

The Mismeasurement of Mobility for Walkable Neighborhoods

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Introduction

This research is about mismeasurement, not about Walkable Neighborhoods. Here we only summarize this field; for details see Lewis and Adhikari.¹ Mobility in this research means the ability of residents to reach destinations in an acceptable travel time. Walkable Neighborhoods has a very specific definition and is always capitalized. Mobility in “Walkable Neighborhoods” has been generally assumed but not actually measured quantitatively. This research analyzes data from large household travel surveys including trip times and purposes of home round trips (defined as trips from home and back home in the course of a day). Understanding these trips is part of broader research to improve our understanding of Walkable Neighborhoods, which is a new field of research on delineated high-density neighborhoods.² However, because of mismeasurement, the data are inadequate, and this research can only lay the groundwork for future research.

Beyond Suburbia

“Neighborhood system” refers to how land use, transportation, and transportation pricing work together, from rural to high density areas. The suburban neighborhood system provides a high standard of living and mobility, but is based on massive subsidization of autos (personal or privately owned vehicles) and uses autos for most trips, resulting in auto-dependency. Suburbia has high living costs, sprawls over large areas of agricultural land and natural habitats, and contributes to rapid global climate heating. Autos pollute the air; vehicle accidents cause injury and death; and a suburban lifestyle correlates with reduced walking for health. Policy generally ignores transportation pricing reform and focuses on speed to cover more distance faster by providing bigger intersections and wider highways.

This research assumes that neighborhoods need to become more affordable, sustainable, walkable, healthier, safer, and socially connected.

Walkable Neighborhoods

In this research, “Walkable Neighborhoods” are defined formally as high-density residential areas with local businesses. They have attractive walking routes and acceptable walking times from home to local business and transit. They have sufficient density over a walkable area to support business mostly with walk-ins. At a fuzzy but critical density threshold (, residents have mobility without owning an auto. Thus, Walkable Neighborhoods are dense, but their streets have more walkers and less auto traffic. They have small parks and primary schools, and may have land uses serving people outside the neighborhood. As density within a walkable area increases, walk-in demand for business and transit increase.

Related research by Lewis and Adhikari found Walkable Neighborhoods in older urban areas close to major employment land uses.³ These old neighborhoods have enough residents to support local business for common needs. They always also have complementary features that help mobility. Related research found that Walkable Neighborhoods have a minimum residential density of 50 persons per neighborhood acre (20.2 per neighborhood hectare) in a delineated area. Such neighborhoods achieve sustainable modes for 60 percent or more of all trips.

Compared to suburbia, Walkable Neighborhoods are more sustainable and livable. They are more cost-effective and have lower living costs (including the combined costs of housing, energy, and transportation), benefiting middle and lower income people. They have local businesses supported by walk-in access, less traffic, and more efficient transit. They support greater sustainability by reducing auto dependency, auto miles traveled, fossil fuel use, greenhouse gas emissions, air pollution, and other measures. Residents walk more and have better health, improved safety from reduced conflicts with autos, and more positive attitudes.

As Litman states, “Conventional transport planning... assumes that the planning objective is to maximize travel speed and evaluates transport system performance using only car travel. A new paradigm recognizes that the ultimate goal of most transport activity is accessibility, which refers to people’s overall ability to reach desired services and activities.”⁴

Likewise, Krizek states that “Many planning efforts aim to develop neighborhoods with higher levels of accessibility that will allow residents to shop closer to home and drive fewer miles.”⁵ Van Wee and Handy state that certain neighborhoods achieved many goals, but “the greatest benefits may come from the enhancement of accessibility.”⁶ They hold that neighborhoods that allow for walking and transit-use provide more mobility than suburbia does through the use of autos.

However, Walkability and Walkable Neighborhoods are different concepts. Walkability is concerned with the attractiveness of walking environments in all urban areas. Attractiveness includes a variety of features, such as a flat tread, adequate site lines, no barriers, landscaping, and lack of blight and crime. For example, AARP’s Livability Index “assesses seven broad categories of community livability: housing, neighborhood, transportation, environment, health, engagement, and opportunity.” Scores in each category are then averaged to determine a total livability score for each location.

Walkability is just one aspect of Walkable Neighborhoods, which also include density, sustainable modes, and complementary features. Walkable Neighborhoods have advantages for livability. They are more affordable considering the combined costs of transportation, housing, and energy. They are healthier because they emit less pollution and encourage more walking, and safer because they require less auto use.

Definitions

This research focuses on times and purposes reported in the household surveys. The concept of destination, place, activity at destination, and purpose of trip overlap.

“Trip” was defined as travel from home in the course of a day to reach a destination activity, but the surveys actually often included a very large number of other kinds of trips. Sometimes travel is its

own purpose, such as travel for pleasure, as discussed by Mokhtarian and Salomon.⁷

“Trip purpose,” for this research, is the reason for a trip from home to destination to home again in the same day. A trip may include more than one purpose.

“Travel time” includes all stages of a trip, door-to-door, to reach a destination, with each stage being a mode of travel.

“Sustainable modes” are walking, biking, transit, and public cars. “Public cars” are taxis, e-hail shared rides, car share services, and car rental.

Specific trip purposes are *italicized*.

“Auto” generally refers to a privately owned vehicle.

“Car” is usually used in the phrase “public car.”

“Density” is defined as residents per delineated neighborhood acre.

Literature

Milakis et al. and van Wee interviewed small samples in Berkeley, California and Delft in The Netherlands and found acceptable travel time was a factor in trip decisions.⁸ The subjects in Delft were more dissatisfied with longer commute times than those in Berkeley. This research used a different methodology based on household surveys, and also found a range of acceptable travel times for the same purpose.

“**Mobility**” is defined as the time it typically takes to achieve common trip purposes, not how fast or how far the distance is to a destination. Faster, longer trips do not necessarily improve mobility. People in a Walkable Neighborhood may not be able to hop in an auto and go somewhere miles away, but they can achieve comparable travel times by sustainable modes.

Mobility and accessibility are similar terms. Mobility emphasizes the ability to move to a destination, while accessibility emphasizes reaching the destination. Accessibility is often used to imply a destination is nearby, within walking distance. Litman suggests that accessibility can be measured as “people’s ability to reach goods, services and activities...” and should be evaluated for different groups, modes, and activities.⁹

A “**Walkable area**” is defined conceptually as an area with attractive walking routes and times. The number of people walking diminishes with walking distance and route attractiveness, but it is not useful to draw hard lines. For analysis, however, some operational definition—if not used rigidly—can be useful in getting a general sense of a walking area. For example, a median walk time of ten minutes includes only half the walkers. An average time of fifteen minutes includes more walkers, more than half. At some point the number diminishes to outliers and is not useful. Similarly, for distance, a half-mile walking distance to business and transit taking ten minutes is useful as an operational definition to get a sense of walkability, but attractiveness can facilitate longer distances. Thus, rigid minimums

and maximums are not useful. Achieving sustainable modes for over 60 percent of trips, on the other hand, provides a useful operational definition.

Data

Household travel surveys categorize travel times by purpose, independent of mode of transportation, speed, and distance travelled. This research uses statistics from large household surveys: National Household Travel Survey (NHTS), the California Household Travel Survey (CHTS), and the American Time Use Survey (ATUS). The NHTS and ATUS surveyed the civilian noninstitutional population for ages five and over; the CHTS included all ages. This research focused on NHTS 2017 data primarily, supplemented by other surveys. They used data from three NHTS years, the one CHTS, and three ATUS years. The NHTS from 2001 and 2009 had twenty-six categories for initial review, the 2016 ATUS had fifteen, and the CHTS had twenty-one.

National Household Travel Survey¹⁰

The NHTS is the primary source of survey data on trips. For NHTS 2017, this research downloaded and analyzed the large NHTS Travel Day Trip File from the Oak Ridge National Laboratory. This file contained records of individual trips organized into twenty-seven categories of trip purposes (where trip purpose is defined by the main activity performed at the destination). The NHTS 2017 also provided data on the average Trip Duration (minutes, Travel Day). It also included many other variables that this research did not use, including travel time by mode and distance for seven times (from 1 to 4 minutes to 50+ minutes) and for twenty-seven modes of travel. Lastly, The NHTS provided details on trip making and a web utility, which helped with analysis by allowing the user to define tables with up to three variables.

California Household Travel Survey¹¹

The CHTS was conducted from 2010 to 2012, surveying 42,431 households, and is available online. It contained high-quality data from three GPS devices: one that was wearable, one placed in a private vehicle, and one in private vehicle with an on-board diagnostic unit. Data from the GPS were compared to that reported by the respondents, with the GPS providing better results. The GPS, for example, reported trip minutes accurately while respondents tended to round to the nearest five minutes. The CHTS categorized data according to twenty-one distinct travel purposes, and by times generally similar to the NHTS.

American Time Use Survey¹²

The ATUS of 2016 reported all activities and travel for one average day (adding up to twenty-four hours) for the whole population. The ATUS used 23 major trip purposes and reported that during an average day in 2016, the average person spent a total of 1.41 hours traveling.

The ATUS lexicon is a rich source of examples of activities related to travel and helps us understand the activities of the twenty-four-hour day in which travel must fit. Time is recorded as either activity time in itself or as travel time related to reaching the site of activity. Time spent traveling home again is assigned to the preceding purpose.

Travel time is not reported per trip, but as all the time spent going to or from a given purpose in the course of a day. This research assumes that the ATUS trip time in a day is generally the result of two trips—one to purpose, and the other back home — so that one way trip time is assumed to be half of a trip’s total time for the whole day.

The ATUS reports data two ways, one for the whole population and the other only for those making the trip. The only purposes involving most people are sleeping and eating. For other purposes, times for the whole population were short because, in fact, many people did not make that trip at all. The analysis has to pay attention to both statistics.

Average hours per day can be confusing. For example, the ATUS combines work hours for those who do work and those who don’t to get an average of 3.69 hours. It is more helpful to know that 46 percent of people worked and how long individuals within that subgroup worked.

Travel Time Budgets

People in suburbia use autos more often and travel faster over longer distances than in Walkable Neighborhoods, where people use sustainable modes of transport for similar trip purposes, traveling more slowly over shorter distances.

The concept of a “travel time budget” (how much time a person is willing to spend on different trips for various purposes) assumes that travel time matters more than mode, speed, and length of trip, and compares neighborhood systems based on how long it takes to travel within them. A slow-speed walking trip may be preferred over a high-speed auto trip if the time it requires is less overall.

This research is not concerned with other variables explaining trips (e.g., monetary cost, free time while riding transit, safety, comfort, and reliability), which are important and should be a next step in the research.

Litman states, “Under favorable conditions walking and cycling time had low or negative costs; users considered time spent on this activity a benefit rather than a cost, because it is enjoyable and provides exercise which reduces the need to spend special time exercising, so users will choose these modes even if they take more time than driving... Because walking and cycling are inexpensive travel modes, their effective speed (travel time plus time spent earning money to pay for transport) is often faster than driving...”¹³

People have varying travel time budgets, with some people, for example, accepting a long commute in exchange for higher housing value while others value living close enough to their place of business to walk. However, these complexities of optimization average out in the statistics.

In aggregate, times cluster around median and average times for each purpose. Travel time budgets, on the other hand, vary with purpose, with long times being reported as acceptable for commutes while shorter times are expected for procuring common goods, services, and meals.

Litman states, “People typically devote 60 to 90 minutes a day and 15 to 20 percent of their household budgets to transport, and are willing to spend 5 to 10 minutes traveling for errands such as shopping

and taking children to school. If such services are sufficiently accessible for pedestrians, some people will choose to walk. If not, most people who can drive will. Similarly, thirty minutes and two to four dollars in expenses represents the maximum one way commute budget.”¹⁴

Mokhtarian and Chen analyzed findings from more than two dozen studies of travel time budgets and agreed with prior researchers that travel times vary at the individual level but become more constant at a higher aggregation.¹⁵ They looked at variables explaining individual travel times, including residential density, but without giving any attention to sustainable modes of transportation taken by residents in neighborhoods with a high enough density.

Prendergast and Williams analyzed the UK National Travel Survey and two surveys conducted in Reading, England, and found stable daily travel time budgets for different population groups.¹⁶ The average time and frequency distributions of travel time showed little variation between weekdays in the aggregate but had great variation for individuals and by socio-economic strata.

People seem to think differently about trips based on their purpose. Some purposes require conscious and deliberate thinking about time and other factors, especially if the individual anticipates taking many trips for the purpose, as when they are deciding where to live or work, or rethinking a purpose that seems to be taking too long. Other time budget decisions may develop over time living in a place, as when an individual determines a preferred grocery store, fast food, drug store, building supply store, or health care provider. Some trip purposes may not actually be part of travel time budgets because people deal with the need for that trip on an *ad hoc* basis when the need arises.

Travel time budgets are an important concept for understanding trips without considering travel speed or distance, creating a level playing field for understanding mobility.

Initial Trip Table

For the initial trip table, this research used the data from NHTS 2017 to delineate twenty-seven trip purposes defined by the main activity performed at the trip’s destination. The table removes a few line items that lack purpose within the scope of this research. This research did, however, analyze responses “prefer not to answer,” “I don’t know,” “Not ascertained,” “Something else” in further detail.

The question of defining some trip purposes as more important than others proved problematic when establishing the methodology of this research. Would number of trips be an appropriate measure of importance? Or is the time it takes to make the trip more important? Ultimately, this research multiplied the number of trips by the trip time (in minutes) to get total travel time, which was used to rank trip purposes without assigning a level of importance to each. The question of trip importance could not be answered because each purpose is **important in its own way**—otherwise, people would not make the trip to begin with.

The surveys covered the household population of the United States or California, excluding Trips by persons in group quarters. While most of the population lives in houses, 2.6 percent live in group quarters, defined as living quarters housing ten or more unrelated persons, such as dormitories, residence halls, immigrant internment camps, barracks, jails, prisons, nursing homes, and retirement communities of various kinds.

Table 1. Initial Table

Initial Table: Trip Purposes and Travel Time NHTS 2017					NHTS 2017	
Trip purpose	Number of trips	Percent of trips	Average trip minutes	Total Travel Time	% of total travel time	Total time rank
<i>Regular home activities (chores, sleep)</i>	311,916	33.9%	23.13	7,214,617	35.9%	
<i>Work from home (paid)</i>	6,474	0.7%	18.64	120,675	0.6%	
<i>Work</i>	98,789	10.7%	24.1	2,379,827	11.8%	1
<i>Buy goods (groceries, clothes, appliances, gas)</i>	132,373	14.4%	17.4	2,307,261	11.5%	2
<i>Buy meals (go out for a meal, snack, carry-out)</i>	72,238	7.9%	18.3	1,319,788	6.6%	3
<i>Visit friends or relatives</i>	37,659	4.1%	28.5	1,072,152	5.3%	4
<i>Serve passenger</i>	56,326	6.1%	17.9	1,009,362	5.0%	5
<i>Recreational activities (visit parks, movies, bars, museums)</i>	31,259	3.4%	31.0	968,716	4.8%	6
<i>Exercise (go for a jog, walk, walk the dog, go to the gym)</i>	31,186	3.4%	17.45	544,196	2.7%	7
<i>Other general errands (post office, library)</i>	28,007	3.0%	17.3	483,681	2.4%	8
<i>Attend school as a student</i>	22,102	2.4%	20.7	457,953	2.3%	9
<i>Health care visit (medical, dental, therapy)</i>	16,761	1.8%	27.2	456,234	2.3%	10
<i>Change type of transportation</i>	9,437	1.0%	46.0	434,102	2.2%	11
<i>Buy services (dry cleaners, banking, service a car, pet care)</i>	23,512	2.6%	16.0	376,662	1.87%	12
<i>Work-related meeting / trip</i>	11,597	1.3%	32.4	375,395	1.87%	13
<i>Religious or other community activities</i>	18,693	2.0%	19.4	363,392	1.8%	14
<i>Volunteer activities (not paid)</i>	8,330	0.9%	19.1	159,020	0.8%	15
<i>Attend child care</i>	2,007	0.2%	19.7	39,558	0.2%	16
<i>Attend adult care</i>	540	0.1%	24.1	13,014	0.1%	17
<i>Trips selected for further analysis</i>	919,206	100.0%	21.9	20,095,606	100.0%	
<i>Trips excluded: prefer not to answer, I don't know, Not ascertained, Something else.</i>						
<i>Tabulation created on the NHTS website at http://nhts.ornl.gov. downloaded 5/25/2018</i>						
<i>Source: Federal Highway Administration, 2017 National Household Travel Survey (NHTS), Saved as NHTS 2017 Tables for paper.xlsx.</i>						

The following analysis examines each purpose, leading to a final table (Table 8) that reinterprets them for the purposes of this research.

Non-Home Round Trips

“Non-home round trips” are those that take an individual from a non-home location and back to that location. A major example is a trip from work and back to work (a “work round trip”), such as going out for lunch or a business meeting and then back to work. These trips reflect the character of the system of the individuals’ work location, not a neighborhood. This research is concerned with home round trips, not non-home round trips.

The CHTS placed eight activities at the work location. The largest of these, *work/job duties*, represents 80 percent of the total work-based trip and seems likely to be made up of home round trips. The other seven, on the other hand, seem likely to be work round trips carried out within or close to the workplace (e.g., meals at work, the most prevalent purpose among these kinds of trips). This research estimated that 80 percent of 2017 NHTS trips to work are made from home and excluded the remaining 20 percent of the *work/job duties* category from analysis on home round trips.

This exclusion is not a precise number by any means and should be considered a place holder for various trips that are non-home round trips.

CHTS also presented *work-related not at the work location* as a unique categorization, and 2017 NHTS included a similar purpose category, *work-related meeting/trip*. Again, there is no information as to whether these are home round or work round trips. This research considered the *work-related meeting/trip* purpose to be a home round trip, without being certain of how many of these kinds of trips really are.

Overnight Trips

“**Overnight away from home**” often involves very long travel times and several days. There is no information about how many trips fell in this category and this research makes no estimate for them. This research is concerned with home round trips, not overnight trips.

Not-Real-Trip Trips

Regular Home Activities and Work from Home

Trips to a destination at home or with no final activity are “not-real-trip trips.” The infelicitous phrasing gets the point across.

Regular home activities (chores, sleep) and *Work from home (paid)* are not-real-trips trips. A person does not need to leave home to get there; the trip purpose is the reason for leaving home in the first place. (In the NHTS, “whyto” is the trip purpose at the destination and “whyfrom” is the activity at the origin of the trip.)

The concepts of purpose, place, activity, and destination have over-lapping meanings, which can cause problems in any attempts to define home by any of these terms. The surveys sometimes did not reveal that the place of a destination activity is the home. Sleep, for example, is reported both as an activity and as a trip purpose without revealing the place where the activity occurred. Similarly, the surveys did not reveal the place of origin for the trip to the sleep destination, so a trip could be from one place in a home to bed. Leaving home to go somewhere else to sleep would be unusual—one would have to leave home for the purpose of sleeping elsewhere. To alleviate this issue, this research removed trips that seemed to go to activities that take place almost entirely in the home. The NHTS 2017 purposes *Regular home activities* and *Work from home (paid)* make up about 35 percent of all trips and are excluded from home round trips in Table 8.

Similarly, the CHTS Final Report included eight trip activities/purposes that took place at home,

implying many trips to home and within the home. One of them, *personal care*, refers to hygiene rituals and hair care performed by one's self, while trips that involved travel to have someone else do it, like a haircut, is categorized as *personal care service*. Often, a trip purpose is reported as *personal care* without revealing where the trip started. Nineteen CHTS trip purposes (45 percent of the total number of trips) are thus excluded from this research, leaving twenty-one purposes that involve travel away from home.

While *Regular home activities* and *Work from home* are not-real-trips trips, they still involve time spent traveling. The ATUS does not include *going home* as a purpose. This travel time needs to be assigned in some way to other purposes. The time can easily be assigned to a trip with a single purpose, but it is more complicated for a multi-purpose trip. One pragmatic simplification is to assign the overall travel time to the last activity before going home, as the ATUS does. However, this inflates the travel time attributed to that purpose. Other approaches would assign the time to an anchor trip or to all the purposes of a multi-purpose trip.

Serve Passenger

The purpose category *Serve passenger*, which appears in the NHTS and CHTS, refers to an individual driving others to a destination in an auto (personal or private vehicle), or driving to the destination to pick them up. *Serve passenger* excludes trips made by drivers paid to carry passengers, like taxi and transit drivers. The NHTS 2001 and 2009 used four purposes: *pick up someone*, *drop someone off* (these two being the largest), *transport someone*, and *take someone and wait* (these two being quite small). NHTS 2017 used just *Drop off /pick up someone*. This research lumps them all together as *serve passenger*.

Serve passenger is a major reported purpose. In the NHTS 2017, *serve passenger* amounted to 8.5 percent of total purposes, one fifth of total travel time, and 10.1 percent of all trips. NHTS 2001 and 2009 reported similar findings, though The CHTS ranked these trips higher, at 10.4 percent of total travel time and 13.1 percent.

Serve passenger is problematic, however, because it is not a real purpose. The real purpose is that of the passenger, such as to get to or from work, health care, school, daycare, or the airport. The surveys do not report the passenger's purpose for enlisting the driver and thus miss the real purpose of the trip. *Serve passenger* time for the driver should be added to trip time of the purpose of the passenger, giving those trips greater total travel time.

Since *serve passenger* is a not-a-trip trip, this purpose is excluded from home round trips in Table 8.

Additionally, *serve passenger* seems to mean using an auto. It is uncertain how a comparable trip would work in Walkable Neighborhoods. There is no need to drop a worker off at a transit station; it is too close. There might be a need to walk children to school, help a dependent get a prescription or health care, or help a friend shop. Public cars could also have *serve passenger* trips.

We can speculate about *serve passenger* for *health care* in Walkable Neighborhoods. People unable to drive in suburbia usually have an adult drive them to a hospital where they would need to find parking, walk-in, and get treatment. In a Walkable Neighborhood, those unable to drive could take

a public car, which involves waiting for the car to pick them up, but saves time at the hospital by dropping them off at the entrance (no parking and no walk-in).

The ATUS did not use *serve passenger*. It used *travel related to [activity]* for all travel. The closest to the concept of *serve passenger* is called *travel related to caring for others*. The ATUS apparently included more than auto tips; it was not clear how such trips worked if not by auto.

The ATUS split the statistics between caring for household members and caring for non-household members, then between children and adults, then among purposes such as *health* and *education*, and then between *caring for* and *helping*. The proliferation of care-related purposes resulted in eight of twelve categories, each with numbers too small to have reportable results. Travel related to *caring for & helping hh/nonhh children* and *helping hh/nonhh adults* (where “hh” means “household”) is 99 percent of the *caring for others* category. The ATUS lexicon describes many activities that give a detailed idea of what care for others mean, but not how they relate to travel or the place they occur.

The ATUS 2018 found 11.5 percent of total travel time is to *care for others*, much higher than for *serve passenger* in NHTS 2017. Yet the percentage of trips is almost the same: 10.5 percent in ATUS and 10.1 percent in NHTS. The ATUS average trip minutes attributed to this category is 18.6 (non-household members) to 18.9 (household members) and NHTS is 17.9 minutes.

Exercise Trip (Loop Trips)

Loop trips start and end at the same destination with no intermediate purpose. The “trip” is an activity, not a trip to a destination where an activity takes place. Here, the issue is to distinguish between exercise as an activity and exercise trips to reach a place to exercise. An exercise trip is travel to a destination with an exercise activity. Jogging, walking, walking the dog, or a drive for pleasure, all going back to the same place, are activities.

The NHTS 2017 combined both exercise as an activity and real trips with exercise as their purpose into a single category: *Exercise (go for a jog, walk, walk the dog, go to the gym)*. The trip to the gym is a trip; the rest are activities. Some surveys distinguished between exercise activities and exercise trips and indicated that the number of activities greatly exceeded the number of trips. Because of the way NHTS 2017 defined *Exercise*, it seemed to be mostly a not-a-trip trip and was, therefore, excluded from analysis of home round trips.

Change Type of Transportation

Change type is a stage of a trip, not-a-trip purpose in itself. In the CHTS, *Change type of transportation/ transfer (walk to bus, walk to parked auto, etc.)* accounted for over 12 percent of CHTS total trip time. Similarly, NHTS 2017 included a *change type* category. It amounted to less total time, only 3.7 percent, but it still ranked tenth of fifteen purposes in total travel time.

The *Change type* category presented two problems: length and not being a real trip.

The long trip time attributed to this category, forty-six minutes, is by far the longest of any purpose. The time is so out of line with others that this research wanted to see travel times by mode.

They emailed Stacey Bricka, MacroSys Senior Research Scientist at NHTS Program Support, who provided a table of duration by mode, including walking, bike, and auto at 13, 25, and 26 minutes respectively—and “something else” at 96 minutes, rail at 107 minutes, inter-city bus at 120 minutes, and airplane at 207 minutes. The extra-long travel times pulled the *change type* category’s average travel time up. It seems likely many of these trips were overnight. *Change type* is an aspect of the larger problem of not being able to separate overnight trips from home round trips.

Additionally, for the purposes of this research, *change type* cannot be considered a trip (i.e., it is a not-a-trip trip because it does not involve going to an activity that is the real purpose of the trip). It is one stage of a multi-stage trip to a purpose. Because of this, *Change type* is eliminated from home round trips.

Bricka also explained that the rationale behind the purpose categories specific to the NHTS is tailored to traffic modeling, reflecting the clientele of the NHTS. In short, the NHTS is not about trip purposes defined as activities at destinations or about home round trips.

Auto per se

Table 1 presents two trip types, *buy goods (groceries, clothes, appliances, gas)* and *buy services (dry cleaners, banking, service a car, pet care)*, that mix trips related to having an auto (personal or private vehicle) with other trip purposes.

Auto per se is the time spent, both trip time and activity time, ensuring that one has a working auto available for real trip purposes (for example, it is not just the time to get to the gas station, but also the time to fill up and pay, which is an activity at the destination). *Auto per se* time includes auto purchase, insurance purchase, earning a driver’s license, auto registration, fueling, other maintenance, repair, smog checks, accidents, and the aftermath of accidents. *Auto per se* even includes studying what auto to buy (think Consumer Reports), vacuuming the interior, washing and waxing the exterior, managing snow chains, and cleaning the driveway. The estimate for *Auto per se*, though incomplete, is shown in Table 2.

The *Auto per se* trip is interesting for two reasons: it is not a true trip purpose and it is not needed in Walkable Neighborhoods. The real purpose of *Auto per se* is to have the ability to make other trips. One does not gas up or get the auto fixed for the fun of it, but to have an auto, which is needed for other purposes. *Auto per se* time should be allocated to the real purposes that are the basis for ownership.

In Walkable Neighborhoods, an analogous concept could be a *walking per se* trip (time and expense spent to be able to walk), which is hard to measure (for example, people can buy shoes for pleasure, not just to make walking trips). Similarly, *Bike per se* involves the time to buy and maintain a bike, thereby allowing for future trips by bike. The time involved, here, is likely to be a fraction of that devoted to *Auto per se*. Trips comparable to *Auto per se* seem likely to be minimal or not needed.

Some components of *Auto per se* are difficult to identify in the surveys. The NHTS 2017 lumps *auto per se* trips into *service an auto* and lumps *buy gas* into *buy goods* or *buy services*. The NHTS 2001 and 2009, under whyto, reported *buy gas* as a trip, attributing 15.9 minutes average time to it in 2001 and 19.3 minutes in 2009.

The CHTS defined the *per se* trip as *Service Auto (gas, oil, lube, repairs)*, which accounted for 17.5 average trip minutes, totaling 2.1 percent of total travel time, placing it fifteenth in rank.

In short, The NHTS does not allow an analysis of *Auto per se*, so this research uses the ATUS 2018 for data for both travel time and activity time in this category, provided by economist for the Bureau of Labor Statistics Michelle Freeman. The ATUS 2018 provides the only data to estimate total time for *Auto per se* and comprehensive data on both “travel related to” *auto per se* and *Auto per se* “activities” themselves. This research adds activity time to travel time to calculate total *Auto per se* time. Ultimately, *Auto per se* totaled 15.6 percent of total travel time, making it the second largest category in total travel time after *work*. The amount of time dedicated to having an auto was surprising.

Table 2. *Auto per se*

Code	Activity	Number of trips (000)	Average trip minutes	Total Travel Time
51	Auto repair and maintenance (by self)	5,438	97	528,574
143	Auto & appliance maintenance/repair assistance for nonhh adults	1,120	92	103,488
209	Purchasing gas	9,604	10	92,198
277	Auto Maint. & Repair Services (not done by self)	2,899	37	106,103
278	Using auto maintenance or repair services	1,817	31	55,600
279	Waiting associated with auto main. or repair services	897	44	39,827
280	Using auto maint. & repair svcs, not elsewhere classified	398	26	10,268
	Travel related to			
505	Travel-auto care & maintenance (by self)	1,196	22	25,834
537	Travel-purchasing gas	9,409	40	378,242
555	Travel-using auto maintenance & repair services	2,828	29	81,446
	Total time for activity and travel related to per se	35,606	40	1,421,581
Unadjusted total travel time				9,141,128
<i>Auto per se</i> as a percent of total trips and travel time				15.6%
<i>Average trip minutes in minutes per day, 2018 annual averages.</i>				
<i>Source: ATUS, Summary Table 2, 2018. Number of trips is number of persons making the trip.</i>				

Considering the large amount of time and expense dedicated to *serve passenger* and *Auto per se*, a Walkable Neighborhood could offer considerable time savings.

Auto per se is eliminated from home round trips in the final table (Table 8).

Trivial etc. Trips

Trivial not-a-trip trip purposes can also be found in ATUS (For example, *Travel Related to Telephone Calls*, which is a very small category in terms of total trip time). In the ATUS 2016 they are twenty-fourth of the twenty-five trip purposes. In the ATUS 2018, the percentage of the population’s time in a day spent traveling to make a call is coded as “approximately zero.” Not only are these trips few in number, but they continue to diminish due to cell phone use. Also, the destination is not a

real purpose. People don't travel to a telephone just to reach it but rather to make the call, which is the true purpose.

Another ATUS example is travel time for *Security Procedures Related to Traveling*. Only 0.3 percent of respondents reported taking this trip, and for time, the estimate is "approximately zero." The procedures that define this category would include going through a metal detector or a search at a courthouse, or going through TSA to catch a plane, where attending court or boarding the plane is the real purpose.

The ATUS also lists dozens of trips statistically so infrequent they are not reported. This over-proliferation of trip purposes requires some consolidation.

Home Round Trips

True Home round trips fall into three broad categories: anchor, short, and long. Table 3 presents only home round trips from the Table 1, first listing work trip as the anchor trip, then short trips, and then longer trips starting with *visit friends*. "Long," here, is relative, meaning only longer than the short trips.

Table 3. Home Round Trips

Trip Purposes	Number of Trips	% of Trips	Average Trip Time	Median Travel Time	Standard Deviation	% of Total Travel Time
Work	98,789	19.6%	25.2	15	22.0	22.9%
Short trips:						
Buy goods (groceries, clothes, appliances, gas)	132,373	26.3%	17.4	10	20.1	21.2%
Buy services (dry cleaners, banking, service a car, pet care)	23,512	4.7%	16.0	10	16.1	3.5%
Buy meals (go out for a meal, snack, carry-out)	72,238	14.3%	18.3	10	22.8	12.1%
Other general errands (post office, library)	28,007	5.6%	17.3	10	17.4	4.4%
Total short trips	256,130	50.8%	17.5	10		41.2%
Longer trips:						
Visit friends or relatives	37,659	7.5%	28.5	15	31.5	9.9%
Recreational activities (visit parks, movies, bars, museums)	31,186	6.2%	31.0	15	32.5	8.9%
Health care visit (medical, dental, therapy)	16,761	3.3%	27.2	20	24.5	4.2%
Attend school as a student	22,102	4.4%	20.7	15	16.9	4.2%
Religious or other community activities	18,693	3.7%	19.4	15	18.5	3.3%
Work-related meeting / trip	11,597	2.3%	32.4	15	32.8	3.4%
Volunteer activities (not paid)	8,330	1.7%	19.1	14	18.2	1.5%
Attend child care	2,007	0.4%	19.7	15	15.0	0.4%
Attend adult care	540	0.1%	24.1	15	22.9	0.1%
Total longer trips	148,875	29.6%	26.2			35.9%
Total	503,794	100.0%	21.6			100.0%
<i>Before adjustments to work, buy goods, buy services, and buy meals.</i>						
<i>Median calculations shown in Home round trips, 2017 NHTS T6 in Final Trip Table data 734,261 rows.xlsx.</i>						
<i>Source: 2017 NHTS T6 in Final Trip Table data 734,261 rows from download of NHTS 2017 trippub.csv.</i>						

The Anchor Trip

An “anchor” is an activity outside the home that occurs over a fairly long period of time at a fairly high frequency, for example, going to work four or more days and working for four or more hours per day in a typical week.

The major anchor trip, and the only one reported in the surveys, is the work trip. However, anchors can also include education, caring for grandchildren or an elderly parent, some other family obligation, or a major volunteer or religious activity.

One frequent aspect of the work trip is the decision about where to live, the locational decision. The locational decision is particularly important for deciding where to live after getting a job in a new location. The general search area is determined broadly by a decision about an acceptable commute travel time. People who prefer a short trip to work may locate their home close to their work place, while others might accept a longer trip in exchange for better housing value. The choice of a location also involves optimizing location according to many other factors such as income, travel time and costs, the affordability and quality of the home and neighborhood, and closeness to good schools, etc. Once the locational decision is made, the home and anchor locations can last for many years and influence many other trip purposes.

For higher education, a student may choose to move to a distant institution or choose a nearby institution to keep living at home. Similarly, a new locational decision may not be about finding a new home; an existing home location may be the basis for finding work. Often a person does not want to move, so the locational decision means finding a job with an acceptable commute.

Sometimes people no longer have an anchor trip at all (for example, due to retirement). They may continue to live in the same location out of inertia, a desire to continue involvement in a community, or to remain in a preferred neighborhood. Alternatively, they may take advantage of more freedom of location, and move to a new location to be close to their children, or move to a retirement community of some kind, or to a place they like.

Locational decisions are important because they change how cities work over long periods of time. People will consider locating in Walkable Neighborhoods if the travel time for the anchor trip is acceptable.

Search for Other Anchors

This research also looked for other purposes that qualify as anchor trips. Research on dwell time at destination and number of trips could indicate non-work anchor trips. The NHTS data file provides insight into both trip purpose (coded whyto) and dwell time at destination by minute (dwell time).

Dwell times (recorded in one-hour intervals up to fourteen hours) are aggregated by purpose, number of trips, and travel time. Figure 1, displaying number of trips by dwell time at destination, shows eight purposes are participated in by enough people for over four hours of dwell time to be considered as possible anchor trips. As expected, *work* is the only purpose of any significance that takes place for four or more hours and had the most time at destination, up to fourteen hours.

The work trip is clearly the major anchor trip purpose. The number of people spending one to eight hours at work is about the same per hour, then reached a peak at nine hours, after which time at work declines steadily (see Fig. 1, line 1 in blue).

The next most common trip with long dwell times, *attend school as a student* (Fig.1, line 3), is a possible anchor trip, but with numbers well below the work trip. *Volunteer activities* (Fig.1, line 2) and *religious or other community activities* (Fig.1, line 13) did not last over eight hours.

Other trips are clearly not anchor trips; they have a precipitous drops in the number of trips by purpose after one hour of dwell time, particularly four short trips: *Buy goods* (Fig.1, line 6), *Buy meals* (Fig.1, line 8), *Other general errands* (Fig.1, line 9), and *Buy services* (Fig.1, line 7, number not shown on line).

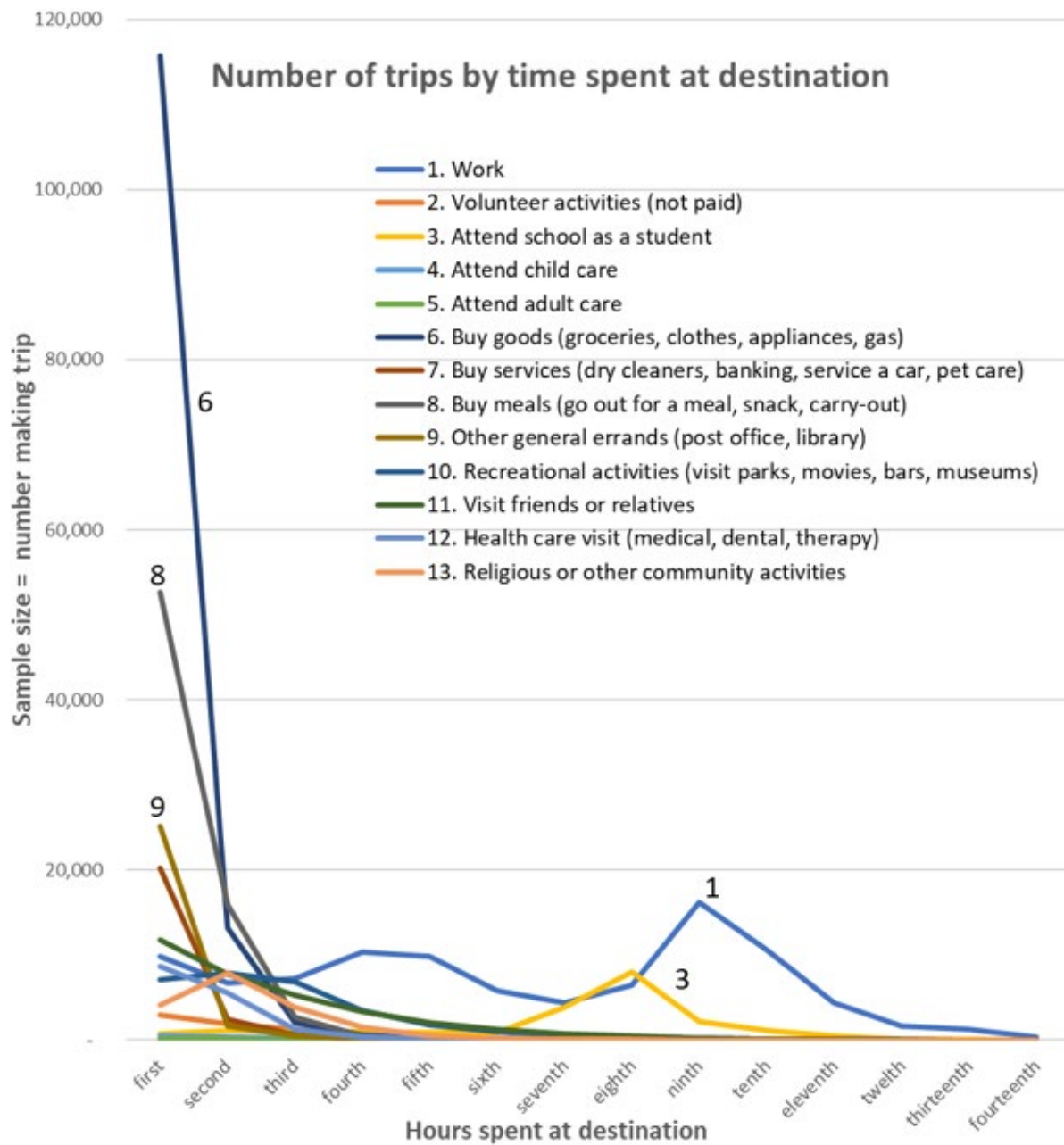


Figure 1. Number of Trips by Time Spent at Destination

Thus, this research does not find evidence of statistically frequent anchor trips besides *work*. Of the various potential anchors, only *attend school* is frequent enough to potentially be considered.

This research also examines travel time to various purposes by dwell time. Some purposes show a correlation between purposes that involve a little more travel time and spending more time at the destination. Three purposes showed dramatic increases in travel time for more time at destination: *Health Care*, *buy goods*, and *Recreational activities*. *Childcare* went up to ten hours with actually declining travel time, perhaps as result of small sample size. These infrequent trips with long dwell times fell between the frequent four short trips with short dwell times and the work trip with long dwell time and high frequency.

Work Trip

The survey shows that *work* is the only major anchor with a long travel time and a long duration at destination. The work trip is 20 percent of home round trips and 23 percent of total travel time. The average work trip took 25.2 minutes with a median time of 15 minutes, indicating that most workers had a commute time significantly lower than the average and a few had very long commutes.

The average *work* trip time in Table 1, which used a different source than the home round trips table (Table 3), is 24.1 minutes. The other six surveys had commutes ranging from 21.5 to 24.6 minutes. The long time spent at work and the importance of the income often justify a longer trip than other purposes. However, a quick trip to work is still an anchor trip.

The long time for the work trip supports transit and walking in old Walkable Neighborhoods—which are located close to employment centers, downtowns, and large institutions—with commute times by sustainable modes comparable to driving. Transit is slower but the distances are shorter. If the distance is short enough to walk, the costs of auto ownership may be avoided with substantial savings.

However, the importance of the work trip may diminish. As commutes have become too long, work at home has increased. Technology for virtual meetings, remote desktops, and data exchange have improved; some workers just take their office computers home and keep going. The COVID-19 pandemic has greatly increased work at home in recent times, not to mention shifting other activities from destinations to home as well.

Short Trips

“Short,” as used here, means both short in time and frequency. Short trips are made to obtain *goods*, *services*, *meals out*, and *other*, all of which are for consumption, with short stays at the destination and more discretion about when and where to go than with an anchor trip.

These purposes use Gross Domestic Product concepts (goods, services, etc.) rather than the character of the trip itself for decisions about trip making. Instead, people probably think in terms of errands and shopping without distinguishing among goods and services.

Short trips are essential when comparing suburbia with Walkable Neighborhoods. As density over a walkable area increases above a minimum threshold of the population, walking distances and walk times decrease and walk-in customers and transit ridership increase.

Individually, each short-trip purpose takes less time than the work trip, but combined, they make up over half of all trips, and the most total travel time at 45 percent. Their aggregate average time is 17.5 minutes and the median is ten minutes.

As density and walkability increase, walking trips can replace auto trips, with trips by sustainable modes reaching 60 percent or more of total trips in Walkable Neighborhoods. People in Walkable Neighborhoods, in fact, may have higher housing costs because of the locational advantages in walkability. Additionally, as density increases, business and transit respond to demand for short trips without distinguishing among the four purposes—*goods, services, meals out, and other*.

Short trips may not factor heavily in locational decisions. Though they still dominate the number and total time of all trips, they are likely to develop after deciding the home location. People may know about a neighborhood's reputation but know little in detail about the area they have just moved into. As they live there, they learn more about available destinations and become more efficient at making local trips. They look for closer stores and restaurants, or find the quality they want farther away and take more time to get there.

Given their statistical importance, this study identified the shortest trips in NHTS 2001, 2009, and 2017, CHTS 2013, and ATUS 2012, 2016, and 2018. In NHTS 2017, short purposes include (as shown in Table 3 on home round trips) *buy goods (groceries, clothes, appliances, gas), buy meals (go out for a meal, snack, carry-out), other general errands (post office, library), and buy services (dry cleaners, banking, service private vehicle, pet care)*. The other surveys used other concepts like *coffee/ice cream/snacks (a favorite), drive-through other, household errands, routine shopping, drive-through meals, eating and drinking, grocery shopping, purchasing food (not groceries), household activities, financial-banking-real estate services, and using household services*.

Table 4. Seven Estimates of Short Trips

	Number of Trips	% of Trips	Average Trip Minutes	% of Total Travel Time
NHTS 2001	151,213	39.3%	15.2	30.6%
NHTS 2009	292,645	41.6%	14.7	31.9%
NHTS 2017	256,130	50.8%	17.5	41.2%
CHTS 2013	70,864	27.0%	14.7	22.6%
ATUS 2012	174,890	35.5%	14.4	29.6%
ATUS 2016	193,358	36.4%	13.7	29.7%
ATUS 2018	203,580	38.0%	14.2	31.6%
Unweighted average			14.9	

Number of trips is in thousands.
 Source: S3 Appendix ATUS Purpose and time.xlsx.

The CHTS showed the lowest short trip percentage. The ATUS 2016 had the fastest short trips at 13.7 minutes. The NHTS 2017 reported the highest total travel time for short trips. Regardless, short trips still cluster as a useful concept relative to anchor trips and longer trips.

Longer Trips Mixed with Short Trips

Short trips, as reported in the surveys, are broadly defined. Indeed, the above section included some purposes that are, in fact, not short trips; they are longer trip purposes that the walkable area does not need to support with a short time. Longer trips should be taken out of overly broad short trips, if possible.

Buy goods: short and longer

Buy goods without the longer trips will be called *short buy goods*. *Short buy goods* could include trips to purchase groceries, drug stores, and hardware/small building supplies. *Long buy goods* would include office supplies, appliances, furniture, major electronics, and other big-ticket items, fancy shops/boutiques, regional shopping malls, and downtown specialized shopping areas.

The CHTS makes a useful distinction between *Routine shopping* (groceries, clothing, convenience store, household maintenance), which amounts to 15.6 percent of trips and 13.5 minutes on average, and *special shopping* for major purchases and specialty items like appliances, electronics, new private vehicles, and major household repairs, amounting to 1.2 percent of trips and 17.2 minutes. Similarly, in the ATUS, *grocery shopping* is distinct from *buy goods*, and useful for defining short trips. The ATUS splits *weekly and convenience shopping* (e.g., bread, milk) or *going to a corner store* from longer short trips like *comparison goods shopping* (e.g., furniture, appliance, clothing); and *specialty goods shopping* (e.g., niche markets, boutiques).

Based on CHTS, this research allocates 1.2 percent of shopping to *long buy goods*.

Buy services: short and longer

Buy services in NHTS 2017 is a category that combines short and longer services, with only one clearly *short service* trip: using an ATM. *Longer service* trip purposes could include somewhat frequent errands such as *dry cleaning* and *pet care*. Even longer, less frequent *longer service* trips could include financial, real estate, insurance, legal, government, marriage, and death services.

The CHTS 2013 is the only survey to report the ATM trip separate from banking, with *drive-through other (ATM, bank)* coming to 0.6 percent of trips and 10.8 minutes per trip. Based on CHTS, this research allocates 0.6 percent of services to *short services* and the rest to *longer services*.

Longer Trips

Trip time occurs along a spectrum, so the line between short and long is not distinct, though still useful. Longer trips are not necessarily particularly long, just longer and less frequent than short trips, with 30 percent of trips and 36 percent of travel time falling into this category. These disparate purposes only have longer travel time in common, with average travel times of 14 minutes and up, an aggregate average time of 26.2 minutes, and medians of 14 minutes and higher. The longer travel time means individual are likely to have to go outside the neighborhood to achieve the trips purpose, and that the trips are, therefore, less walkable. By the same token, the lengths may also suggest the use of slower sustainable transportation modes (i.e., transit).

There are nine longer purposes from Table 1, listed also below:

Visit friends or relatives

Recreational activities (visit parks, movies, bars, museums)

Health care visit (medical, dental, therapy)

Attend school as a student

Religious or other community activities

Work-related meeting / trip

Volunteer activities (not paid)

Attend childcare

Attend adult care

Based on the above discussion, this research also adds:

Longer buy goods

Longer services

Unmixing Longer Trip Purposes

Longer trips have the same problem as shorter trips in that they include significantly diverse purposes in one broad category. Standard deviation measures how much travel times are dispersed or concentrated around the average. A small deviation indicates a clustering of travel times and a specific trip purpose. A large deviation and large differences between standard deviations and the median may indicate different specific purposes lumped together. Upon completing this analysis, the four longer trip purposes with the largest standard deviations (32.8, 32.8, 31.5, and 24.5, respectively) also had the longest trip times (over 24 minutes): *work-related*, *recreation*, *visit friends*, and *health*.

However, trip purposes with similar frequency, average travel times, and standard deviations could still be combined as a single purpose. Apparently dissimilar purposes may be functionally similar when analyzing mobility. This research's analysis is concerned with functional similarity for trips in urban systems, not an elaboration on specific purposes.

Despite the large standard deviation, the *work-related* category still seems likely to be one purpose with too few longer trips to be worth special attention. *Health* also functions as one purpose.

Recreational activities

Recreational activities (visit parks, movies, bars, museums), in NHTS 2009, is composed of five purposes:

- *Rest or relaxation/vacation* (42.3 minutes)
- *Go out/hang out: entertainment/ theater/ sports event/go to bar* (24.6 minutes)
- *Social/recreational* (25.3 minutes)
- *Social event* (23.4 minutes)
- *Visit public place: historical site/museum/park/library* (22.3 minutes)

The much longer time devoted to *rest or relaxation* indicates a different trip purpose from the other four shorter purposes. Indeed, it could be categorized as part of *excursions*, which could be defined as having a half day or more of trip and activity time. The shorter trip purposes could be defined as *informal social trips* of a half day or less. *Excursions* are likely to have a different character and less frequency than *informal social trips*. The ATUS reported *relaxing and leisure* at 13.2 minutes and *socializing and communicating* at 16.2, helping further define *informal social trips*.

NHTS 2009 also contained a hard-to-place purpose, *attend funeral/wedding*, with a length of 35.8 minutes that indicates it would fit with excursions.

Multi-Purpose Home Round Trips

A multi-purpose home round trip has two or more purposes. Combining trip purposes can reduce trip time per purpose. While most home round trips are single purpose, there are still many that are multi-purpose. A person may accumulate some errands before deciding that, combined, they are worth the trip time, shortening travel time per trip. *Meals out* and other short trips lend themselves to multi-purpose home round trips, both as part of a *work* or *education* trip or as an errand trip.

Walkable Neighborhoods usually cluster trip destinations in a central area, improving efficiency for multi-purpose trips, like shopping and errands.

This research found no data in the literature on home round trips in general, let alone on multi-purpose home round trips. The literature uses a broader concept that includes all multi-purpose trips in “trip chains” or “tours,” usually in the context of quantitative methods, models, private vehicles, and miles.¹⁷ Activity-based computer modeling is beginning to use tours. San Diego, for example, still uses a traditional four step model, which does not model tours, but is also developing an activity-based model that would project tours (<http://www.sandag.org/index.asp?subclassid=120&fuseaction=home.subclasshome>).

Tours

A few discussions of chains or tours in existing literature looked at home round trips. Krizek, for one, studied the concept of neighborhood accessibility (NA) in seventy neighborhoods of Puget Sound for ten purposes. He defined NA in terms of density, land use mix (local goods and services), and street patterns (block size). He included home round trips in NA and argued that analysis of one way trips from a to b did not consider the chained nature of most travel. Multi-purpose home round trips reduce time per errand. Households living with higher NA made more multi-purpose round trips for work and maintenance (personal, appointment, and shopping) with shorter, faster trips than those in low-NA areas. He advocated the importance of multi-purpose home round trips facilitated by mixed use for achieving acceptable trip times.¹⁸

NHTS 2009 on Tours

NHTS 2009, unlike NHTS 2017, contained tour data.¹⁹ The NHTS 2009 had three types of anchor locations—home, work, and other—in various combinations (such as home-to-home). The NHTS anchor activity time was anything thirty minutes or more. The “other” category included all purposes or destinations besides home and work. “Stops” were less than thirty minutes. This research analyzed tours that included the home (home-to-home, home-to-work, work-to-home, home-to-other, and other to home), which had 130,112 records.

Time per Stop, Home-to-Home Tours.

NHTS 2009 reports time per stop, number of trips, and number of stops on home-to-home tours. Figure 2 shows data for up to six stops (seven or more stops only occur in 0.3 percent of total trips). About 61 percent of the trips had only one stop, devoting thirty-eight minutes to the one purpose. As the number of stops increased, total time went up but time per stop decreased rapidly. Tour data shows substantial time savings with more stops. For example, at five stops, each stop took only seventeen minutes.

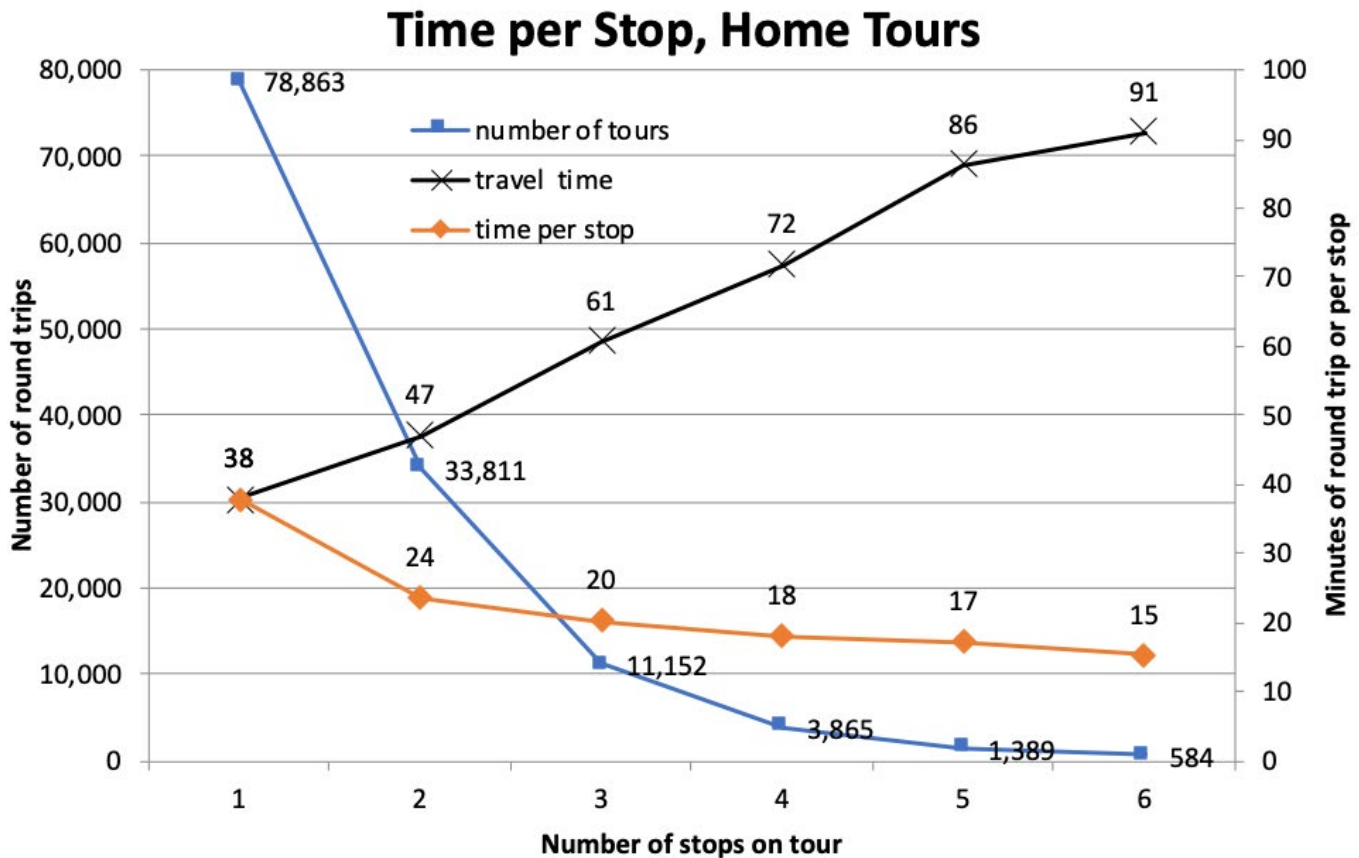


Figure 2. Time per Stop, Home Tours

Home-to-Home and Linked Tours

A home-to-home tour is one multi-stop trip from home and back with no work or other NHTS anchor. A linked tour is two multi-stop trips—first from home-to-work, then from work-to-home—and the same for home-to-other and other-to-home.

The number of home-to-home trips is 90,261 in NHTS 2009, and the number of linked tours is much larger at 252,713. The travel time for home-to-home is also much shorter, though this is irrelevant as one trip would logically be shorter than two. The number of home-to-home tours drops off quickly to forty minutes, while linked tours take much longer, peaking at thirty minutes, declining rapidly to seventy minutes, and then declining slowly to two hours.

Home-to-home tours average fourteen minutes and the linked tours average forty-one minutes. The home-to-home tour median is ten minutes and the linked tour median is thirty minutes. Linked tours are more than three times as long, probably because they involved a long *work trip* while the home-to-home trips probably involved more *short trips*.

Further, the tour data is consistent with other data showing that the *work trip* takes significantly longer than other trip purposes.

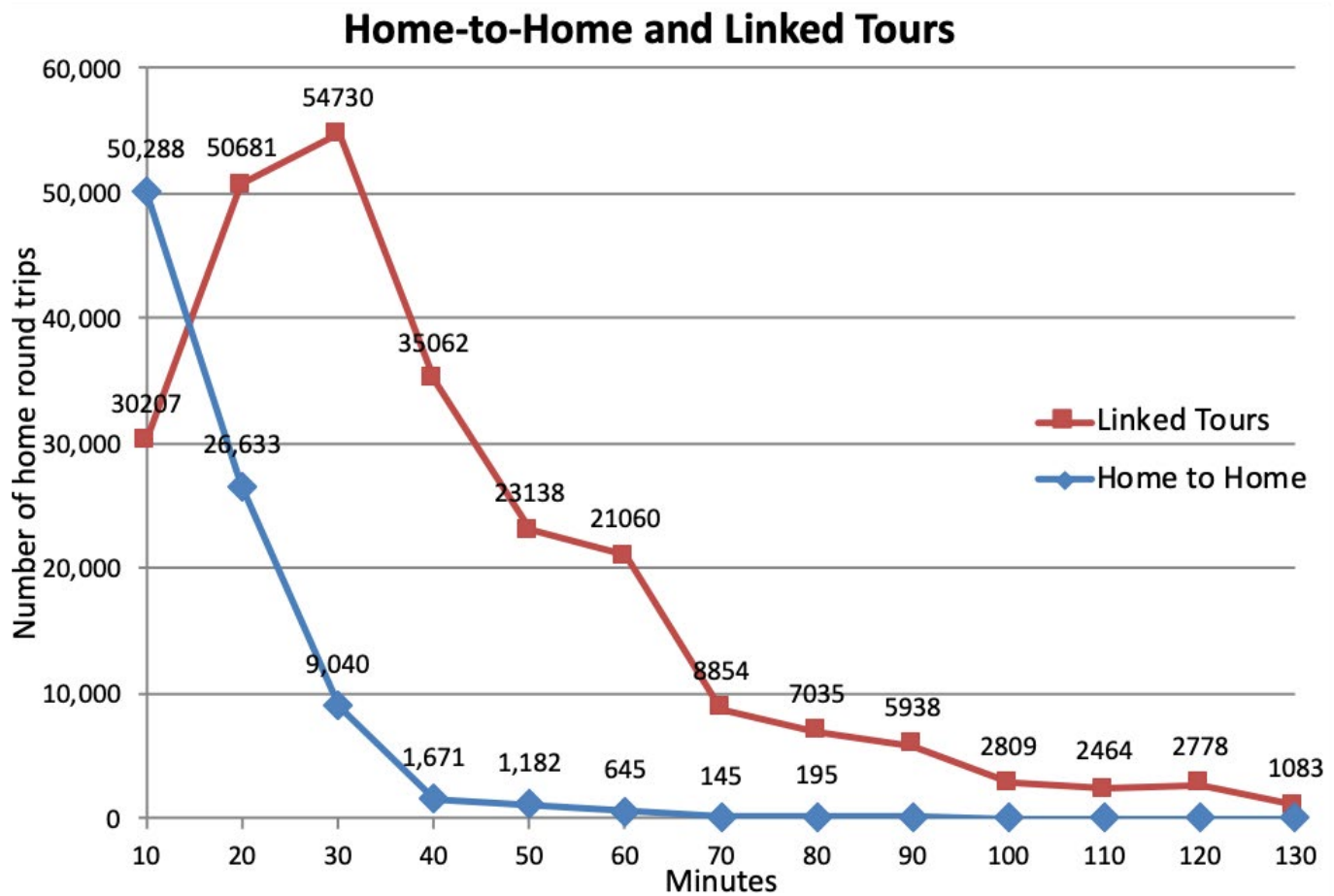


Figure 3. Home-to-Home and Linked Tours

Tour Purposes

NHTS 2009 also displayed data on thirty-one trip purposes for tours. For home-to-home tours, the top nine purposes ranged from 23 percent down to 2.5 percent of the total. They are as follows:

- *Buy goods: groceries/clothing/ hardware store;*
- *Serve passenger;*
- *Go to gym/exercise/play sports;*
- *Buy services: video rentals/dry cleaner/post office/car service/bank;*
- *Pet care: walk the dog/vet visits;*
- *Get/eat meal;*
- *Shopping/errands;*

- *Visit friends/relatives; and*
- *Buy gas.*

This list is different from the NHTS 2017 list. *Go to gym/exercise/play sports*, is a real trip. *Pet care: walk the dog/vet visits* mixes a trip with a not-a-trip trip.

For linked tours, eleven purposes had 2.5 percent or more of total trips. These purposes overlapped with those for home-to-home, containing *Go to work; Go to school; go to religious activity; medical/dental services; and Go out/hang out: entertainment/ theater/sports event/go to bar.*

BATS on Tours

As with NHTS 2009, the Bay Area Transportation Survey (BATS, 2000)+ of the San Francisco Bay Area Metropolitan Transportation Commission provides ideas about multi-purpose trips.²⁰ BATS states that the data shows the propensity of workers and students to travel directly from home-to-work or school in the morning as opposed to driving directly home during the evening commute.... Therefore, the number of people traveling directly from home-to-work is 14.5 percent higher than those traveling directly from work-to-home. This reflects the increased willingness of individuals to make intermediate trips during the commute home (to stop at the grocery store or gym, or for a meal, etc.) as opposed to making these stops on the way to work or school.

“The largest sub-group of non-home-based trips are shop (other)-to-shop(other) trips... The second and third largest subgroups are work-to-shop (other)...and work-to-social/recreational... The majority of work-to-shop (other) trips (54.3 percent) are comprised of shopping away from home activities... This includes midday work-to-shop trips as well as stops at the grocery store at the end of the workday. Approximately 28 percent of work-to-shop (other) trips are for trips from work to personal services such as banking, dry cleaning, or government services. Work-to-social/recreational trips are primarily made up of work-to-meal trips (70 percent), which typically represent midday work-to-lunch trips. Another major contributor to work-to-social/recreational trips is work-to-recreation/entertainment trips (16 percent). Since this category includes exercise, midday and post-work trips from work to the gym likely make up the plurality of work-to-recreation/entertainment trips.”

This research analyzes BATS data on the purposes of stops on tours in Alameda County.

Table 5. BATS Data on Tours

Shop	5	32%
Maintenance	6	21%
Eating Out	7	18%
Visiting	8	7%
Discretionary	9	21%
All		100%

Source: Shimon Israel, staff analyst, MTC, email and calls, November 2013 to July 2014.

Using Pivot Tables to Unmix Trip Purposes

Buy Meals

An Excel pivot table uses a matrix of one variable in the rows and another in the columns with the same type of data (e.g., average travel time for trip purposes, or number of trips for trip purposes). The variables used in this research are *whyto* (the destination purpose of a trip) in the rows and *whyfrom* (the destination of the previous trip—that is, the origin of the new trip) in the table where a *whyto* row crosses a *whyfrom* column, that cell shows the purpose of the origin to the purpose at the destination.

This terminology can be confusing because the origin uses terms that are usually understood as destinations.

The table also shows the totals for each purpose at the ends of the rows for *whyto* and at the bottom of the columns for *whyfrom*.

This research also looked at *buy meals* because it is a large number of trips and has a travel time of 18.3 minutes (as shown in Table 1), which is longer than the other short trips, *buy goods*, *buy services*, and *other general errands*.

This research wanted to see if the pivot table would support grouping the longer *buy meals* trips separate from the shorter to see if the aggregate *buy meals* mixes different trip purposes. The CHTS provides a clue. The CHTS splits *buy meals* into *Drive-through meals (snacks, coffee, etc.)* (with 13.6 minutes) and *Eat meal at restaurant/diner* (with 18.8 minutes).

The pivot tables are not included in this research but are available from this research. In practice, each workbook had a number of worksheets going from raw data to the final analysis. Table 6 provides an example of one worksheet from a pivot table workbook.

Table 6. Sample Pivot Table

Pivot table whyto by why from, minutes																			
	01	03	04=Work-r	05	06	07=Change	08=Atten	09	10=	11=	12=	13=Buy meals	14=	15=Recreatio	16=	17=Visit frie	18=	19=.	
Sum of W	Column Labels																		
Row Labels	1	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Grand Total
01=Regu	1											x							
03=Work	3																		
04=Work	4											71,476							
05=Volu	5																		
06=Drop	6											x							
07=Chan	7											112,518							
08=Atter	8																		
09=Atter	9																		
10=Atter	10																		
11=Buy (11																		
12=Buy s	12																		
13=Buy i	13		279,773			233,857						745,004		1,257,425		957,684			3,473,743
14=Othe	14																		
15=Recr	15											1,304,745							
16=Exerc	16																		
17=Visit	17											1,767,201							
18=Healt	18											x							
19=Relig	19																		
Grand Total												4,000,944		total travel time, longbuy meals					7,474,687
														total trips, longbuy meals					290,159
														average travel time, longbuy meals trips					25.8
														total travel time buy meals					25,496,479
non-home based, exclude													subtract long TT from tota TT					18,021,792	
same for short buy meals.													total trips buy meals					1,348,065	
													subtract longTs from total Ts					1,057,906	
													average travel time, short buy meals trips					17.0	
													longbuy meals % total buy meals					22%	

average travel time for longbuy meals: minutes times number =total travel time (sum all times and trips); divide by all trips.

To get to this sheet, the first sheet has the matrix of average trip minutes and the second has the matrix for number of trips. These sheets reference hidden data and are difficult to work with. They are copied to sheets with values only for minutes and number of trips.

For minutes, trips from various origins to go buy a meal took less time (18.4 minutes on average) than trips from a meal to various destinations (20.1 minutes). People also made fifty-six more trips going to meals than going from their *buy meals* location to their next purpose.

This research stipulate that *long buy meals* trips amount to twenty minutes and longer.

Whyto had five cells over twenty minutes and whyfrom had eight. Three whyto cells had short times; this research eliminated the corresponding whyfrom. For example, from whyfrom 13 to whyto 1 took 20.7 minutes, but whyto 1 to whyfrom 13 took only 18.5 minutes. This is too short, so this research also ignore cells 13 to 1. This leaves ten cells where all had long trip times.

Successive sheets estimate total travel time, number of trips, and average trip time for the ten cells with *long buy meals* trip times, arriving at an estimate of 25.8 minutes.

The average time for *short buy meals* is a residual from subtracting all the longer trips, coming out at 17 minutes. *Short buy meals* are now similar to buy goods (at 17.4 minutes) and other errands at (17.3 minutes).

While useful for adjusting the Final Table (Table 8), the pivot table cannot distinguish within a cell whether the *buy meals* are, in fact, *fast food* or *restaurant*. The pivot point analysis is less useful because the underlying data lacks this distinction. Future research with data on *fast food buy meals* could find shorter trip times. This category would include take out, pick up, delivery, fast food, drive through, snacks, coffee, and ice cream—concepts which were used in some surveys. *Longer buy meals* would be restaurants and dining out.

Change Type of Transportation

Change type is a non-trip trip and, therefore, is excluded from home round trips in the final table (Table 8). However, this research wanted to see if a pivot table would reveal more about the real purpose of this type of trip. To investigate, the research used a pivot table using 917,811 records from the NHTS 2017 trippub file to populate whyto and whyfrom.²¹ The results show that 29 percent of people going to a change type destination are coming from home, 10 percent are coming from work, and those coming from all other origins are in lesser numbers, with one exception. Eighteen percent of trips come from change type as the purpose for going to the origin to the destination of the new trip, which is also change type. An example would be changing from a bus to a train. The table shows where those completing a change type trip are headed to next, with similar results: 30 percent are headed home, 8 percent are going to work, and most other destinations are in lesser numbers. The most important exception is the 18 percent that are going from change type to change type.

Serve Passenger

Serve passenger accounts for 6 percent of all trips and is a non-trip trip, and is, therefore, excluded from home round trips in the final table (Table 8). Here, this research investigate what the real purpose of the driver is by looking at the purposes of the passengers. As with *change type*, NHTS 2001 provides data on the purpose of passengers, and this research wanted to see what a pivot table would reveal.

The [trippub.csv](#) file reports 184,575 trips by passengers. Their purposes are the real purposes of the drivers. In 4.8 percent of cases, the purpose of the passenger is *serve passenger*, which does not make sense (highlighted in the table).

Passenger purposes are reported in Table 7. The largest purpose, accounting for 33.8 percent of this category, is to get home. This is not a real purpose but can be assumed to be related to the purpose of the passenger for leaving home earlier in the day. No other purpose stands out. The major purposes of passengers in declining order are *buy goods*, at 15.3 percent of trips, then *buy meals*, *recreation*, *visit friends*, and *attend school*, with the rest falling under 5 percent. Only 2.4 percent of passengers are going to work.

One passenger purpose within this category, *change type of transportation*, is not clear; it might refer to changing from an auto to transit.

Table 7. Serve Passenger Pivot Table

Serve Passenger Pivot Table Whyto:	Passengers		Next Purpose of Drivers After a Serve Passenger Trip	
	number	percent	number	percent
<i>Home</i>	62,349	33.8%	22,579	41.9%
<i>Work at home</i>	254	0.1%	830	1.5%
<i>Work</i>	4,463	2.4%	5,247	9.7%
<i>Work meeting / trip</i>	881	0.5%	318	0.6%
<i>Volunteer activities</i>	1,226	0.7%	312	0.6%
<i>Serve passenger</i>	8,902		7,221	13.4%
<i>Change type of transportation</i>	1,896	1.0%	325	0.6%
<i>Attend school</i>	10,006	5.4%	934	1.7%
<i>Attend child care</i>	879	0.5%	131	0.2%
<i>Attend adult care</i>	102	0.1%	17	0.0%
<i>Buy goods</i>	28,318	15.3%	4,814	8.9%
<i>Buy services</i>	3,957	2.1%	811	1.5%
<i>Buy meals</i>	20,968	11.4%	3,991	7.4%
<i>Other general errands</i>	4,892	2.7%	966	1.8%
<i>Recreational activities</i>	10,957	5.9%	1,472	2.7%
<i>Exercise trip</i>	3,730	2.0%	834	1.5%
<i>Visit friends or relatives</i>	10,493	5.7%	1,372	2.5%
<i>Health care visit</i>	4,015	2.2%	956	1.8%
<i>Religious, other community</i>	6,287	3.4%	751	1.4%
Total	184,575	100.0%	53,881	100.0%
Sample size, data used	792,357		792,357	
% of sample who are passengers/drivers		23.3%		6.8%

Source: Serve passenger NHTS 2001 trippub 923573 rows from NHTS 2001 trippub.csv/xlsx

Some of this research' hypotheses proved false, here. For example, this research expected passengers to be dropped off at transit, but the number of *change type* trips is small. Similarly, they did not expect many people would be getting rides for *short trips*, but the four short purposes (*buy goods*, *buy services*, *buy meals*, and *other general errands*) totaled 31.5 percent of passenger purposes, the largest percentage of any category.

The data also indicates the next purpose of the drivers. By far, the largest destination of drivers after a *serve passenger* trip is home plus work at home at 43.4 percent. The next most common purpose of the driver, at 13.4 percent, is another *serve passenger* trip, such as to pick up and then drop off another passenger. No other purposes after *serve passenger* stand out. In declining order, they are *work*, with 9.7 percent, followed by *buy goods* and *buy meals*.

There are many more passengers than drivers, a fact probably explained by carpooling and group trips with family or friends.

From Initial Table to Final Table

Table 8 shows adjustments to the initial table (Table 1) following the sequence of the analysis above to add up to the same total as the Table 1 (919,206 trips).

Table 8. From Initial Table to Final Table

Trip purpose	Number of Trips	% of Trips	Average Trip Minutes
Step by step from initial table to final table for the same number of trips.			
Trips from Initial Table	919,206	100.0%	22
Not home round trips			
Estimated at 20% of work trips	19,758	2.1%	25
20% of work trips moved here			
Travel (overnight or more)	unable to ascertain		
Not-a-trip trips		0.0%	
Regular home activities (chores, sleep)	311,916	33.9%	23
Work from home (paid)	6,474	0.7%	19
Serve passenger	56,326	6.1%	18
Change type of transportation	9,437	1.0%	46
Auto per se-gas (from short buy goods)	4,756	0.5%	17
Auto per se-service a car (from short services)	361	0.039%	16
Exercise (go for a jog, walk, walk the dog, go to gym)	31,186	3.4%	18
Total not-a-trip trips	420,456	45.7%	
Total, not home round trips + not-a-trip trips	440,214	47.9%	
Home round trips			
Anchor trips	79,031	8.6%	25
Home round work trips (80% of work trips)			
Short trips			
Short buy goods (groceries, clothes, appliances, gas) minus 3.6% to auto per se	126,029	13.7%	17
Short services (ATM) minus 0.039 to auto per se	141	0.0%	16
Short buy meals (go out for a meal, snack, carry-out)	56,081	6.1%	17
Other general errands (post office, library)	28,007	3.0%	17
Total short trips	210,258	22.9%	17

Trip purpose	Number of Trips	% of Trips	Average Trip Minutes
Longer trips			
Visit friends or relatives	37,659	4.1%	29
Recreational activities (visit parks, movies, bars, museums)	31,259	3.4%	31
Attend school as a student	22,102	2.4%	21
Health care visit (medical, dental, therapy)	16,761	1.8%	27
Work-related meeting / trip	11,597	1.3%	32
Religious or other community activities	18,693	2.0%	19
Volunteer activities (not paid)	8,330	0.9%	19
Attend child care	2,007	0.2%	20
Attend adult care	540	0.1%	24
Longer buy goods (1.2% of buy goods))	1,588	0.2%	17
Longer buy services (dry cleaners, banking, pet care) (minus 1.5% to per se and 0.6% from short services)	23,010	2.5%	16
Longer buy meals	16,157	1.8%	26
Total, longer trips	189,703	20.6%	25
Total, home round trips	478,992	52.1%	
Total all trips	919,206	100.0%	22
<i>Table has order of magnitude estimates.</i>			
<i>Source: National Household Travel Survey (NHTS) 2017, Federal Highway Administration</i>			

Table 8: From Initial Table to Final Table

^a Table has order-of-magnitude estimates.

^b Data for work trips are split between non-home and home.

^c This research did not estimate *overnight trips*.

^d This research estimates *non-home work* to remove them from home round trips.

^e Data for the two *auto per se* estimates are subtracted from their original location.

^f This study estimated not-a-trip trips to remove them from home round trips.

^g Pivot table split to *buy meals* which had combined short and long.

^h Data for the two *auto per se* estimates are subtracted from their original location.

ⁱ Data for *buy goods*, *buy services*, and *buy meals* are split between short and long.

Source: National Household Travel Survey (NHTS) 2017, Federal Highway Administration

The important findings are that 48 percent of trips were not home round trips and that short trips were 23 percent of total trips, with anchor trips at only 9 percent of trips. If the not home round trips were redistributed evenly, anchor trips about 16 percent. short trips about 44 percent and longer trips about 40 percent.

Mismeasurement

Because of mismeasurement, there is no useful information about home round trips for neighborhoods, let alone Walkable Neighborhoods. Table 8 does not allow conclusions about travel time budgets. Of the 919,000 trips in 2017 NHTS, 48 percent are clearly not relevant. Also, Home round trips still contain non-home round trips, overnight trips, and different trip purposes mixed together, so the total of irrelevant trips could be 60 percent or more of the total.

A major type of non-home round trip is the work round trip, taking the individual from the workplace and back to work without going home. Table 8 reduced work trips by a place-holder order-of-magnitude estimate. Other kinds of non-home round trip are mixed into home round trips with no way to estimate them.

An unknown number of *overnight away from home* trips are included in home round trips. This research did not estimate them.

A number of trips were classified as “not-real-trip trips”: *Regular home activities* and *Work from home* are excluded because the trip purpose does not require leaving home. Home activities do not require a trip because the person is already there. The 2017 NHTS trip purpose *exercise (go for a jog, walk, walk the dog, go to the gym)* seemed to refer mostly to loop trips, not-real-trips trips.

Serve passenger is not a real purpose; the real purpose is that of the passenger. Similarly, *Change type of transportation* is not a purpose; it is a stage on the way to a purpose.

Auto per se—time to get gas, service the vehicle, etc.—is not a real purpose; the purpose is to have a way to reach real purposes.

Furthermore, many categories lump together functionally different trip purposes into overly broad definitions. *Buy goods* and *buy services* are far too broad. *Buy meals* shows significant time differences related to associated trip purposes, and mixes frequent short trips for pick up and fast food with longer trips for less frequent sit-down meals at restaurants.

Reforming the Survey for Home Round Trips

A new survey instrument would allow deeper understanding of travel behavior and trip purposes.

Technology has revolutionized survey research on household travel behavior, lowering costs and improving quality. GPS devices worn by respondents greatly improve the ease and accuracy of trip logging, especially for door-to-door, multi-stage trips and short walk stages. Better travel time survey data should help understanding of neighborhood systems and comparing suburbia to Walkable Neighborhoods. Better data would help us understand how to attain mobility without owning an auto.

A reformed surveys should use these concepts:

Home round trip survey purposes and concepts
• Record time, mode, if serve passenger or serve another, single purpose or multi-purpose
• Anchor trips: work or other purpose, over 4 hours at destination, 4 or more days per week
• Work-related trips not to the usual work place
• Short buy goods and services trips; groceries, drug store, hardware, ATM, post office, library
• Longer buy goods trips; shopping, furniture, appliances, expensive items, special shops
• Longer buy services trips; financial, insurance, real estate, governmental

• Short buy meals trips; take out, fast food, informal meals out
• Longer buy meals trips; restaurant, special meals out
• Child education and child care trips by children and adults
• Education trips by self-mobile teens and adults
• Health care; medical, dental, therapy
• Religious or other community activities
• Volunteer activities
• Visit friends or relatives
• Trips for recreation; parks, movies, bars, museums
• Trips for exercise; indoor and outdoor (not exercise itself)
• Auto per se activity time and trip time
• Reasons for owning or not owning an auto

Education should include infant and preschool care outside the home. *Education* should be divided between the younger children who need to be accompanied on the trip and teens and adults who can travel on their own to secondary school or higher education.

Campuses can function similarly to Walkable Neighborhoods; College students should be included in the survey because they are likely to make a high number of walking trips.

Exercise trip should be included as a purpose. NHTS 2001 and NHTS 2009 reported real trips for exercise as *Go to gym/exercise/play sports*. However, in NHTS 2017 these real trips are folded into *Exercise (go for a jog, walk, walk the dog, go to the gym)*, which mixed loop trips in with the real trip *go to the gym*. The CHTS also showed real trips under the category of exercise, both *outdoor exercise* and *indoor exercise*. The new survey needs to exclude loop trips and report only trips to reach exercise locations.

Time should be door-to-door time including all stages. Time is too often measured as auto time without considering that a walker can be a hundred feet along by the time a driver turns on the ignition.

Auto per se does not exist in Walkable Neighborhoods. Surveys should report *auto per se* separately from real trips and allocate the time to trips using the auto. Then, time-by-purpose can be realistically and fairly compared to that in Walkable Neighborhoods.

Future research must also explore how *serve passenger* functions in Walkable Neighborhoods. *Serve passenger* takes a large amount of time in suburbia but may take little in Walkable Neighborhoods. In future research, *Serve passenger* trips should be redefined as *help another's trip* and would not be recorded as a purpose. The trip would be assigned, rather, to the purpose of the person being helped. For example, in Walkable Neighborhoods, a *help another's trip* assigned to *education* could refer to walking a child to school.

Besides reporting on individual purposes, the survey would look at total trip time to compare total time for high-speed cars in suburbia with slow-speed sustainable modes in Walkable Neighborhoods.

A longer travel time may not mean less mobility. Transit riders could value their ride to read and relax, and walkers might value the time to be outside and exercise.

A reformed survey will also be useful beyond just comparing neighborhood systems. Rapid changes in travel behavior may be reducing auto dependency in general. Trips from the home may decline as fewer people go out for forms of entertainment which are being replaced by streaming at home. Bank visits decline as online banking and cell phone transactions increase. Retail and grocery trips are falling as e-commerce and home-delivery options provide a more convenient, reliable, and cost-competitive alternative to going to the store. Public cars make it possible to not own an auto and still make trips that otherwise require one.

The NHTS, CHTS, and ATUS should update, coordinate, and clarify their surveys. The NHTS and ATUS, as federal surveys, should use the same definitions and concepts as well as a common list of purposes and definitions of real trip purposes that apply in all kinds of neighborhoods and home round trips. The CHTS and other state surveys should be consistent with the federal survey's terms, from which they can elaborate further categories as needed. The ATUS provides great detail on activities but loses power by generating so many categories which have too few respondents for reliability and no data at all is reported. Travel related to caring for others in the ATUS should also be related to *serve passenger*.

Such a reframed survey would be so different from the existing household surveys that there would be discontinuity between them. The problem remains that those surveys have little to do with home round trips and neighborhoods. Some pilot research should test the value of the new information generated by a reformed survey, one focused on real household trip purposes, travel times, and sustainable modes. A reformed survey would help answer many questions not currently covered due to mismeasurement. A new survey would also over-sample existing Walkable Neighborhoods because so few exist.

An expectation of this research was that mobility would be very similar between suburbia and Walkable Neighborhoods, but mismeasurement prevented any findings. However, the research did find that much time spent on suburban trips (*auto per se, serve passenger*) would not be needed in a Walkable Neighborhood, indicating more mobility and more time for other things. Alternatively, there could be a human propensity to spend a certain amount of time each day travelling regardless of system, mode, location, culture, or economics. People may not want to save trip time, but to optimize it, taking more time to reach more preferred destinations. A reformed survey would help answer questions on mobility and propensity to travel.

Conclusions

The focus of this research to this point has been household travel surveys and their relevance for neighborhood systems, particularly Walkable Neighborhoods, using the definitions of this new field. Below, this research speculates broadly on issues of Walkable Neighborhoods and policy.

American Culture: Failure to ask

The major surveys to date have not asked the right questions for analysis of home round trips. They are not framed to provide understanding of neighborhood systems let alone help them become more sustainable. They do not consider the importance of short trips as density over a walkable area increases and the support they lend to a transition to sustainable modes. The major purpose of the surveys seems to be to model auto traffic.

Why have the surveys not asked the right questions? One reason is that American auto culture lacks awareness of their non-monetary and external economic costs. There is little awareness of pricing reforms that would de-subsidize auto use and help make the economy more productive for all economic values. Elected officials have even less awareness of how to persuade a skeptical public that sees the costs of pricing reforms and not the benefits. Generally, people believe the economy goes up if the dollar goes up when, in fact, if external costs are included, the whole economy may be shrinking.

The auto culture supports ineffective policies like expanding highways for faster speeds or bigger intersections to improve level of service. These policies usually lead to longer and faster trips with no improvement in mobility, simply allowing more spreading out. Smart growth and housing subsidies may subsidize cars if the rent includes the cost of parking. Such projects, in fact, are often planned on suburban parking ratio requirements and oversupply parking. Charging separately for parking provides an incentive for less auto ownership if the surrounding land use supports sustainable modes. Discussions of walkability pay little attention to neighborhood systems, travel time budgets, and pricing reforms. There is concern about climate change, but a lack of awareness of the underlying economics behind it or of Walkable Neighborhoods as a solution.

Pricing reforms would internalize external costs of autos and benefit the whole economy. They would begin to restructure transportation and land use, reversing the biases of the 1920s onward, which artificially expanded suburbia.

Pricing reforms should include

- a gas tax high enough to cover public service costs of autos carbon and other pollution surcharges to pay the cost of the pollution;
- congestion tolls;
- cost-effective transit;
- stopping job increases in job surplus locations, which externalize housing costs and congest commute infrastructure;
- unbundling²² based on market demand or economic costs, whichever is greater;
- eliminating “free” parking using high-tech, easy-pay, demand-responsive meters;
- land-based finance (off-site exactions; dues/rents) for fast/frequent/free shuttles in dense

corridors;

- insurance and drunk/impaired driving reforms to enforce responsible driving;
- traffic calming road design; and
- “complete streets,” which generally reduce width for autos and increase space for pedestrians, bicycles, and landscaping on shopping streets.

Improving Old, Dense Neighborhoods

Old, existing Walkable Neighborhoods need to be understood not just as historic artifacts in a few big cities but as systems that work. Pricing reforms would radically diminish the high external costs of auto intrusion (traffic, congestion, safety hazards, barriers to crossing streets, transit slowed by cars, large areas of parking and streets, noise, pollution, etc.). These costs are imposed on the walking and biking population. Reduced auto intrusion would help increase sustainable modes, revealing the efficiency of the underlying system.

Auto ownership is an important issue in itself. The average cost of an auto can be assigned to the reasons for buying it, like cost per mile for the trip to work. After that, the marginal cost of more trips is very low, encouraging more auto trips. If trips that really need an auto, like certain longer trips, can be achieved instead by public cars, extra trips by autos can be avoided. The system uses more sustainable modes and becomes more sustainable and livable. Auto ownership is less needed, more expensive, and less functional than sustainable modes.

Already, despite the cars, high density neighborhoods in Boston and San Francisco achieve sustainable mode shares of over 60 percent of trips. This research predicts that these neighborhoods meet travel time budgets for short trips with a median of about ten minutes and an average of about fifteen minutes.

Bicycling

The discussion of short trips in this research largely focused on how far people walk. However, bicycling can easily extend the distance one can travel within the same travel time, enlarging the area possible for a Walkable Neighborhood. The distance could enlarge from a walking distance radius of about a half mile to one-and-a-half miles. Such a distance would allow more residents, resulting in more walk-in demand for local businesses. It would expand the area for denser development and reduced auto use. Europe has made remarkable progress promoting bicycling with well-used bicycle lanes and massive bicycle parking at transit stations. Bicycling is also increasing in some U.S. cities, particularly considering e-bike use. Clearly, bicycling can contribute to increasing sustainability in all kinds of neighborhoods.

Public Cars

Policy should promote public cars, which are especially likely to serve the role of the auto when other sustainable modes are too slow or difficult. The infrequent need for a public car reduces

costs compared to auto ownership. *Health care* trips, for example, are important and varied (e.g., emergency, urgent care, and scheduled appointments), involve possible physical difficulty traveling, and are often urgent. A taxi or shared ride can pick someone up at their home and drop them off right at an entrance of their destination, avoiding the need to hunt for parking and walk-in. Public cars may reduce the need for *serve passenger* trips. The increase in use of public cars in central area contributes to congestion, but most of the traffic is by autos. Pricing reform and other policies to reduce autos in dense neighborhoods would support public cars and reduce congestion.

Planning

Planning can improve walkability, decrease walk times, help bicycling, increase density, improve complementary features, promote more local businesses and transit ridership, and support living without owning an auto. Land use planning should not consider the smaller area covered in a median walk time. Instead, it should consider the longer distance, greater area, and larger population covered by the average walk time. Barriers to walking often prevent sustainable development adjacent to an attractive center. If the density exists, making pathways safer and more attractive can increase walking.

Suburbia

There are many ways for suburbia to become more sustainable. Suburbia dominates the landscape, and even small improvements over large areas can have big gains. Bicycling has less systemic potential in suburbia than Walkable Neighborhoods, but with the increased range made possible by e-bikes, along with in-fill and higher density development, it can be made less automobile-dependent. The increase in working from home also makes suburbia more sustainable. Short trips in denser suburban areas with local businesses may lead to shifts toward sustainable modes of transportation.

Advocacy

At the grassroots level, many organizations are advocating for pedestrians, two of which are America Walks (<http://americawalks.org/>) and Walk Score (<https://www.walkscore.com/>). America Walks provides documentation of many aspects of walking policy. Walk Score rates walking, bicycling, and transit options for ten thousand neighborhoods in three countries using walking time, assigning a higher score for destinations reachable within five minutes and declining to zero at thirty minutes. The website states:

Walk Score also measures pedestrian friendliness by analyzing population density and road metrics such as block length and intersection density. Data sources include Google, Education.com, Open Street Map, the U.S. Census, Localeze, and places added by the Walk Score user community (<https://www.walkscore.com/methodology.shtml>).

These organizations generally use fifteen minutes as an outer limit for walking time and ten minutes as a median walk time for Walkable Neighborhoods. However, neither they nor the national and state surveys provide the needed data on home round trips and Walkable Neighborhoods.

Neighborhoods are the largest land use in urban areas, and Walkable Neighborhoods reduce the social, economic, and environmental costs of mobility. Home round trips and short trips are important for understanding travel behavior in neighborhood systems, yet they have not been studied in large household surveys, let alone with Walkable Neighborhoods in mind. The problem of mismeasurement needs more awareness among academics, economists, planners, survey agencies, and elected officials. Better data can be used to improve all neighborhood systems and the use of sustainable modes of transportation.

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22. Unbundling means dividing a rent between living space rent and parking space rent, generally so the two add up to the bundled rent. However, they can also vary separately, based on separate markets.

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