analysis of a comprehensive dataset collected among 2,155 young adults and members of the preceding Generation X who live in California, as part of a panel study of millennials' residential choices, lifestyles, travel behavior and adoption of new technologies. This paper presents an overview of the research, and discusses preliminary results from the analysis of the California Millennials Dataset. We focus on the adoption of multimodality among the members of the two generations, and compare it to measures of accessibility by various travel modes of the respondents' residential location. The study highlights differences in travel behavior between those that travel by car by necessity (e.g. because they live in locations where few travel options are available) and those that do so by choice (e.g. despite the availability of other modes). The study provides useful insights for planners and policy-makers, through improving the understanding of millennials' choices and the impact of lifecycle, period and generational effects on future travel.

Key words: Millennials, Travel Behavior, Lifestyles, Multimodality, Accessibility

1. INTRODUCTION

Young adults (often referred to as "millennials", or members of "Generation Y") are increasingly reported to have different lifestyles and travel behavior from previous generations at the same stage in life. Among the observed changes, millennials tend to postpone the time they obtain a driver's license, often choose to live in central urban locations and not to own a car, drive less even if they own one, and use alternative non-motorized means of transportation more often. Several explanations have been proposed to explain millennials' behaviors, including their preference for urban locations closer to the vibrant parts of a city, changes in household composition, and the substitution of travel for work and socializing with telecommuting and social media.

Millennials' behavior has been attributed an important role in explaining the changes in car travel observed in the United States and other developed countries, with the total vehicle miles traveled (VMT) that have (at least temporarily) "peaked" (cf. Metz, 2013; Goodwin, 2012; Sivak, 2015), before rebounding sharply in the United States to new records highs in 2016 (FHWA, 2016; Circella et al., 2016a). Several studies have investigated the factors affecting the residential location and mobility choices of millennials. However, the debate in this field is still dominated by speculations about the factors affecting millennials' behavior. Previous studies have been limited by the lack of information on specific variables (e.g. personal attitudes and preferences, for studies based on National Household Travel Survey data), or the use of convenience samples (e.g. studies on university students).

The connected tech-savvy millennials are a popular figure in the media headlines, and they certainly are a common presence in San Francisco, Los Angeles, or any other major city in the country. Not all millennials fit this stereotype, though, and there are large masses of young adults that still behave in a way that is more similar to older cohorts: they are likely to get married while still in their 20s, often live in single-family homes, drive alone for their commute, and raise their children in predominantly suburban areas. Understanding the different patterns in lifestyles and behaviors among the various segments of the heterogeneous population of millennials, and quantifying their impact on travel demand and the use of various means of transportation, is of extreme importance to researchers, planners and policy-makers.

This study improves the understanding of millennials choices through the analysis of data collected in California from multiple rounds of surveys administered to a panel of millennials and older adults. In the first stage of the research, we designed a comprehensive online survey and administered it to a sample of California residents, including millennials and members of the preceding Generation X, who were included in the study for comparison purposes. We used a quota sampling process to ensure that enough respondents from both age groups were sampled from each combination of geographic region of California and neighborhood type, and controlled for demographic targets of the sample for five dimensions: gender, age, household income, race and ethnicity, and presence of children in the household.

The result is the California Millennials Dataset, an unprecedented dataset which contains detailed information on the respondents' personal attitudes, preferences and environmental concerns; lifestyles; adoption of online social media and information and communication technology (ICT); residential location; living arrangements; commuting and other travel-related patterns; auto ownership; awareness, adoption and frequency of use of the most common shared mobility services (including car-sharing, bike-sharing, dynamic ridesharing and on-demand ride services such as Uber or Lyft); major life events happened in the past three years; expectations for

future events and propensity to purchase and use a private vehicles vs. to use other means of travel; political ideas and sociodemographic traits.

This paper presents an overview of the research, and describes the data collection process and survey instrument. We present descriptive statistics on the first wave of collected data, and compute a multimodality index to analyze respondents' use of various means of travel. We discuss the travel behaviors of the members of the two generations, and compare their adoption of multimodal travel with measures of accessibility based on the residential location of the respondents, in order to identify different rationales behind the adoption of travel modes either *by necessity* (e.g. captive car-users, who do not have adequate access to other travel modes) vs. *by choice* (e.g. users who have more space to make decisions on the travel modes to use).

The remainder of the paper is organized as follows. Section 2 briefly reviews previous studies that focused on millennials' mobility. Section 3 provides an overview of the research, the survey content, data collection and sampling approach. Section 4 presents descriptive statistics on selected individual preferences, measures of travel behavior, and the adoption of technology and shared mobility. The development of a multimodality index, and the comparison of multimodal vs. monomodal behaviors with local accessibility are the subject of Section 5. Section 6 presents some final conclusions, and the next steps of the research.

2. MILLENNIALS' MOBILITY

In this study, we follow the definition of "millennials" consistent with the studies published by the Pew Research Center, which identify millennials as the individuals born between 1981 and 1997 (i.e. they were 18 to 34-year-old, as of 2015). This segment of the population is credited for having different behaviors and lifestyles from older generations. Millennials postpone the time they obtain a driver's license, often choose to live in central urban locations where accessibility by various travel modes is higher, more often choose not to own a car, drive less even if they own one, and use alternative means of transportation more often (Blumenberg et al., 2012; Kuhnimhof et al., 2012; Blumenberg et al., 2015; McDonald, 2015, Circella et al., 2016b). Still, it is not easy to separate the generational component of millennials' behaviors from other factors affecting their mobility choices, which include the changing economic conditions and fluctuations in fuel prices, traffic congestion in large metropolitan areas, changes in the urban form of American cities, household (HH) composition and personal lifestyles, the eventual substitution of physical trips with information and communication technologies (ICT), a stronger tendency towards multimodality, and the increased availability of alternative travel options including new shared mobility services such as car-sharing and on-demand ride services (e.g. Uber) (Wachs, 2013, Polzin et al., 2014; Buehler and Hamre, 2014).

Recent sociodemographic shifts and modifications in habits and lifestyles include modifications in HH composition and living arrangements, changes in personal attitudes, reduction in (and postponement of) childbearing, and the increased diversity in the population (Zmud et al., 2014). Technological innovations further contribute to reshaping transportation. Not only the adoption of ICT, e.g. online shopping, telecommuting, etc., has important effects on travel as it reshapes individuals' relationships with the use of travel modes and organization of activities (cf. Mokhtarian, 2009; Circella et al., 2016a). Shared mobility services have further reshaped transportation through the introduction of options that give users increased mobility and accessibility without the costs of owning a vehicle. Shared mobility services range from car-sharing services, including fleet-based services such as Zipcar or Car2Go and peer-to-peer services

such as Turo, to ridesharing services, including dynamic carpooling such as Carma and on-demand ride services (also known as ridesourcing) such as Uber and Lyft, and bike-sharing services. Shared mobility services modify several factors affecting travel decisions, including travel cost, convenience and security (Taylor et al. 2015). The adoption of these services can affect auto ownership (shifting individuals' preference away from car ownership) and have sizable impacts on daily schedules, lifestyles, and even residential location. Not surprisingly, early adopters of shared mobility services are predominantly well-educated young individuals who live in urban areas. These services are particularly popular among millennials, who are heavy users of ICT and are more open to the sharing economy (Polzin et al., 2014; Zipcar 2013; Buck et al., 2013; Rayle et al., 2014).

Millennials' behavior differs from that of their older counterparts due to a combination of lifecycle, period and cohort effects, including lifestyle-related demographic changes, such as shifts in employment rates, delays in marriage and childbearing (Pew Research Center 2014), and shifts in attitudes and use of virtual mobility. In their analysis of National Household Travel Survey (NHTS) data, Polzin et al. (2014) showed that millennials exhibit different travel behavior than the preceding generations at the same age and identified several factors such as residential location, race, employment and economic status, living arrangements, licensure status, among others, that are expected to influence millennials' mobility. McDonald (2015) also analyzed NHTS data and highlighted that all Americans traveled less from 1995 to 2009, but millennial travel decreased the most. The study indicated that demographic shifts typical of the 18-to-34 age group could explain 10-25% of the differences in travel patterns. The author concluded that an additional portion (35-50%) could be explained by other variables such as changing attitudes or virtual mobility, even if she could only infer this as NHTS data do not contain information on these variables. The remaining percentage is attributed to the general decline in travel across all generations. Garikapati et al. (2016) analyzed older and younger millennials, and found that older millennials have more similar behaviors to their Gen X counterparts at the same age. Still, it is unclear if millennials will adapt to the same travel patterns of the prior generations or if lingering differences will remain in their travel and time use patterns as they age. For example, real estate sales data signal an increase in the number of millennials moving to more suburban locations, even if with a "delay effect" (compared to previous generations) due to the older age at which they establish new households.

Understanding the factors affecting millennials' choices, and their potential long-term impacts on travel demand, is extremely important for planning processes and policy-making. Still, previous studies have been limited by either (1) the lack of information on specific variables, such as personal attitudes or the adoption of new technologies and emerging mobility services, for studies based on NHTS or other household travel surveys at the statewide or metropolitan planning organization (MPO) level; or (2) the use of non-random samples, such as convenience samples drawn from specific segments of the population, e.g. university students.

3. THE CALIFORNIA MILLENNIALS DATASET

This study builds on a large research effort undertaken to investigate the relationships among millennials' residential location, individual attitudes, lifestyles, travel behavior and vehicle ownership, the adoption of shared mobility, and the aspiration to purchase (and use) a vehicle vs. use other means of travel in California. A rich dataset was collected in fall 2015 with a comprehensive online survey administered to 1,191 millennials (i.e. young adults, 18-34) and 964 members of the Generation X (i.e. middle-age adults, 35-50), selected with a quota sampling

approach from the six major regions of California and three neighborhood types. The study is part of a longitudinal study of the emerging transportation trends in California designed with a rotating panel structure, with additional waves of data collection planned in future years. For additional information on the survey content and data collection, see Circella et al. (2016b).

The study is designed to investigate the impact of numerous factors on mobility choices, including both classical explanatory factors such as economic variables, residential location and land use patterns, and speculative factors that have been attributed a role in explaining millennials' behavior, including personal attitudes and preferences, environmental concerns, adoption of technology and travel substitution with ICT alternatives, use of new transportation modes, e.g. car-sharing or on demand ride services such as Uber/Lyft, delayed household formation and modifications in socio-demographics.

3.1 Survey Content

The survey used in this project includes 11 sections, which collected information on:

a. *Individual attitudes and preferences* (measured through the agreement with a group of 66 statements on a five-level Likert scale, for 20 dimensions including social habits, adoption of technology, environmental concerns, etc.);
b. *Use of online social media and adoption of ICT devices and services*;
c. *Residential location and living arrangements*;
d. *Employment and work/study activities*;
e. *Transportation mode perceptions*;
f. *Current travel choices* (including information on commuting trips, leisure trips, activities conducted while traveling, and long distance travel);
g. *Awareness, adoption and frequency of use of the most common shared mobility services* (including car-sharing, bike-sharing, dynamic ridesharing and on-demand ride services such as Uber or Lyft);
h. *Driver's licensing status and vehicle ownership*;
i. *Previous travel behavior and residential location* (and information on the major life events from the past three years);
j. *Expectations for future events* (and propensity to purchase and use a private vehicles vs. to use other means of travel);
k. *Sociodemographic traits.*

During the survey design, we engaged several stakeholders and colleagues at other research institutions, California state and local agencies, and other partner organizations, to obtain feedback on the survey content and improve the survey tool. We extensively pretested the survey, and tried to balance the trade-off between the complexity of the content (and the amount of information that is collected) and the time required to complete the survey.

3.2 Sampling Process and Data Collection

We administered the survey to a sample of millennials and members of Generation X in California. We used a web-based opinion panel to invite members of these population segments to complete the survey, and used a quota sampling approach to ensure that enough responses were included from each geographic region of California and neighborhood type where the respondent lives (classified as predominantly urban, suburban or rural). Sociodemographic targets were used to make sure that the sample mirrored the characteristics of the California population on five key sociodemographic dimensions: sex, age, income, race and ethnicity, and presence of children in the household.

For the purposes of this study, we divided California in six major regions:

- MTC – Metropolitan Planning Organization (San Francisco Bay Area);
- SACOG – Sacramento Area Council of Governments (Sacramento region);
- SCAG – Southern California Council of Governments (Los Angeles/Southern California);
- SANDAG - San Diego Association of Governments (San Diego);
- Central Valley (eight counties in the central San Joaquin Valley); and
- Northern California and Others (rest of State not included in the previous regions).

A total of 5,466 invitations were sent out, and 3,018 complete cases were collected. The high response rate is not surprising considering the data collection method used for this project, and the higher propensity of opinion panel members to respond to survey invitations. After excluding severely incomplete, inconsistent or unreliable cases, the final dataset includes 2,155 valid cases. Table 1 presents summary descriptive statistics for this dataset.

3.3 Sample Weights, Geocoding and Integration with Land Use Data

In order to correct for the non-representativeness of the sample, we used a combination of cell weighting and the iterative proportional fitting (IPF) raking approach. We used targets for age, perceived neighborhood type, and geographic region to apply cell weights. This weighting process compensates for the effects of the quota sampling process used in the data collection and the intentional oversampling of some regions.[1] Further, in the application of the IPF raking, we used targets from the American Community Survey (ACS) 2015 1-year estimates to correct for the deviation of the sample from the statistics of the California population on race, ethnicity, presence of children in the household, household income, student/employment status, and sex.

While any remaining sampling bias can limit the ability to generalize the results from this sample to the entire population of interest, the method used in this study remains very valid to compare the two subsamples of millennials and Gen Xers, who were recruited with the same methodology. The sampling method, which controlled for the distribution of several sociodemographic traits in each subsample, and the application of weights allow us to build robust analyses of these data.

In order to match detailed data on the characteristics of the built environment in one's residential neighborhood, we geocoded the street address (or the closest intersection, if the address was not available) provided by each respondent using the Google Map API. Approximately 85% of cases could be successfully geocoded. We used the geocoded residential location of each respondent to integrate additional data from external sources including Census block group socioeconomic, demographic, and built environment variables (for more details, see Circella et al., 2016c). These data were used to develop the measures of accessibility in Section 5.

[1] We intentionally underrepresented the residents of major metropolitan areas, mainly Los Angeles and to a lower extent San Francisco, and oversampled individuals who live in other areas (rural counties and less populated regions), in order to collect enough respondents for each region, and build robust analyses for all subsamples.

Table 1. Demographic statistics in the California Millennials Dataset (N=2,155)

	Millennials		Gen X	
	Number of cases	Percentage of total	Number of cases	Percentage of total
Total	1191	100%	964	100%
Gender				
Male	480	40.3%	396	41.1%
Female	695	58.4%	562	58.3%
Transgender	6	0.5%	2	0.2%
Decline to Answer	10	0.8%	4	0.4%
Presence of Children in the Household				
Household without Children	663	55.7%	426	44.2%
Household with Children	528	44.3%	538	55.8%
HH income				
Prefer not to answer	97	8.1%	61	6.3%
Less than $20,000	128	10.7%	79	8.2%
$20,001 to $40,000	251	21.1%	141	14.6%
$40,001 to $60,000	222	18.6%	152	15.8%
$60,001 to $80,000	186	15.6%	170	17.6%
$80,001 to $100,000	106	8.9%	130	13.5%
$100,001 to $120,000	83	7.0%	74	7.7%
$120,001 to $140,000	37	3.1%	44	4.6%
$140,001 to $160,000	30	2.5%	45	4.7%
More than $160,000	51	4.3%	68	7.1%
Age				
Younger Millennials (18 - 26)	363	30.5%	--	--
Older Millennials (27 - 34)	828	69.5%	--	--
Younger Generation X (35-43)	--	--	476	49.4%
Older Generation X (44 - 50)	--	--	488	50.6%
Ethnicity				
Hispanic	320	26.9%	181	18.8%
Non-Hispanic	871	73.1%	783	81.2%
Race				
Asian/Pacific Islander	192	16.1%	140	14.5%
White/Caucasian	735	61.7%	664	68.9%
Black/African American	44	3.7%	54	5.6%
American Indian/Native American	26	2.2%	14	1.5%
Other/multi-racial	194	16.3%	92	9.5%
Education				
Prefer not to answer	4	0.3%	4	0.4%
Some grade/high school	33	2.8%	9	0.9%
High school/GED	177	14.9%	101	10.5%
Some college/technical school	395	33.2%	247	25.6%
Associate's degree	117	9.8%	125	13.0%
Bachelor's degree	359	30.1%	327	33.9%
Graduate degree (e.g. MS, PhD, MBA, etc.)	81	6.8%	116	12.0%
Professional degree (e.g. JD, MD, DDS, etc.)	25	2.1%	35	3.6%
Average HH size	3.12		3.14	
Average # of Vehicles in the HH	0.66		0.65	
Total Number of Commuters (to Work and/or School)	908	76.4%	682	70.7%
Primary Commute Mode (Most Recent Commute)				
Drive alone	626	68.9%	512	75.1%
Carpool	84	9.3%	48	7.0%
Motorcycle or motor-scooter	4	0.4%	2	0.3%
Work-/School- provided shuttle	8	0.9%	1	0.1%
Public transit	79	8.7%	57	8.4%
Uber/Lyft (on-demand ride services)	5	0.6%	3	0.4%
Bike or e-bike	27	3.0%	10	1.5%
Walk or skateboard	57	6.3%	30	4.4%
Other	18	2.0%	19	2.8%

4. TRAVEL BEHAVIOR OF MILLENNIALS

The analysis of the California Millennials Dataset allows investigating several trends associated with individual attitudes and travel behavior of millennials, and compare them with the attitudinal and behavioral patterns observed among the older Gen Xers.

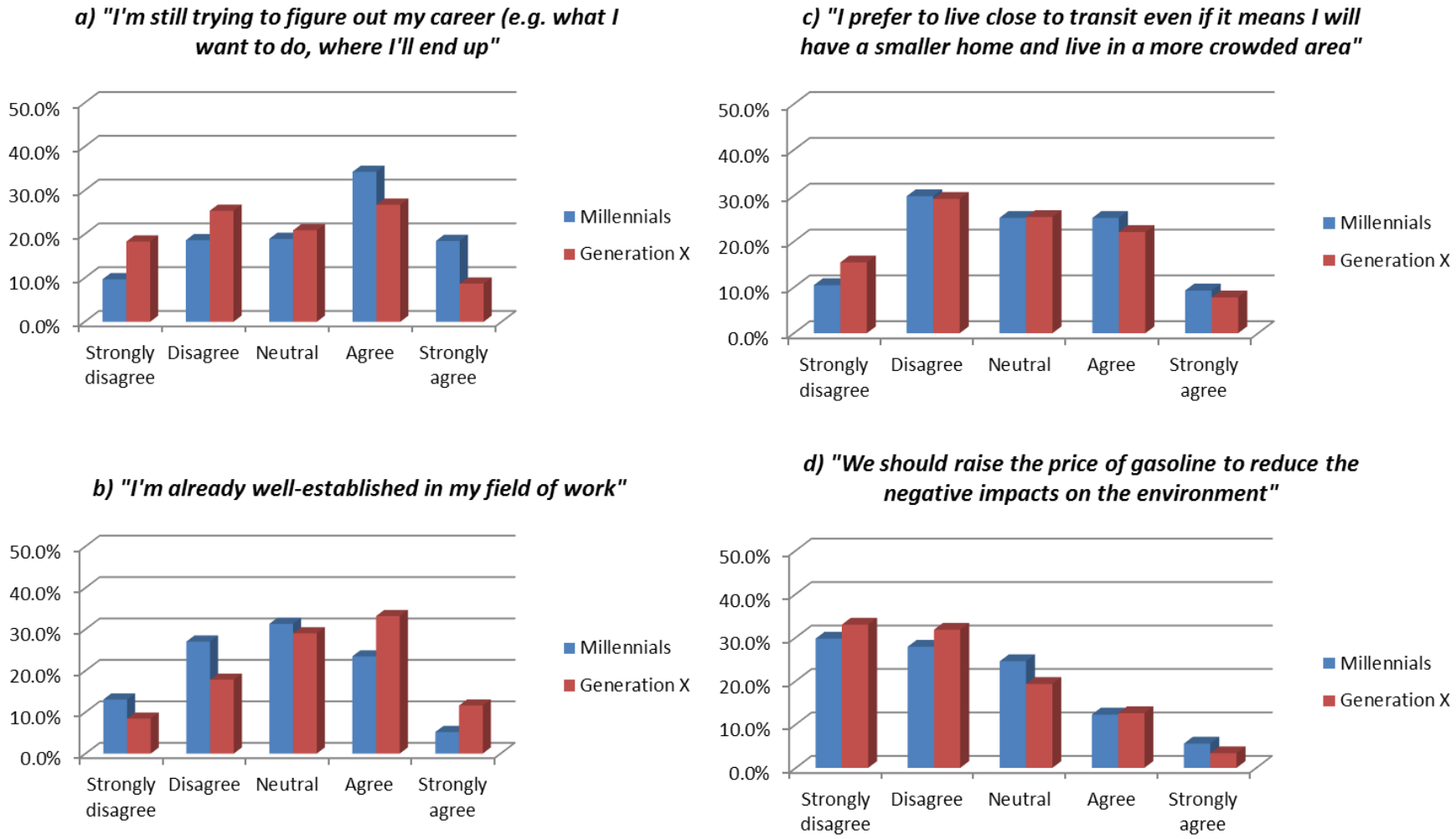
Millennials report, on average, weekly VMT that is about 19% lower than their older peers from Generation X, and this relationship holds when controlling for the neighborhoods where millennials live: urban millennials report to travel by car, on average, for only 89 miles per week, which is significantly lower than the 110 miles per week of urban Gen Xers. Similarly, the average weekly VMT for suburban millennials is only 112, compared to an average of 134 VMT of suburban Gen Xers. This measure mirrors similar differences in other measures of travel behavior, including the adoption of non-motorized modes of travel. The average number of vehicles owned by the households in which millennials live is not statistically different from that one of other households in the sample. However, the average number of vehicles per household driver is lower for millennials (as an effect of the larger number of children that live with Gen Xers). In a related publication under preparation, the research team is investigating the factors affecting vehicle ownership and the propensity of the members of the various generations to modify the number of vehicles in the household. Some of the observed differences in travel behavior and vehicle ownership might be associated with the *student* status of some millennials. The impacts of student status, the transient stage in life of many young adults, and student debts will be investigated in future stages of the research.

A higher number of millennials report not to have a valid driver's license. Approximately 15.2% of millennials reported not to have a driver's license at the time they completed the survey, compared to only 8.2% Gen Xers without a license. All respondents were at least 18 years old at the time they completed the survey, and no large differences are recorded in the age at which respondents obtained the license. This seems to suggest that, even if a larger proportion of millennials does not have a driver's license, those that have one tend to obtain it more or less at a similar stage of life than their older peers.

Figures 1 and 2 report selected information on attitudinal profiles and adoption of technology of millennials and Gen Xers. For example, the parts (a) and (b) of Figure 1 report the degree of agreement, measured on a 5-level Likert scale from "Strongly disagree" to "Strongly Agree", with the statements "I'm still trying to figure out my career (e.g. what I want to do, where I'll end up)" and "I'm already well-established in my field of work", among millennials and members of Gen X. These statements were part of the 66 statements in the attitudinal sections of the survey. Millennials confirm their characteristics of a transient generation, who are still at the beginning of their career, and are not well-established in their work.

We also explored the relationship of millennials with technology and social media. Consistent with expectations, millennials are more likely to agree that social networks such as Facebook make their life more interesting. They also recognize a stronger role of smartphones in making it easier to "go around", and appear less concerned than older adults about learning how to use new technologies (results not shown for brevity). The need to be always "connected" and use smartphones and other internet-enabled devices is behind the importance associated with having a Wi-Fi and/or 3G/4G internet connection available at all times (Figure 2-b).

1



2
3 **Figure 1: Selected attitudes of millennials and Gen Xers, with regard to (a, b) stage of life, (c) preferences for urban form, and (d)**
4 **environmental issues**
5
6

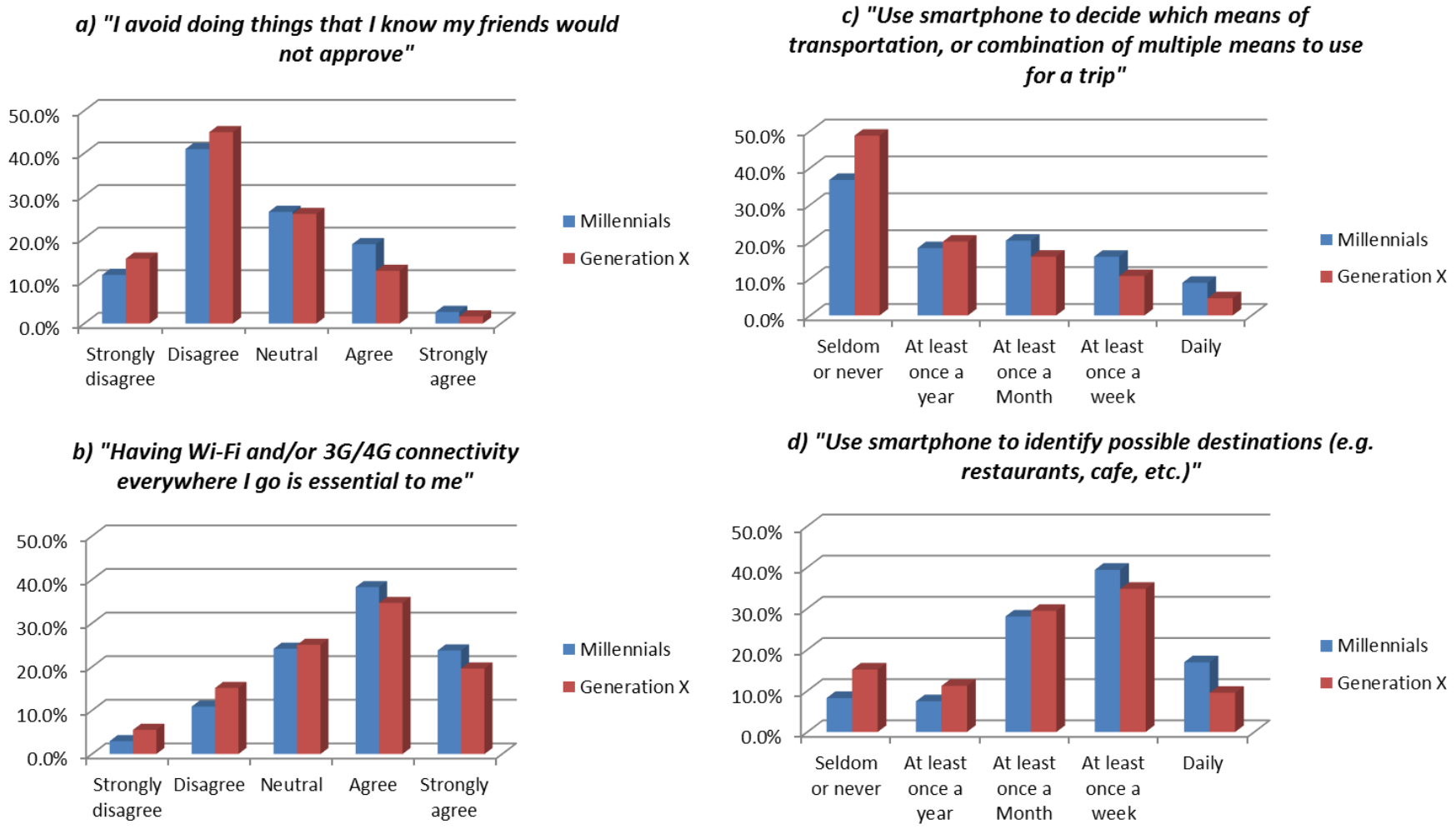


Figure 2: (a, b) Selected technological-related attitudes of millennials and Gen Xers, and (c, d) use of smartphones for various activities

These findings are consistent with the stereotype of millennials who make a larger use of technology (smartphones, in particular) to simplify their life and adjust to a dynamic and mobile life organization. Millennials are also found to use their smartphone apps more frequently to conduct a number of activities, including "Identify possible destinations (e.g. restaurant, café, etc.)" (Figure 2-d), "Learn how to get to a new place", "Decide which means of transportation, or combinations of multiple means, to use for a trip" (Figure 2-c), "Check traffic to plan my route or departure time", and "Navigate in real time (e.g. using Google Maps or other navigation services)" (for more details, see Circella et al., 2016b).

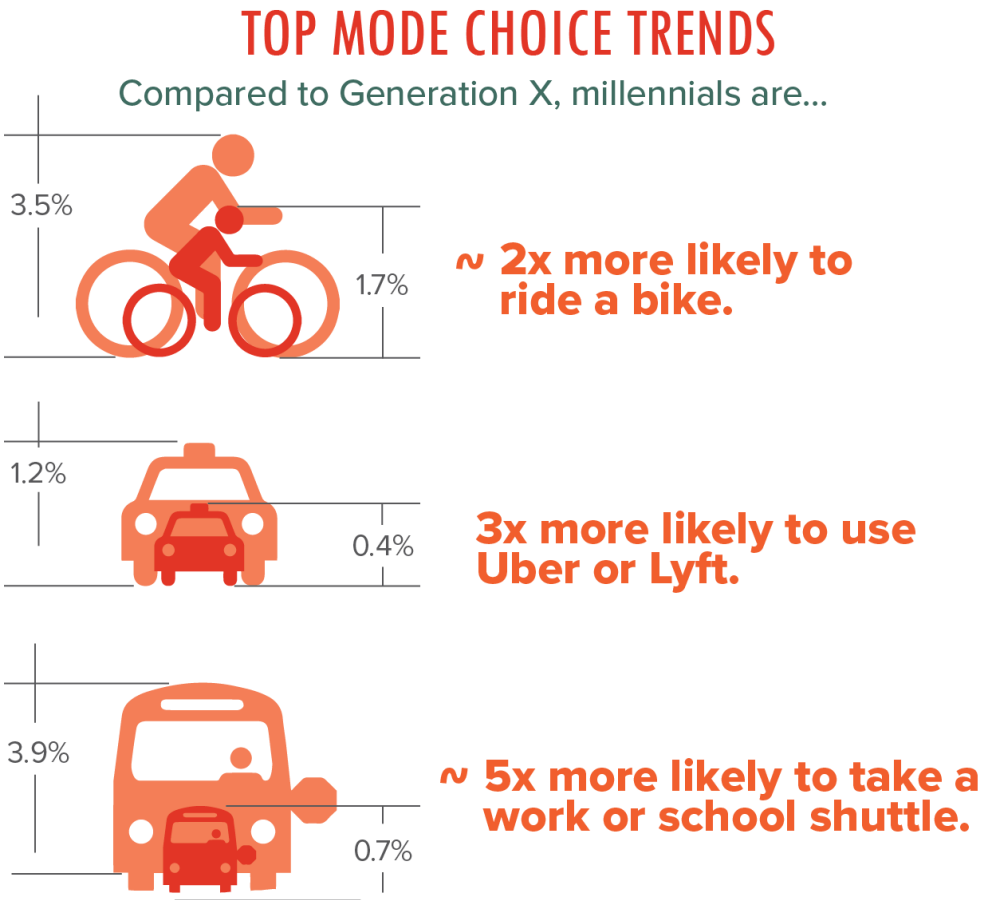


Figure 3: Major trends in the use of non-car modes among millennials and Gen Xers

Millennials more often adopt alternative modes of transportation (see Table 1), and more often engage in multimodal behaviors and intermodal trips which involve the use of more than one commute modes. Similar trends are observed for non-commute and leisure trips. Figure 3 summarizes some major trends in the use of non-car modes among millennials and Gen Xers.

Millennials appear to be more at ease at doing more than one activity at the same time ("multitask"): a higher percentage of young adults reports that they engaged in travel multitasking during their most recent commute (Figure 4). Also as a consequence of their engagement in travel multitasking, millennials report a slightly higher level of satisfaction with their current level of travel, compared to Gen Xers. In future stages of the research, we plan to investigate the impact of the propensity to engage in, and frequency of adoption of, travel multitasking on the use of various means of transportation and commute mode choice.

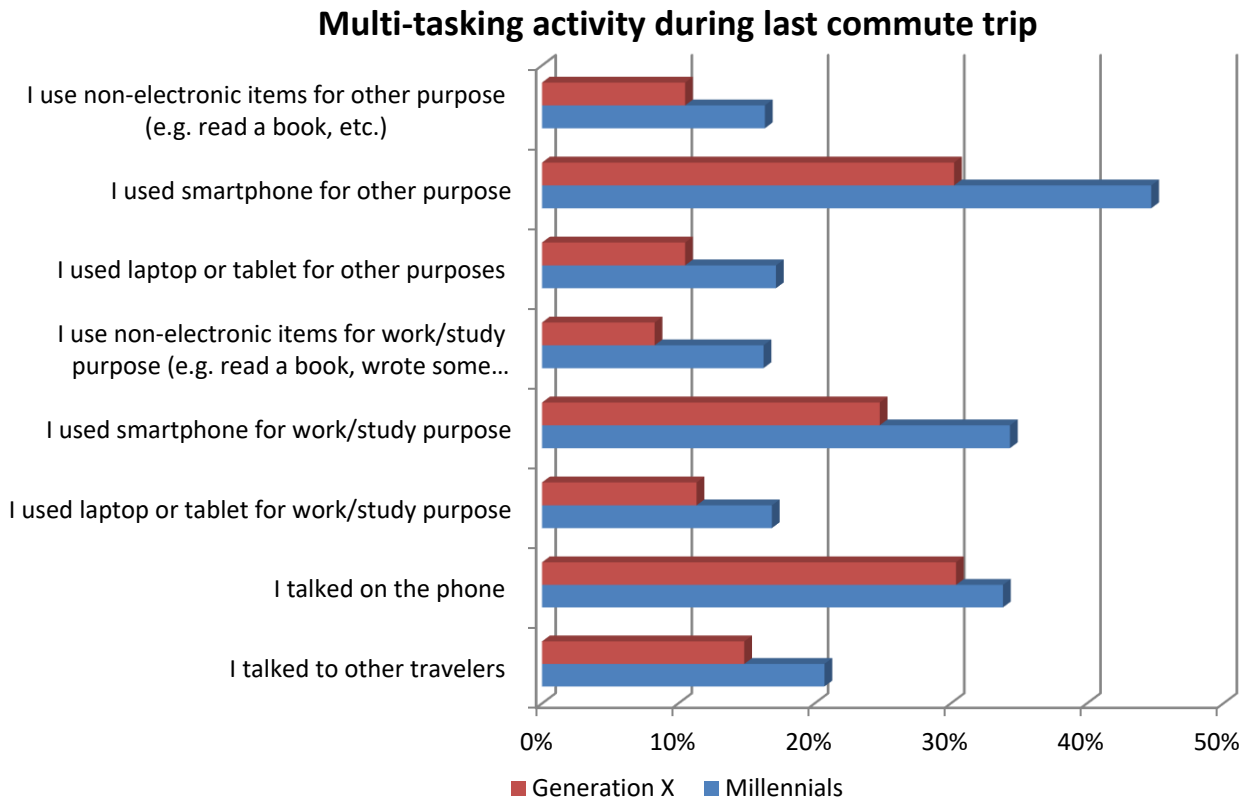


Figure 4: Engagement in various types of activities during the last commute trip (all travel modes)

We collected information on the awareness, availability and frequency of adoption of a number of shared mobility services, including car-sharing, bike-sharing, dynamic ridesharing and on-demand ride services such as Uber or Lyft. Millennials consistently reported using all shared mobility services more often than Generation X. Further, we wanted to understand the impact of the adoption of shared mobility on the use of other modes. Somewhat worrisome, while most respondents reported that the use of Uber or Lyft reduced their use of their car, and often substituted for a trip on which they would have otherwise driven, a larger percentage of millennials, compared to Gen Xers, reported that the use of Uber/Lyft actually reduced the amount of walking/biking they did (for more details, see Circella et al., 2016b).

5. MULTIMODAL BEHAVIOR OF MILLENNIALS AND GENERATION X

We develop several measures of accessibility using two main sources of data: the Smart Location Database (SLD) develop by the US Environmental Protection Agency and Walkscore.com. SLD data provide land use measures on density, diversity, design, access to transit, and destination accessibility at the Census 2010 block group level (Ramsey & Bell, 2014). We complemented these data with the walk scores, bike scores, and transit scores available from walkscore.com, which reflect more micro-level built environment characteristics and are based on recently updated

data sources.[2] For the respondents that provided a valid street address we computed accessibility measures based on the census block group for the SLD measures, and on the latitude and longitude of the residence for the scores from Walkscore.com.

In this analysis, we further classified millennials in two groups: the *independent millennials* who do not live with their parents, and the *dependent millennials* who live with their parents. We assume that independent millennials have more flexibility in choosing their residential location, while dependent millennials are affected by their parents in their residential location choice.

For each respondent in the dataset, we computed several multimodality indices using information on the mode(s) that the individual used for their last commute tour.[3] We classify respondents based on their mono- vs. multi-modality status as *mono-car* (i.e. individuals who drove alone or carpooled for their entire commute tour), *mono-transit* (i.e. individuals who only used public transportation services such as bus, commuter rail, and light rail for the entirety of their commute tour), *mono-walk* (i.e. individuals who only walked to work or school), *mono-bike* (i.e. individuals who only biked to school or work), and *mono-other* (i.e. individuals that exclusively used other modes of transportation, e.g. on-demand ride services, ferry, etc. for their commute). We also defined two inter-modal indices for individuals who used more than one modes during their commute tour: *intermodal-car* (an index that identifies individuals who used a car as their main commute mode in conjunction with other secondary modes) and *inter-modal green* (that identifies individuals who used any non-car modes as their primary mode of transportation combined with other secondary modes).

We computed these indices for all respondents that commute regularly to work or school at least once per week, and provided a valid home address. The sample available for this analysis consists of 483 independent millennials, 320 dependent millennials, and 584 Gen Xers. Figure 5 reports the summary statistics for the two largest metropolitan areas of California, San Francisco and Los Angeles, comparing the average for four of the eight multimodality indices that were created and the average accessibility measures for the three groups that have been identified. In both regions,[4] independent millennials have the highest values for all accessibility measures. A similar trend is observed in Figure 6, which compares the percentage of multimodal travelers and the average walk score for the place of residence for the three groups in all regions of California (for additional details, see Circella et al., 2016c).

[2] There are some limitations in the use of the walk score when comparing different neighborhoods: for example, many communities where the homeowners maintain the parks, community centers and other amenities get low scores from Walkscore.com because the facilities are not considered "public", even though anyone who lives anywhere near has access and the communities are not gated. Despite these limitations, the score provides a useful measure of a neighborhood walkability, with a standardized score that can be easily compared across locations.

[3] Additional measures of multimodality were computed for non-commuting/leisure trips, but are not further discussed, for brevity.

[4] The trends in both regions are similar, but the levels of accessibility by non-auto modes are higher in San Francisco/MTC, while the percentage of *mono-car* commuters is higher in Los Angeles/SCAG.

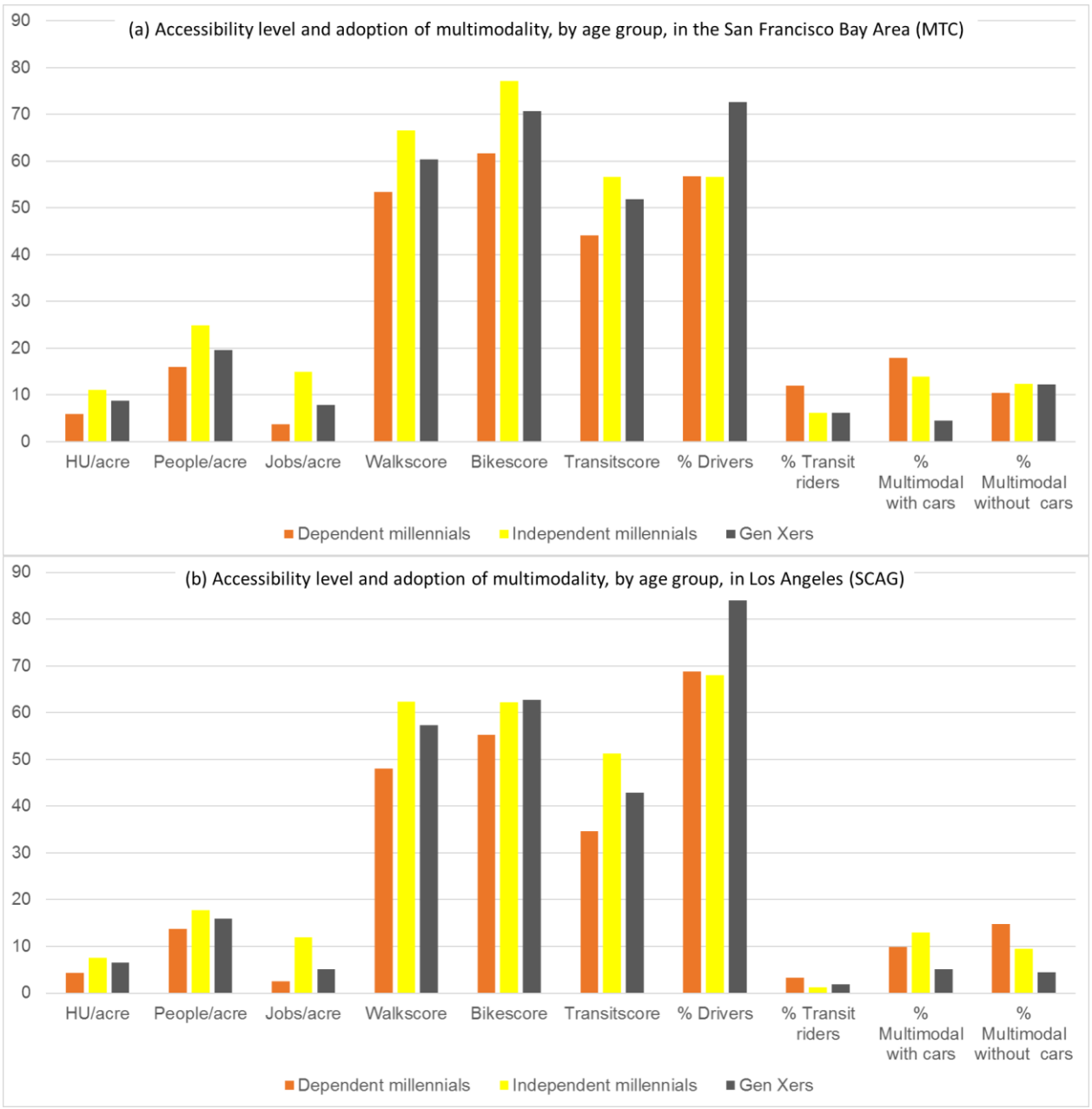


Figure 5: Accessibility level and adoption of multimodality, by generational group, in (a) the San Francisco Bay Area (MTC); and (b) Los Angeles (SCAG)

Important differences are observed among dependent and independent millennials. Dependent millennials tend to live in areas that have the lowest levels of accessibility by non-car modes, probably due to the residential location chosen by other household members. Independent millennials more often live in locations with higher accessibility. Such locations are more conducive to the adoption of *greener* and non-auto commute modes (and/or may reinforce the propensity of young adults to use such modes), as more often done by the individuals in this group. At the other end of the spectrum, Gen Xers rely heavily on the use of cars for their commute.

Interestingly, on average, Gen Xers are often found to enjoy better travel accessibility than dependent millennials. This seems to signal that at least a part of dependent millennials tends to

drive less in spite of living in neighborhoods that are less conducive to multimodality and to the use of non-auto modes. Several explanations could be behind this finding, including the impact of lower income and weaker economic conditions, reduced family obligations (e.g. millennials who live with their parents are less likely to have their own children to escort to school or extracurricular activities), and/or higher propensity towards such behaviors. Most likely, a combination of these factors is behind these trends.

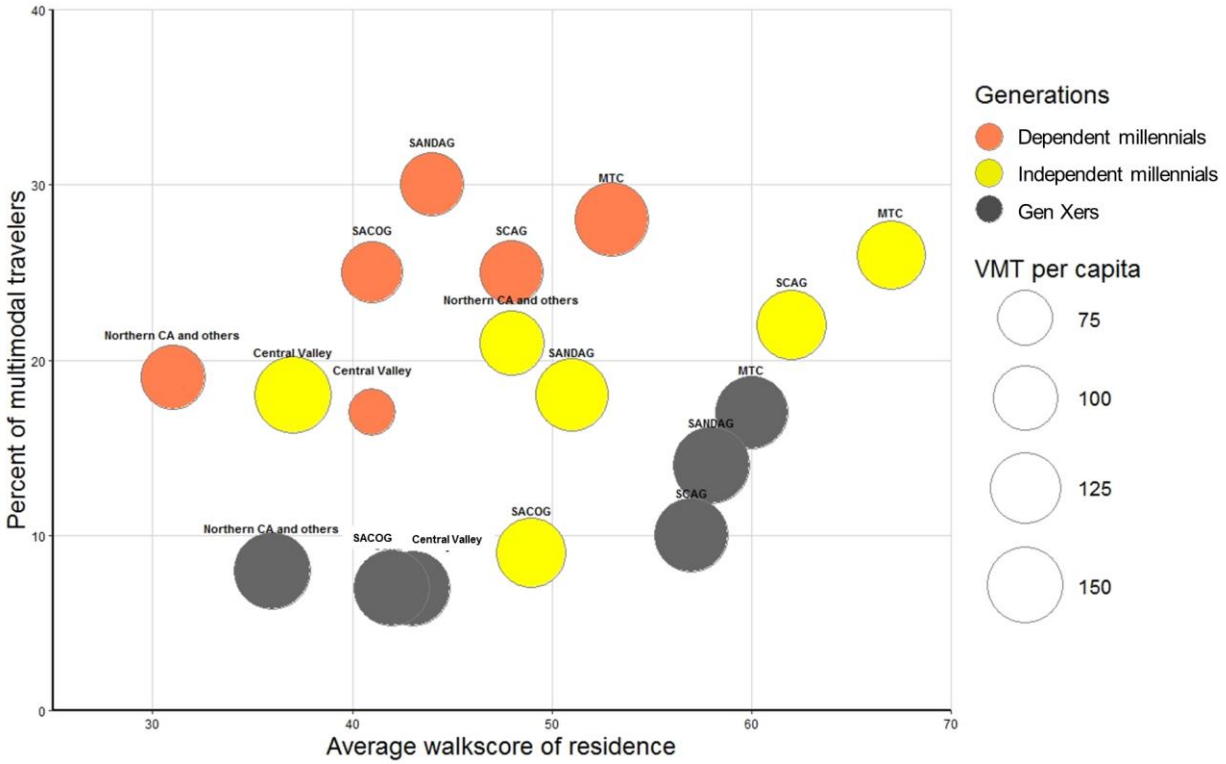


Figure 6: Average walkscore in the place of residence and percentage of multimodal travelers by region and age group

In summary, and not surprisingly, accessibility and multimodality are positively correlated: residents of more accessible neighborhoods are more often found to be multimodal commuters. However, millennials, and especially dependent millennials, are found to make the most of their built environment potential, either due to individual choices or the presence (or lack) of travel constraints. They are less likely to be mono-drivers and more likely to be multimodal commuters, even if they live in neighborhoods that are less supportive of such behaviors. This suggests that the connection between the built environment and travel patterns may differ by generation: in future steps of the research we plan to further investigate (and model) the relationships between accessibility and multimodal behavior among the members of the different generations, while controlling for other factors affecting residential and travel choices.

6. CONCLUSIONS AND FUTURE RESEARCH

Millennials are often described as a dynamic generation, whose tastes, lifestyles, consumer and travel behavior differ from those of previous generations at the same stage in life. They often are early adopters of new trends that later are adopted by other segments of society. Understanding

the dynamics behind millennials' travel behavior and mobility-related decisions is of outmost importance for scientific research and for planning processes.

Millennials are in a "transitional" stage of their life, in which they are building the basis for their future life, family and work career. They will contribute to create new households and influence future travel patterns in many ways. This study provides an important step in improving the understanding of millennials' mobility decisions, and of the factors that affect them, through an unprecedented systematic data collection effort aimed at collecting information on a number of variables that have been attributed a role in affecting millennials' behaviors. Millennials are found to be more technologically oriented than older peers. They use the internet and/or smartphone apps more often to perform several activities, and engage more often in travel multitasking. They show a stronger commitment to protecting the environment, and are less opposed to increases in gas taxes to provide funding for public transportation. Our data confirm the higher adoption of emerging transportation services among millennials. The impact of shared mobility on the use of other means of travel is not straightforward. Millennials often report reducing their use of transit or the amount of walking or biking as the result of the use of Uber/Lyft.

During the next stages of the research, we plan to capitalize on this ambitious research program for the investigation of the mobility of millennials in California. The full analysis of this dataset will provide important insights into the relationships among travel behavior, personal preferences, adoption of technology and residential location of millennials. We plan to estimate frequency models for the use of various means of travel, segmented for millennials and Generation X. We will explore the permanent vs. temporary nature of millennials' choices. We will test the prevalence of personal attitudes, lifestyles, and geographic location, and investigate the impact of stage of life (e.g. being married, presence of children) on the travel behavior of millennials. Finally, we plan to investigate the heterogeneity in the population of millennials (and older adults): how many millennials match the stereotype of urbanite/socialite common in the media? We plan to develop a cluster or latent class analysis to analyze different profiles of people, and investigate the proportion of millennials and Gen Xers that fit in the stereotype, e.g. live in urban areas, have dynamic lifestyles, are heavy users of social media, own zero (or few) cars, use public transportation, and adopt new technologies, and what differences exist with the other segments of the millennial population.

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