



THE TRANSPORTATION FUTURE:

TRENDS, TRANSPORTATION, AND TRAVEL

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Chapter 1: Introduction

Transportation is undergoing a period of significant change in the United States, evident by changes in transportation demand. Many factors influence transportation demand and in different ways. Some trends increase demand; some decrease demand; and others shift demand across modes, time of day, and geographies. Technological advances, coupled with demographic and economic trends, have made it incredibly difficult to predict the transportation future. Furthermore, new industries are evolving, while old ones are becoming obsolete. The COVID-19 pandemic is an unprecedented event, and future impacts on transportation and travel (if any) are unclear. While technology increasingly allows people to work remotely, many workers are still geographically tied to their workplaces. eCommerce and on-demand shipping are decentralizing warehouses and increasing last-mile deliveries through various methods (e.g., drones, autonomous robots, and couriers). Automation, artificial intelligence, and connectivity are changing the way the transportation system is used, operated, and managed. The only certainty going forward is that there will be change.

While there is so much more to say about other surface modes, such as transit, this report focuses primarily on trends in transportation and travel in relation to demand for travel on our Nation's roadways. This report provides an overview of current trends in transportation and travel, broken down into the following chapters:

- **Chapter 2: Population and Geography:** Discusses trends in population growth, demographic shifts, and changes in settlement patterns.
- **Chapter 3: Vehicles and Drivers:** Provides insight of trends in vehicle ownership, fleet composition, and driver's license rates.
- **Chapter 4: Industry and Workers:** Includes information about economic trends, industry trends, freight movement, industry and labor markets, income, and transportation costs.
- **Chapter 5: Travel Demand:** Discusses changes in travel demand, including overall demand, mode choice, and travel characteristics.
- **Chapter 6: Technology Trends:** Highlights advances in technology and resulting mobility opportunities and challenges, such as the growth in telecommunications, vehicle technologies, and changing transportation services and business models.
- **Chapter 7: Emerging Themes and Considerations:** Discusses broader emerging themes across demographic, economic, and technological trends and how they may impact transportation.

Key trends noted in this report by chapter include the following:

Chapter 2: Population and Geography:

- **Population growth:** While the U.S. population continues to grow, the overall population growth rate has slowed every year since 2015. Most population growth has been in the West and South.
- **Where people live:** While the focus is often on urban and rural areas, 42.6 percent of the population lives in areas categorized as suburban and small town.
- **Age matters:** Americans have continued to age, with the proportion of people ages 65+ growing faster than those younger than 30. The demand for transportation varies greatly based on age.
- **Race and ethnicity:** The U.S. population is also becoming more diverse. Increased diversity brings changes in where people live and how they travel.

Chapter 3: Vehicle and Drivers:

- **Vehicle ownership:** Vehicle growth has far outpaced the growth in U.S. population, workers, and households, more than tripling in the last four decades
- **Household fleet characteristics:** In 2017, sport utility vehicles (SUVs) made up 24 percent of the household vehicle fleet, which is an increase from 19 percent in 2009. A new safety feature or emissions standard implemented today would take at least 4–7 years before it is included in approximately 50 percent of the household vehicle fleet.
- **Driver licensing trends:** The number of people ages 65 and older has grown, as has the number and percent of older licensed drivers.

Chapter 4: Industry and Workers:

- **Vehicle miles traveled (VMT) and gross domestic product (GDP):** Total lane miles increased from 8.2 million miles in 2000 to 8.8 million miles in 2019. At the same time, total annual VMT increased from 2.8 trillion miles to 3.28 trillion miles.
- **Industry trends:** The U.S. transportation system moved 5.25 trillion ton-miles of freight valued at more than \$18.9 trillion in 2018; the highest share was moved by truck. Almost half of all ton-miles shipped by truck are at a distance under 500 miles. This proportion has remained steady from 2013–2018.
- **Jobs and workers:** In 2019, 63.1 percent of the population was in the labor force. Workers between the ages of 35 and 44 and 45 and 54 make more trips than workers in other age cohorts at an average of 3.85 and 3.76 trips per day, respectively.
- **How people work:** Just under 55 percent of workers in professional and technical occupations have the flexibility in their work start times compared to less than 30 percent of workers in manufacturing, construction, maintenance, and farming.

- **Income:** The percentage of the population in the labor force was 63.1 percent in 2019. Since 2009, the percentage of the household budget spent on transportation increased from 15.9 percent to 17.3 percent in 2019.

Chapter 5: Travel Demand:

- **Household travel demand:** Over the past five decades, household travel demand has consistently outpaced population growth.
- **Travel characteristics:** In 2017, the average trip length for all trips was 11.6 miles, while the average work commute was slightly longer at 12.2 miles. Travel party size for work trips by vehicle has increased slightly from 1.14 in 1995 to 1.18 in 2017.
- **Commute to work:** Commute travel time increased slightly from 25.2 minutes in 2010 to 26.9 minutes in 2019. Carpooling to work decreased from 10.4 percent of all work trips in 2010 to 9.0 percent in 2019. Working from home increased from 4.1 percent in 2010 to 5.2 percent in 2019.

Chapter 6: Technology Trends:

- **High-speed telecommunications:** While a total of 97 percent of Americans in urban areas have access to high-speed Internet services, not all are Internet subscribers. That number falls to 65 percent of households in rural areas and 60 percent on tribal lands.
- **Innovation in transportation services:** More change has occurred in the last 6 years than in the last 60 years in terms of transportation options.
- **Shared mobility:** In 2019, 136 million trips were made using shared micromobility, with 63 percent of them made using e-scooters. In comparison, in 2018, 84 million trips were made using shared micromobility, with 46 percent of them made using e-scooters.
- **On-demand ride services:** The percentage of people using ridesharing apps has increased rapidly. For example, in 2015, only 15 percent of Americans used ridesharing services. By fall 2018, this number increased to 36 percent.
- **Mobility hubs:** Mobility hubs, an emerging transportation service, provides an integrated suite of mobility services, amenities, and supporting technologies.
- **Vehicle technologies:** In 2018, there were around 208,000 new registrations of electric vehicles (EVs) and hybrid EVs (HEVs), which was twice the number of new registrations in 2017.
- **Connected and automated vehicles:** The United States has long been a leader in vehicle technology and transportation systems research, including intelligent transportation systems (ITS), connected vehicle systems, and automated driving systems (ADSs). Numerous technologies have emerged from such research efforts to become commercial and consumer products.
- **Driver assistance systems:** Driver assistance systems have increased in prevalence. While many of these applications are convenience features, others are effective safety features.
- **Unmanned aircraft systems (UASs):** The adoption of UASs is growing rapidly among both consumers and companies. Initially applied in the transportation sector for bridge inspections, the retail industry is leading the way in commercial applications.

Chapter 7: Emerging Themes and Considerations:

- **Urban, rural, and suburban:** Determining if and how transportation innovations can be applied to less dense communities may be critical to achieving equity in access, mobility, and safety.
- **Telecommunications as a travel mode:** Understanding the opportunities and impacts of potential shifts from travel to telecommunications for some activities can inform planning and policy in areas such as access to goods and services, mobility, sustainability, and equity.
- **Integration and interoperability:** Coordination across modal silos and regions is difficult and is often a lower priority in an environment of constrained budgets. This is a significant barrier to achieving the vision of a seamless transportation system. New ideas, resources, and tools are needed to facilitate regional and modal coordination of policy, investments, information, and maintenance.
- **Public and private sector roles:** It may be a challenge to balance the public good with the innovation and efficiency that private enterprise brings to the transportation sector.

Chapter 2: Population and Geography



Chapter 2 Highlights

Key trends from this chapter include:

- **Population growth:** While the U.S. population continues to grow, the overall population growth rate has slowed every year since 2015. Most of the growth has been in the West and South.
- **Where people live:** While the focus is often on urban and rural areas, 42.6 percent of the population lives in areas categorized as suburban and small town.
- **Age matters:** Americans have continued to age, with the proportion of people ages 65+ growing faster than those younger than 30. The demand for transportation varies greatly based on age.
- **Race and ethnicity:** The U.S. population is also becoming more diverse. Increased diversity brings changes in where people live and how they travel.

People use the U.S. transportation system every day. Whether it be to go to work or school, shop, visit loved ones, ship goods, make service calls, go on vacation, and more, virtually every activity involves some form of transportation.

As people's characteristics, needs, and preferences change, so too does the way they use transportation. Changes occur in a variety of areas. Changes in demographics, such as the size and age of the population, drive changes in demand. Geographic changes can shift transportation demand or change transportation needs. Social changes influence preferences and expectations, while technological innovations change what is possible, including how activities are completed, the transportation services available, and the way goods and services are provided.

Population Growth

As the Nation's population continues to grow, so does overall transportation demand. How and where the population is growing and changing directly affects the type and distribution of transportation demand.

Population growth results from two factors: natural increase (births and deaths) and immigration. While the

U.S. population has grown significantly over the past two decades, experiencing a 16.3 percent increase from 282 million people in 2000 to 328 million people in 2019, the overall population growth rate is declining.⁽¹⁾ More specifically, the rate has slowed every year since 2015.⁽¹⁾ This is due to recent declines in the number of births and in the number of people immigrating to the United States.

The past decade (i.e., 2010–2020) experienced an average annual growth rate of 0.66 percent. The average annual growth rate in the previous decade was 0.97 percent. Population growth between 2019 to 2020 was the slowest in 120 years at 0.35 percent. Even with declining growth rates, the U.S. population is still expected to grow to 404.5 million people by 2060.⁽²⁾ The following figure provides an overview of the U.S. population growth rate by decade from 1790 to 2020.⁽³⁾

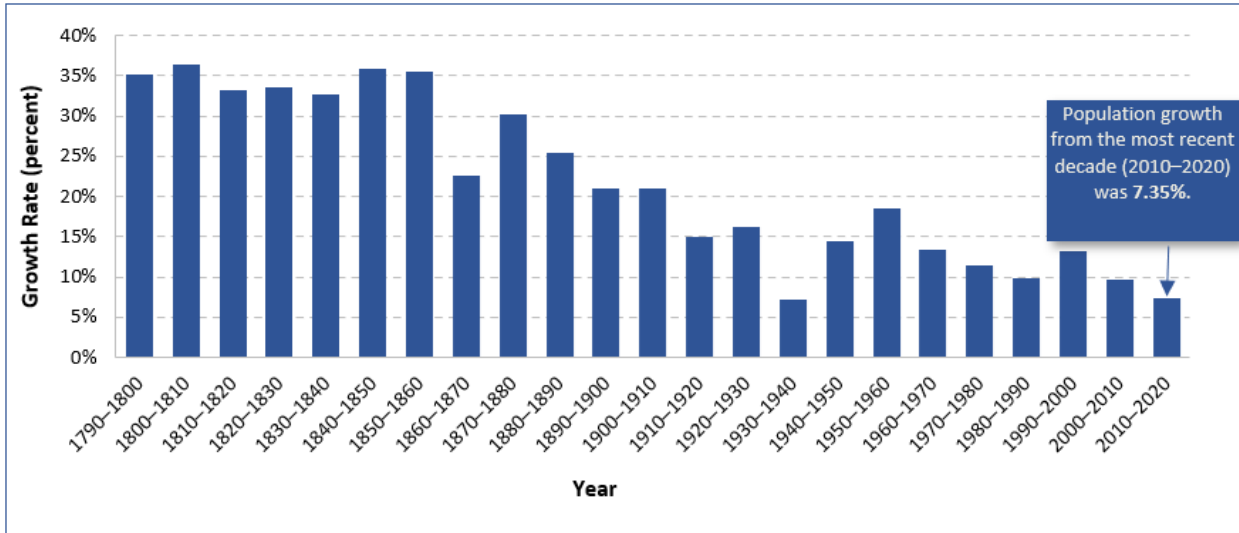
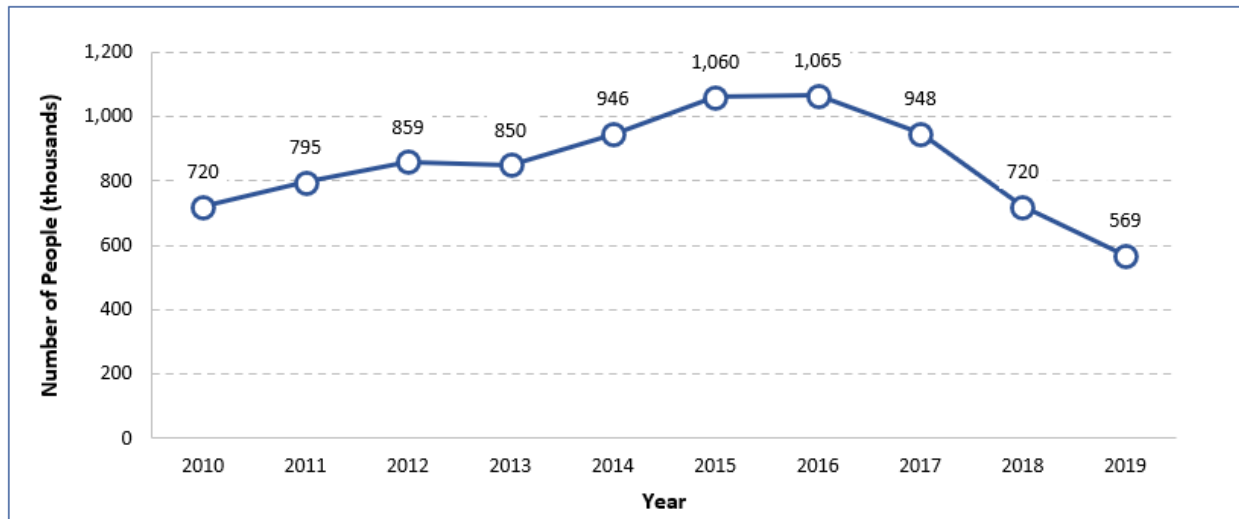


Figure 1. Estimated U.S. population growth by decade (1790–2020).^(4,5)

The rate of population growth is an important consideration when forecasting demand. This is especially true not only when tracking natural increases (accounting for 61.7 percent growth from 2018 to 2019) but also immigration (accounting for 38.3 percent growth from 2018 to 2019). While over 1 million people immigrated to the United States in both 2015 and 2016, this number has decreased to less than 600,000 in 2019 (see figure 2).⁽⁶⁾ This is important because new immigrants are more likely to walk, bicycle, carpool, and use public transit as compared to native-born Americans.⁽⁷⁾ This is especially the case in the first 3–5 years of living in the United States.



Note: “Year” represents the annual estimate period ending on June 30. Released data report 2010 as a quarter year (April 1, 2010–June 30, 2010) instead of a full year.

Figure 2. Net migration between the United States and abroad (2010–2019).⁽⁶⁾

While the number of households in the United States has grown from 108.2 million in 2001 to 128.5 million in 2020, the average number of people per household has declined from 2.58 in 2001 to 2.53 in 2020 (see figure 3).⁽⁸⁾ This may be due, in part, to lower birth rates; the size of the older population; or patterns of marriage, employment, and housing costs. Well-recognized trends contributing to smaller households and families include fewer children per family, more single-parent families, and a larger number of people living alone.⁽⁸⁾ As there are many household travel activities, such as grocery shopping, trips to places of worship, or dining out, transportation demand increases overall where there are a greater number of households for the same population size.

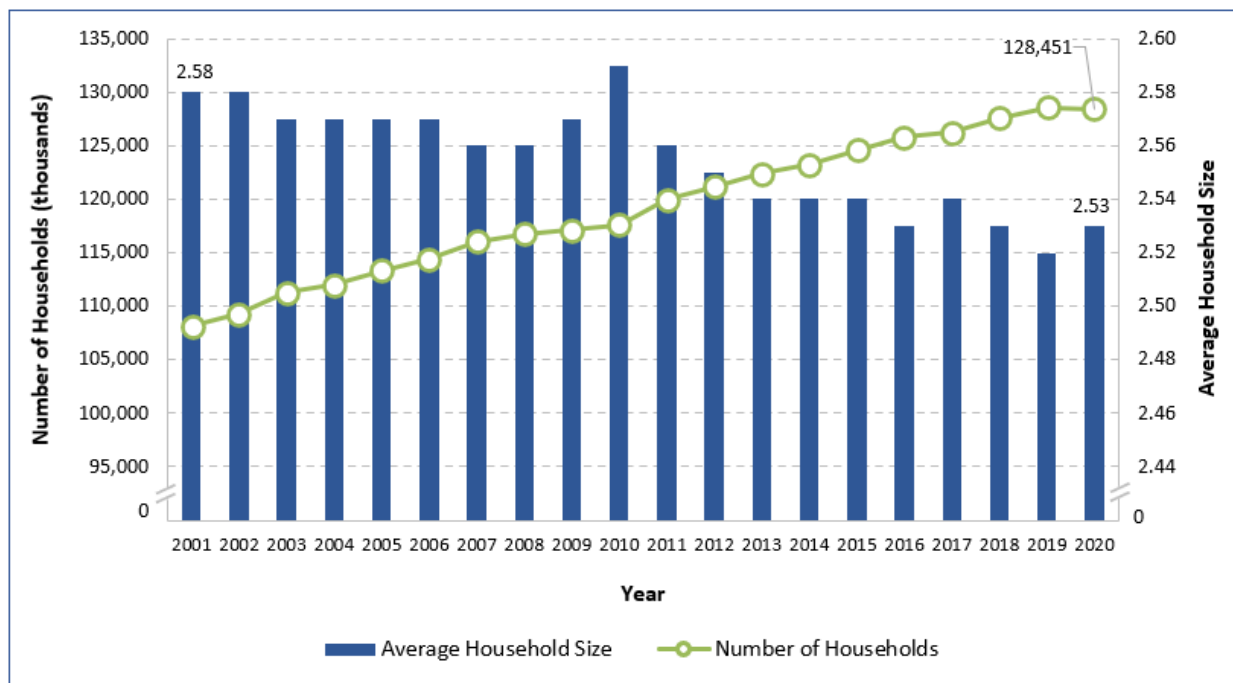


Figure 3. Number of households and average household size (2001–2020).⁽⁹⁾

Where People Live

Changes in where people live impact the distribution of demand across the transportation system. For example, areas with higher population growth rates will likely experience growth in demand for transportation services. Suburban counties with aging populations may need to provide more safe transportation alternatives for older residents. Rural areas experiencing new growth in work-from-home professionals may need to consider increased demand for local travel. Additionally, urban areas may need to enhance access to shared mobility modes, such as carpooling or transit, to meet growing transportation demands particularly among those seeking to balance affordable housing outside the larger metropolitan areas.

Census Regions

In the United States, all but four States saw population growth between 2000 and 2019.⁽¹⁰⁾ Texas, Florida, and California had the largest numbers of new people—in 2019 alone, Florida and

California attracted the largest number of immigrants at 74,000 and 89,000, respectively.⁽¹¹⁾ The District of Columbia, Texas, Utah, and Colorado had the greatest percentage increases, while populations declined in Vermont, Connecticut, West Virginia, and Illinois since the 2010 Census.⁽¹⁰⁾ Figure 4 shows these trends over time aggregated by Census region.

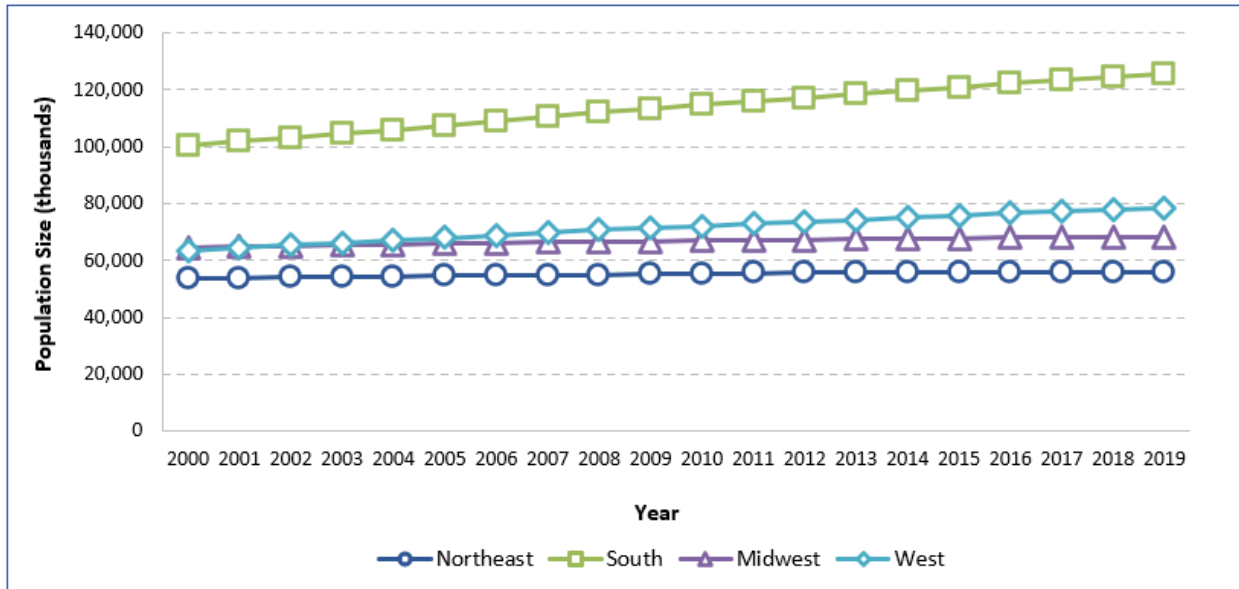


Figure 4. Population size by region (2000–2019).⁽¹¹⁾

Between 2017 and 2018, over 31.8 million people moved within the United States. Of that, approximately 2.6 million people moved to a different region, while the remaining moved within the same region (see table 1).⁽¹²⁾

The South has experienced statistically significant net gains from domestic migration most years since 1981. Between 2017 and 2018 alone, the net population in the South grew by approximately 512,000 people.

+512,000

Table 1. Migration flows between U.S. regions (2017–2018) (numbers in thousands).^(12,13)

Moved From	Moved To				Total Moved From
	Northeast	Midwest	South	West	
Northeast	—	79	412	104	595
Midwest	54	—	356	146	556
South	122	276	—	317	715
West	68	162	459	—	689
Total Moved To	244	517	1,227	567	2,555
Net Gain or Loss	(351)	(39)	512	(122)	—

—Not applicable.

Note: Net gain or loss calculated as “Total Moved From” less “Total Moved To” for a given region.

Because of differences in growth, regional shares of the total population have shifted considerably in recent decades. Between 1950 and 2019, the South's share of the U.S. population increased from 31 percent to 38 percent. Conversely, the Northeast's proportion declined from 26 percent to 17 percent (see figure 5).¹

With an overall growth rate of 26.67 percent from 1950 to 2019, the South has experienced significant growth.

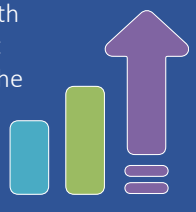
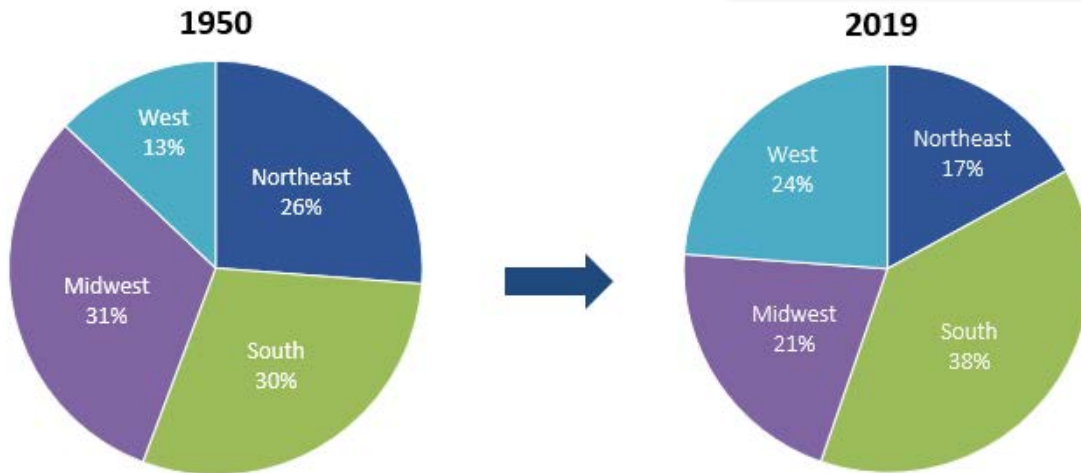
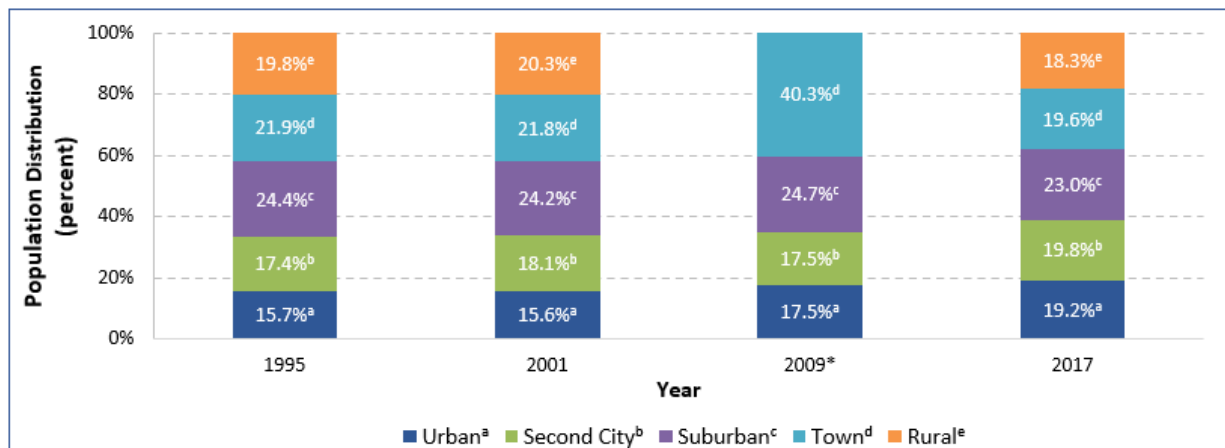



Figure 5. Population share by region (1950 vs. 2019).⁽¹⁴⁾

Urban Versus Rural

Research, policy, and planning often frame transportation in the context of the urban versus rural dichotomy. However, much of the U.S. population is in areas that are neither rural nor urban. In fact, in 2017, 42.6 percent of the population lived in areas categorized as suburban and town (see figure 6). This is an important distinction, as suburban travel often is more similar to rural travel as compared to dense urban areas.



*In 2009, the Town and Rural categories were combined as a single category.

Figure 6. Population by household location (1995–2017).^(15–18)

¹See figure 7 for State distribution by Census region.

Another way to describe where people live is based on their “urbanicity,” which reflects a combination of population density and employment opportunities. This report uses urbanicity measures developed by Claritas and appended to the Federal Highway Administration’s (FHWA’s) National Household Travel Survey (NHTS) data series.^(19,15–18) Urbanicity categories and corresponding population density scores are described in table 2.

Table 2. Urbanicity categories and population density scores.

Urbanicity Category	Definition	Population Density Score
Urban	Highest density population centers found in the largest cities.	75–99
Second city	Medium-to-high density population centers that are concentrated in larger towns and small cities offering a mix of services and employment opportunities to the surrounding suburban and rural areas.	40–90
Suburban	Low-to-medium density areas that are adjacent to urban and second cities. They are characterized by their linkages to the urban and second cities by commuting patterns, shopping, and social/recreational travel, among others.	40–90
Town and rural*	Low-to-very low density areas.	0–40

*While Town and Rural are considered separate categories, they are mostly combined in this report.

Population Density

Density is one of the main factors in how the U.S. Census defines geographies and is an important determinant on the feasibility of many transportation modes. As shown in figure 7, much of the United States is increasing in population density. The figure also shows the shifts in population from the Northeast and Midwest to the South and West over the past decade.

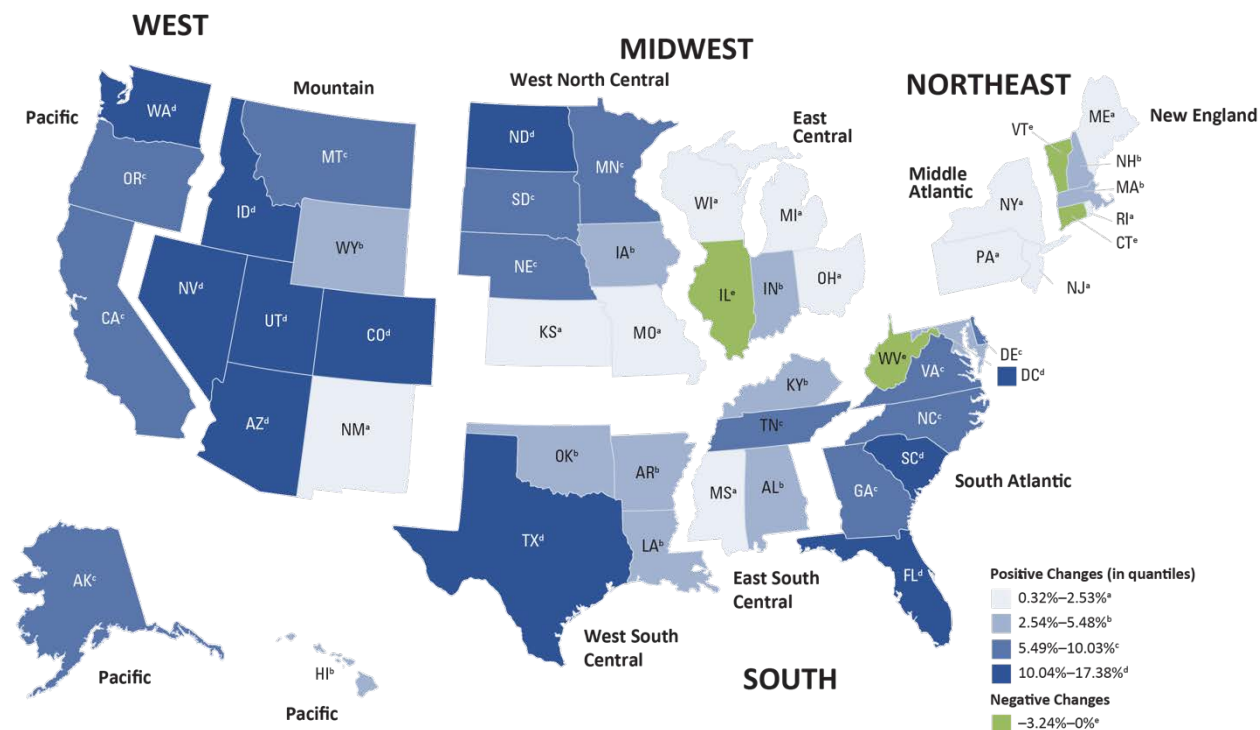


Figure 7. Percentage change in population density by Census division (2010–2019).⁽²⁰⁾

Age Matters

The size of the aging Baby Boomer population is a topic that has received quite a bit of attention over the past few years. Americans have continued to age, with the proportion of people ages 65+ growing faster than those younger than 30, resulting in the median age increasing from 32.9 years in 1990 to 38.5 years in 2019, as shown in figure 8.

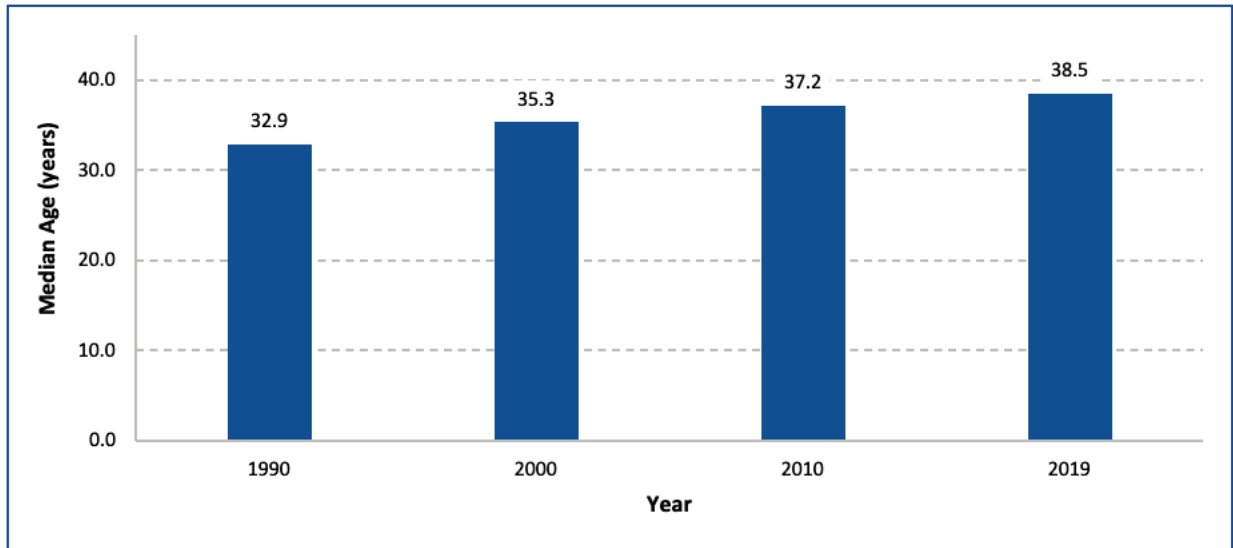
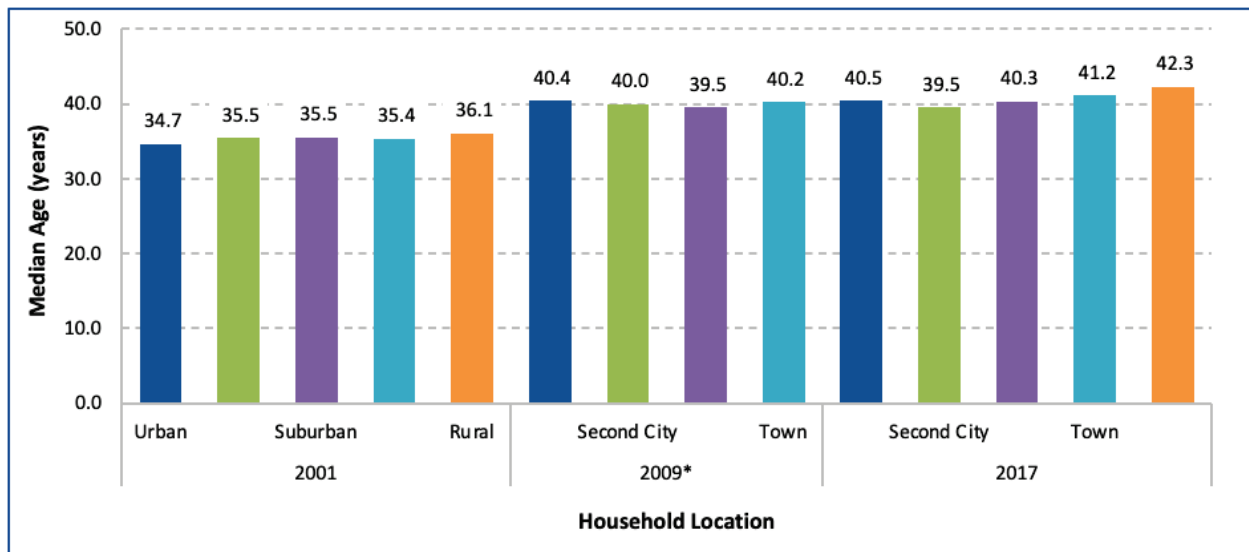


Figure 8. Median U.S. population age (1990–2019).^(21,22)

As indicated in figure 9, median age varies by household location, with urban and second-city dwellers tending to be younger and those in the small towns and rural areas tending to be older.

Did you Know?

The last of the Baby Boomer generation is currently in the 55- to 59-year-old age cohort.



*In 2009, the Town and Rural categories were combined as a single category.

Figure 9. Trends in median age by household location (2001–2017).^(15–18)

As shown in figure 10, the highest population growth rates have been among seniors (e.g., people ages 60 and older). This is a continuing trend in the United States—there are more older drivers on roads, and there are more seniors who may require transportation services. This is especially true in suburban and rural areas, where the majority of people over 60 live. These areas are overwhelmingly auto dependent with fewer travel options.⁽²³⁾

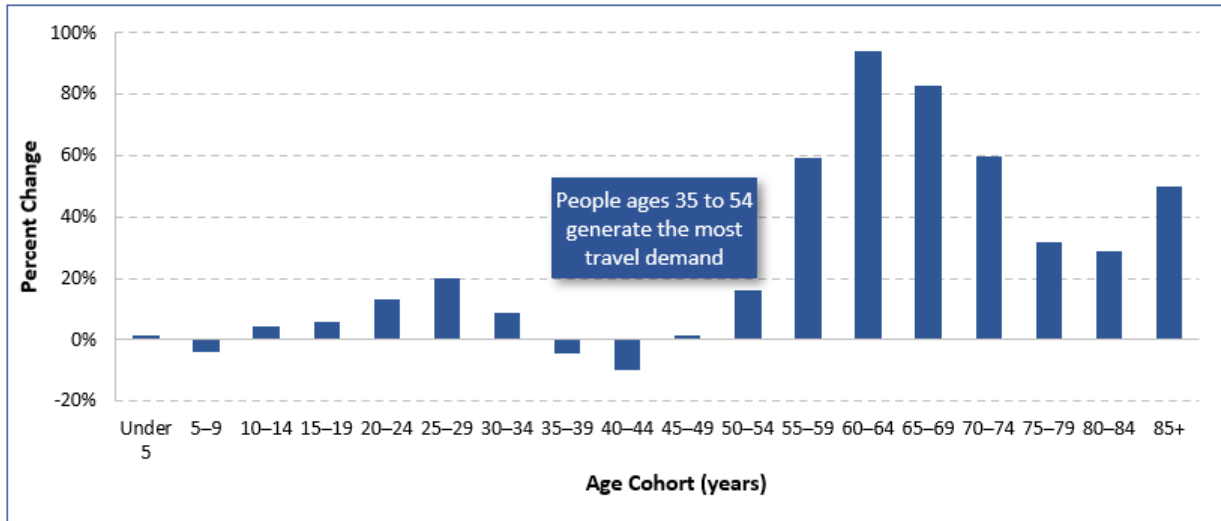


Figure 10. Population percent change by age cohort (2000–2019).^(24,25)

Most significant is the negligible change in population size of people between the ages of 35 and 54 over the past two decades (see figure 11). These cohorts have seen very small growth rates and—in some cases—actual declines in population size. Since 2000, the 35- to 54-year-old age cohort has also declined as a percentage of the total population. In 2019, 35- to 54-year-olds comprised 25.1 percent of the U.S. population—a decrease from 29.5 percent in 2000.

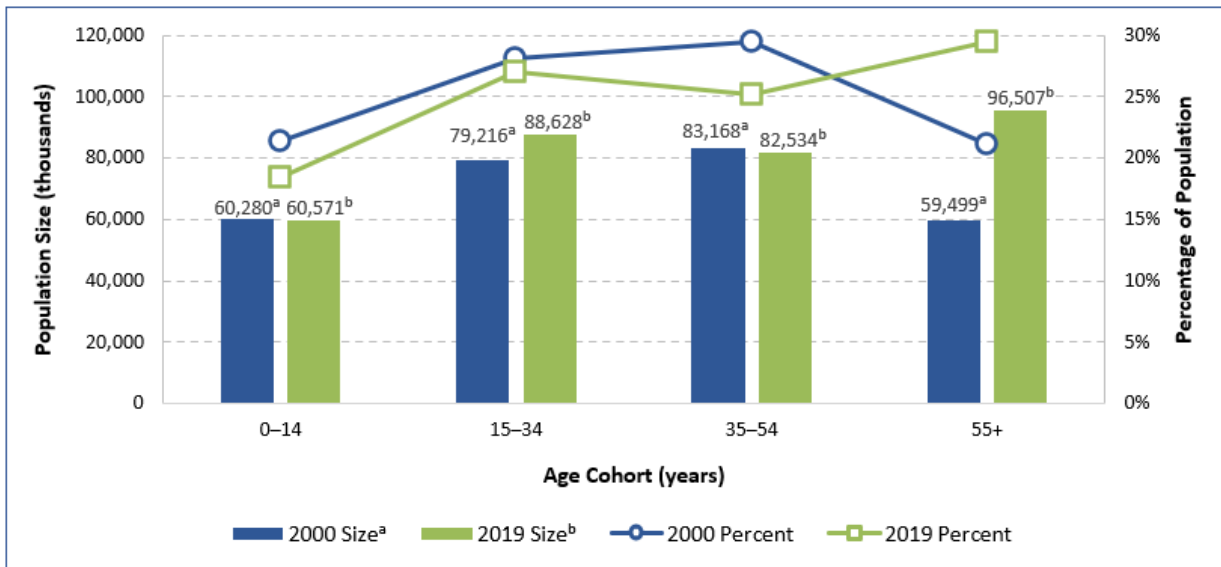


Figure 11. Population size and percentage of the population by age cohort (2000 vs. 2019).^(11,26)

This is noteworthy because this age cohort comprises people who make the most trips (i.e., workers and households with children), with an average of almost 1,400 trips per year in 2017 (see figure 12). This population change is significant as compared to all other age cohorts. As new age cohorts emerge (e.g., Generation Y) that have a larger population than the cohort before them (e.g., Generation X), this will increase the size of the 35- to 54-year-old age cohort in future years. The current 35- to 54-year-old age cohort will soon join the aging Baby Boomer cohort, who are working longer and driving longer than their earlier counterparts.

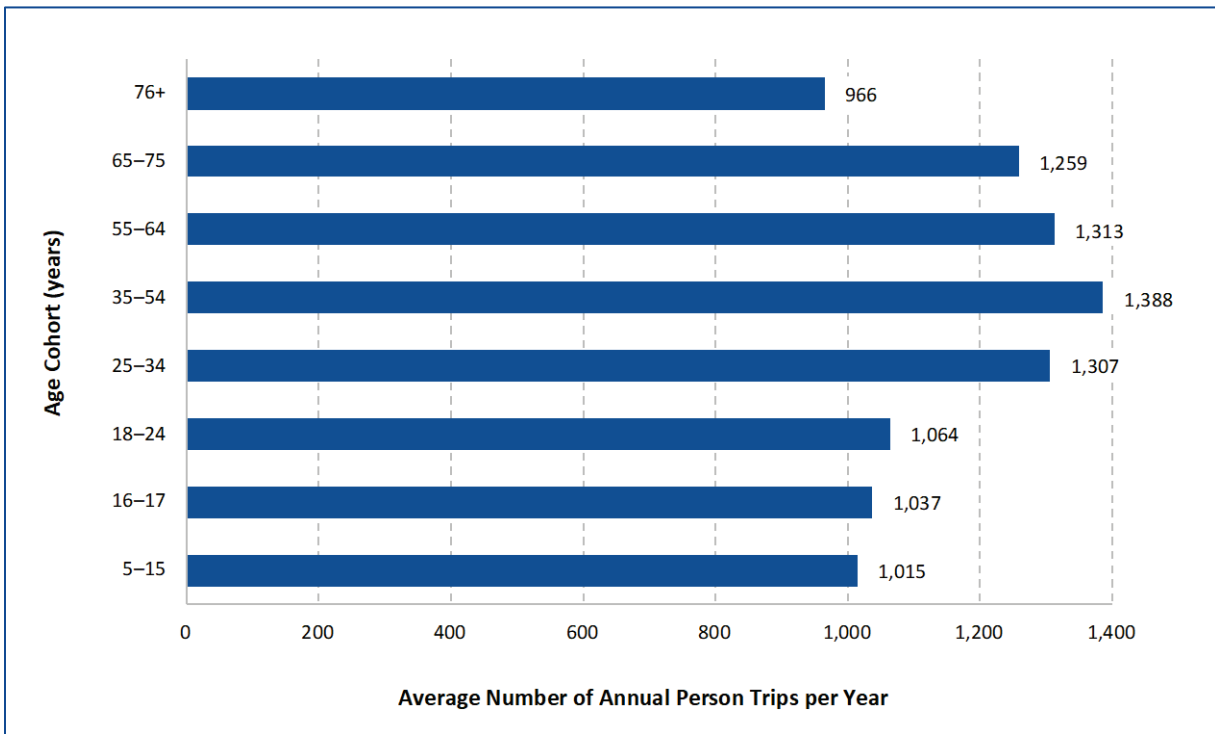


Figure 12. Trip rate by age (2017).⁽¹⁸⁾

Race and Ethnicity

The U.S. population is not only aging, but it is also becoming more diverse. In 1990, 24 percent of the Nation’s population comprised people of color—12 percent Black, 9 percent Hispanic (of any race), and 3 percent Asian and Pacific Islander (see figure 13). In 2019, the Hispanic population (of any race) increased to 60 million, which was 18 percent of the total population. By 2060, 56 percent of the U.S. population is forecast to be people of color.⁽²⁾

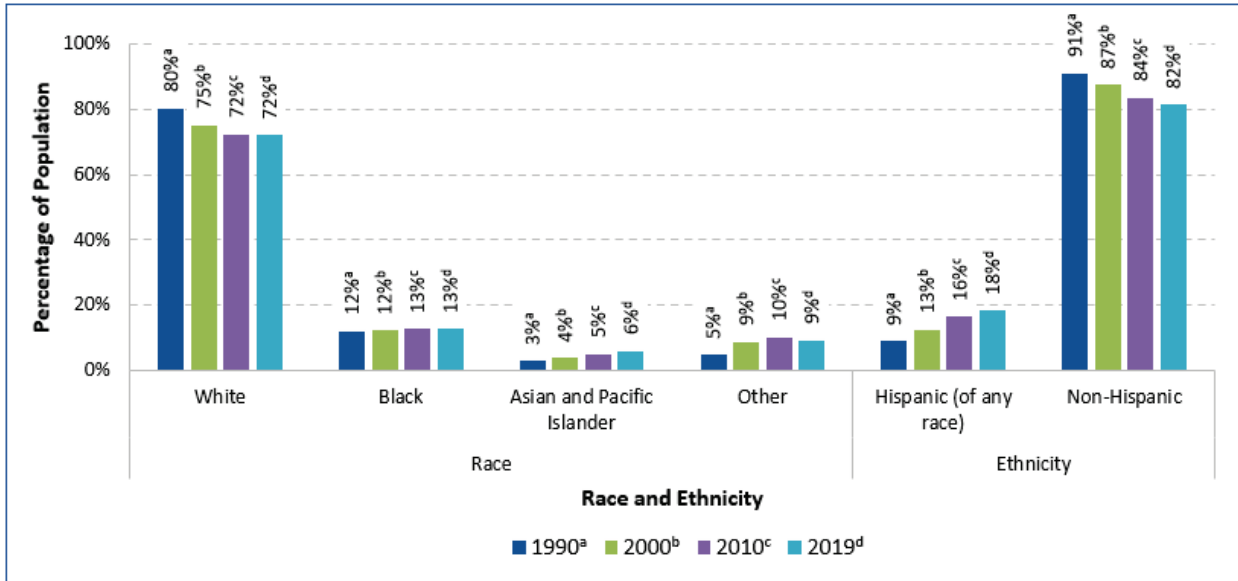


Figure 13. Percentage of U.S. population by race and ethnicity (1990–2019).^(4,21)

Increased diversity in the United States brings changes in where people live and how they travel. As highlighted in figure 14, the average daily person trip rate is lower for minority population groups as compared to white travelers. Trip rates declined across all racial groups from 1995 to 2017.

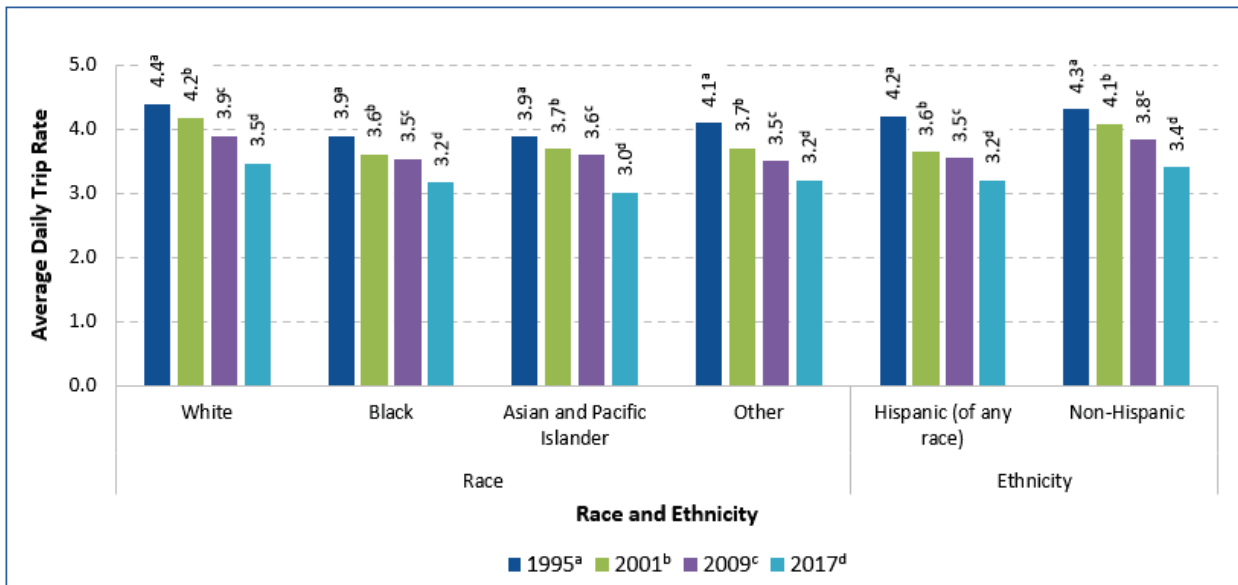


Figure 14. Person trip rates by race and ethnicity (1995–2017).^(15–18)

The level of trip making is also closely tied to income. When looking at daily trip rates by race and ethnicity across household income quintiles, households with higher incomes generally took more daily trips (see figure 15). On exception is Black households, where the highest average daily trips are made by households with incomes between \$25,000 and \$74,999.



Figure 15. Average daily trip rate by household income and race and ethnicity (2017).⁽¹⁸⁾

How Do Population and Demographic Trends Impact Transportation Demand?

Population and demographic trends, such as growth, median age, and household size, impact transportation demand in different ways. Let's explore this more closely.

0.66%
Population
Growth Rate



As our Nation's population continues to **increase**, the **demand for transportation increases**.

People 55+
Comprise 29.4%
of Population



Older people drive less than their younger counterparts. As our **population ages**, **demand for transportation decreases**.

Average
Household Size
is 2.53 People



Decreasing average household size tends to **increase transportation demand**, as there are fewer people to take on travel responsibilities.

Chapter 3: Vehicles and Drivers

Chapter 3 Highlights

Key trends from this chapter include:

- **Vehicle ownership:** Growth in vehicle ownership has far outpaced the growth in U.S. population, more than tripling in the last four decades.
- **Household fleet characteristics:** SUVs made up 24 percent of the household vehicle fleet in 2017, which is up from 19 percent in 2009. A new safety feature or emissions standard implemented today would take at least 4–7 years before it is included in about half of the household vehicle fleet.
- **Driver licensing trends:** People 65+ years old have experienced a growth in total population as well as a growth in the number and percentage of licensed drivers.

One of the most important factors influencing transportation demand is vehicle availability. Growth in vehicle ownership has far outpaced growth in U.S. population, more than tripling in the last four decades.

Vehicle Ownership

Vehicle ownership varies across the Nation. Overall, 8.6 percent of U.S. households do not have access to a vehicle (either by choice or by circumstance) according to the 2019 American Community Survey.⁽²⁷⁾ Not surprisingly, income is one of the major determinates of the number of vehicles in a household (i.e., lower-income households tend to own less or no vehicles compared to higher-income households). However, additional factors influence vehicle

Did You Know?

20 percent of low-income households do not have a vehicle.



ownership besides income. Figure 16 depicts the percentage of zero-vehicle households by household attributes in 2017. Households with no vehicles were more

likely to live in urban areas, be renters, and have incomes under \$25,000 as compared to households with at least one vehicle.

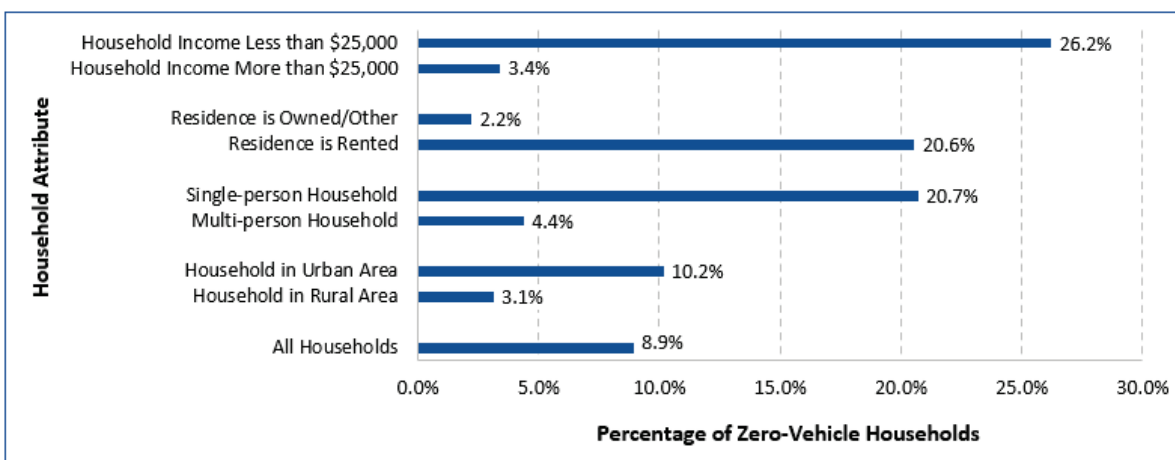


Figure 16. Percentage of zero-vehicle households in the United States by household attribute (2017).⁽¹⁸⁾

However, the vehicle ownership model may be changing, as exemplified by the slowing growth in the average number of vehicles per household. Figure 17 shows that the average number of vehicles per household has leveled off over the past two decades. This is likely due to changes in household size, labor force participation, and access to alternative transportation modes (such as on-demand transportation and shared modes). For example, as household size decreases, the number of vehicles per household also declines, as there are fewer drivers.

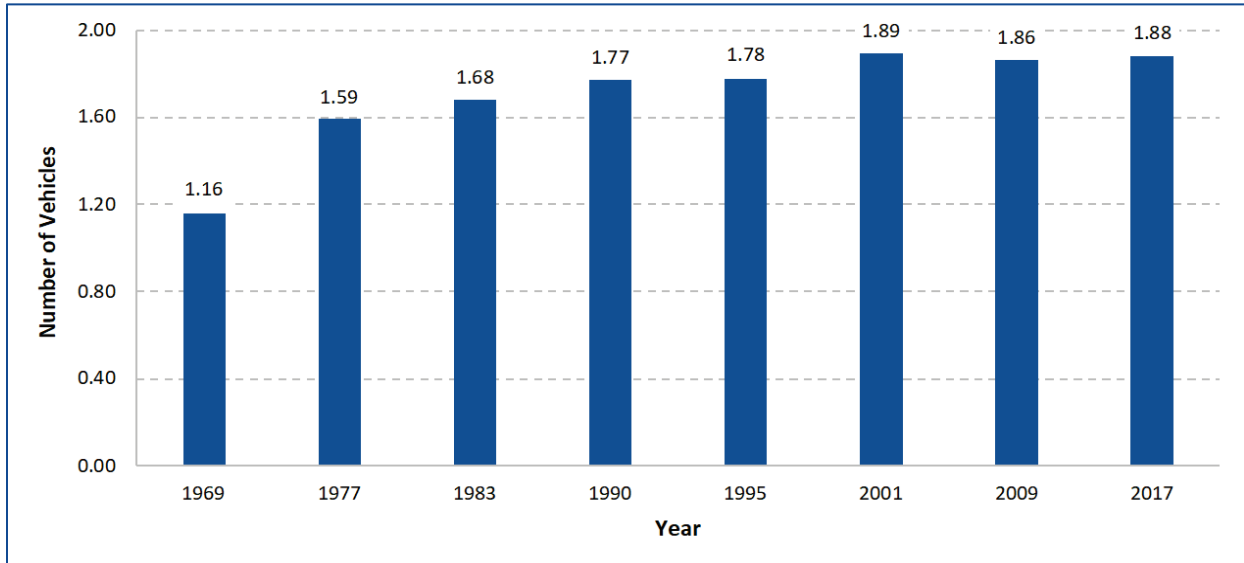


Figure 17. Average number of vehicles per household (1969–2017).⁽²⁸⁾

The number of vehicles per household has not changed significantly in cities since 2001, as highlighted in figure 18.

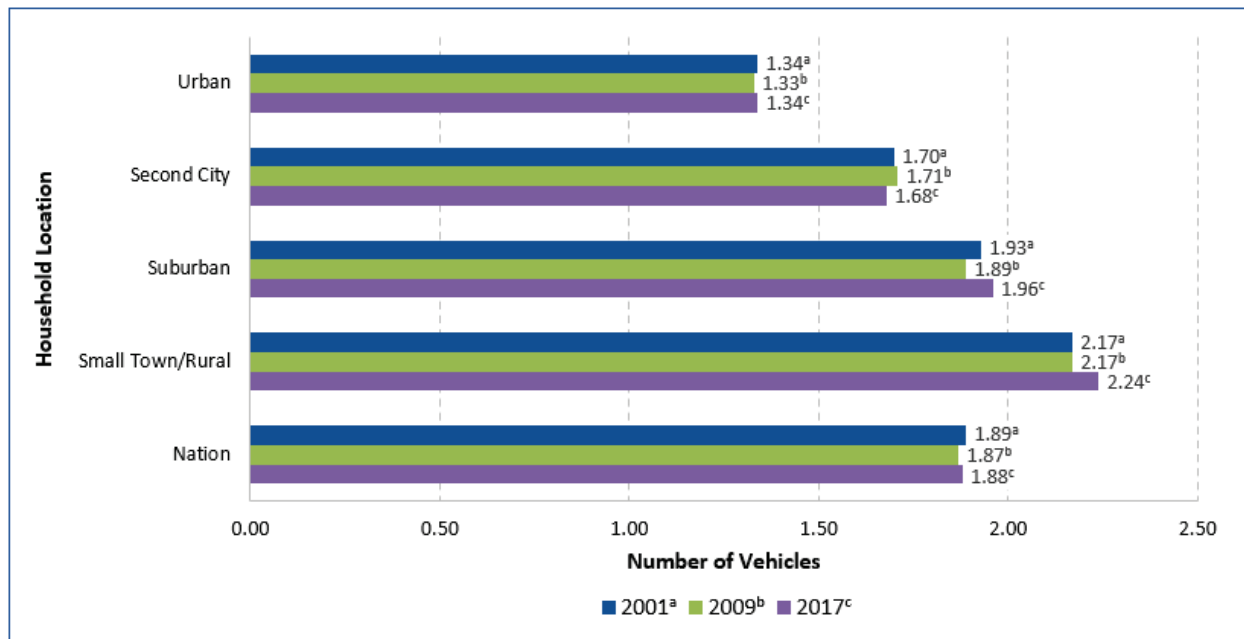


Figure 18. Average number of vehicles per household by household location (2001–2017).^(16–18)

Overall, there has been an increase in total registered vehicles (both private and commercial) traveling on U.S. roadways. From 2001 to 2019, total registered private and commercial vehicles increased by 20 percent from 226.6 million to 272.4 million.⁽²⁹⁾ Most of the increase can be attributed to registered private and commercial trucks, which increased from 90 million in 2001 to 156 million in 2019—a 73 percent increase. At the same time, from 2001 to 2019, the number of registered autos decreased by 21 percent from 136 million to 107 million, respectively.⁽²⁹⁾

Household Fleet Characteristics

Fleet Composition

At the household level (i.e., personal vehicle ownership only), the number of household vehicles increased by 10 percent from 202 million in 2001 to 222 million in 2017.⁽²⁸⁾ From 2001 to 2017, the SUV share of household vehicles increased by 12 percent, while the auto share of household vehicles decreased by 7 percent in that same time period (see figure 19).

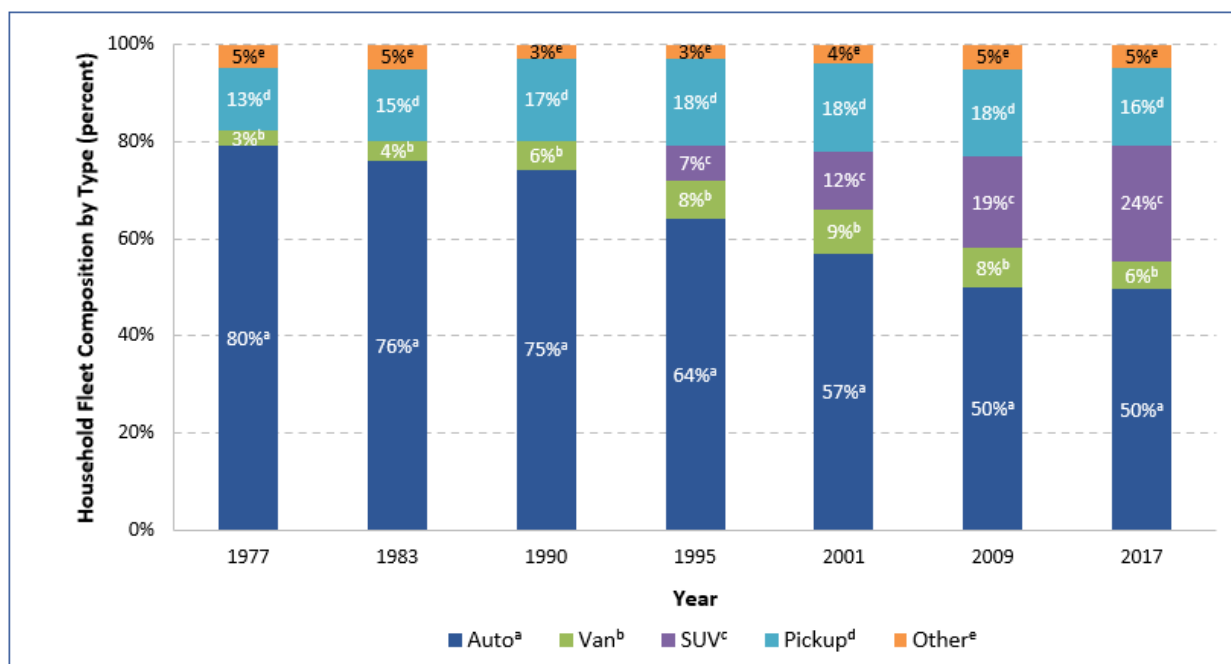


Figure 19. Household vehicle fleet composition by year (1977–2017).⁽²⁸⁾

Fleet Age

Average vehicle age increased by 16 percent from 8.9 years in 2001 to 10.3 years in 2017 (see figure 20). Lower fleet turnover slows the adoption of vehicle advancements into the fleet. This includes advancements available in newer vehicles, such as safety capabilities, better fuel economy, communication technology, and infotainment features.

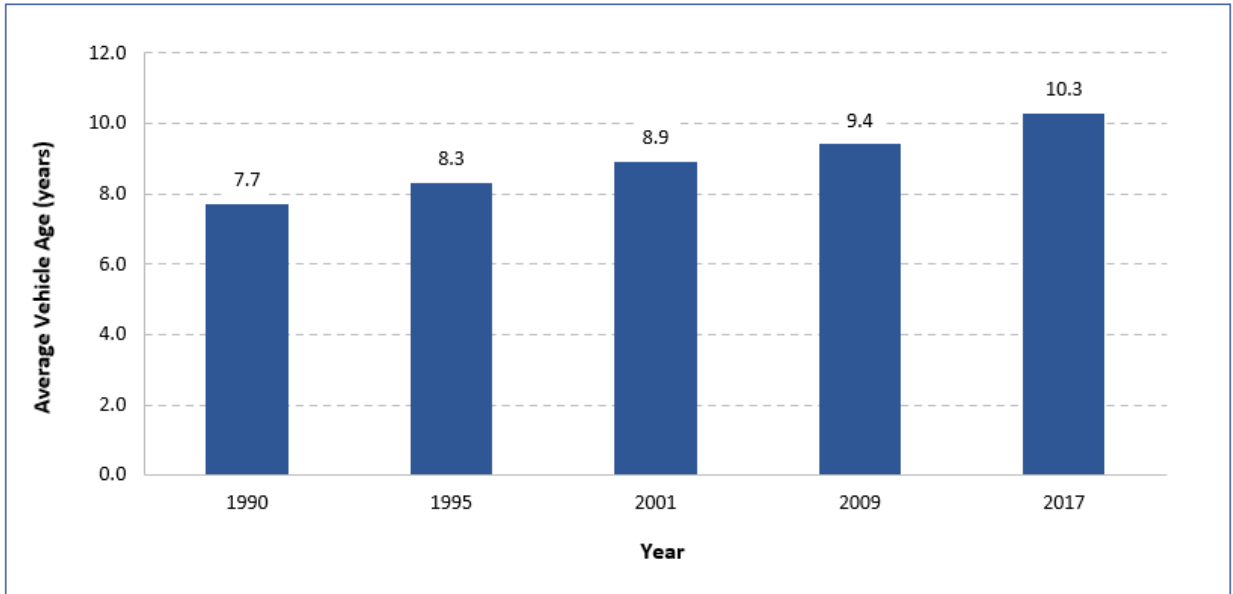


Figure 20. Average household vehicle age by year (1990–2017).⁽²⁸⁾

In rural areas and small towns, the average household vehicle age increased by 18 percent from 9.3 years in 2001 to 11.0 years in 2017. As of 2017, suburban households own the newest vehicles (9.4 years).^(16,18) According to recent research, in 2020, the average age of vehicles on U.S. roadways rose to 12.1 years; this was the first time that average vehicle age rose above 12 years. While the average vehicle age has increased steadily over the last two decades, this increase in 2020 was due in part to a drop in new car sales.⁽³⁰⁾

VMT

Per figure 21, autos made up 49 percent of household vehicles driven and 52 percent of all household VMT in 2017.⁽¹⁸⁾ Pickup trucks—the vehicle type with the greatest average age at 13.1 years—made up 14 percent of all household VMT.

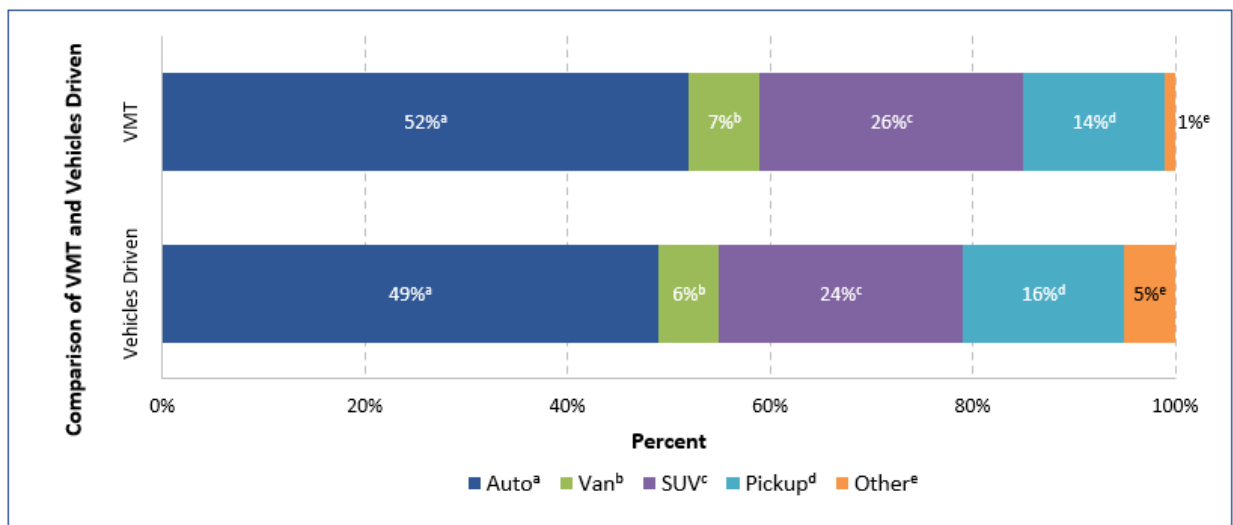


Figure 21. Percentage of household VMT and vehicles driven by vehicle type (2017).⁽¹⁸⁾

Vehicles that are 8 years old or older generate just under half of all household VMT. A little more than one-quarter of household VMT was made by vehicles 1–3 years old (see figure 22).



A new safety feature or emissions standard implemented today would take at least 4–7 years before it is included in about half of the household vehicle fleet.

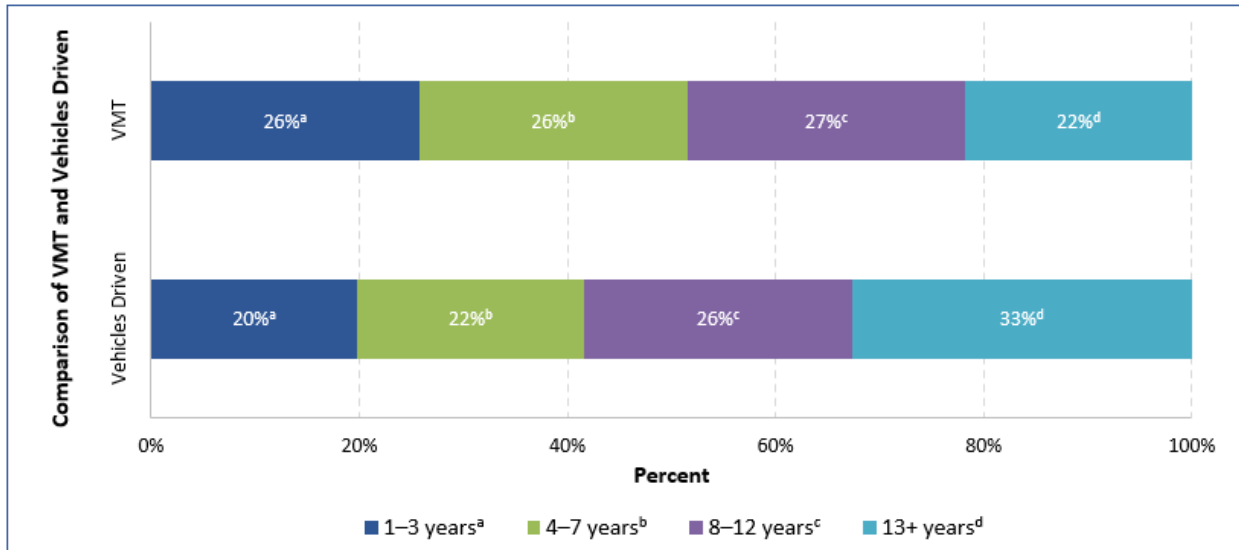


Figure 22. Percentage of household VMT and vehicles driven by vehicle age cohort (2017).⁽¹⁸⁾

Driver Licensing Trends

The proportion of total licensed drivers (i.e., ages 16 and older) in the United States has declined slightly from 86.5 percent in 2001 to 84.1 percent in 2019.⁽³¹⁾ People ages 65 and older have experienced a growth in total population as well as in the number and percentage of licensed drivers. For example, the percentage of people ages 85 and older with a driver’s license grew from 50 percent in 2001 to 60 percent in 2019 (see figure 23). Given that there were 6.3 million Americans ages 85 and older in 2019, that equates to 3.8 million drivers ages 85 and older.



Did You Know?
There are 3.8 million drivers 85 and older in the United States.

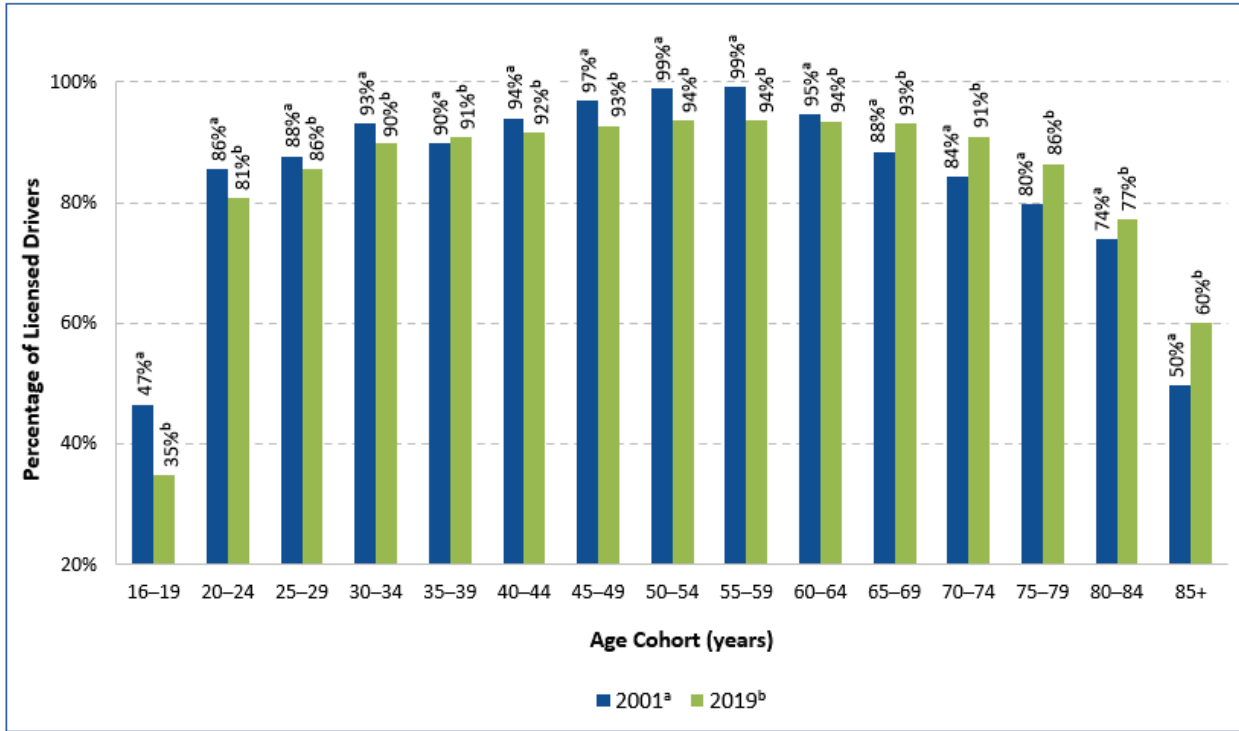


Figure 23. Percentage of licensed drivers by age cohort (2001 vs. 2019).⁽³²⁾

As shown in figure 24, a greater percentage of people living in suburban and rural areas had a driver’s license as compared to urban areas. The decline in licensing between 2009 and 2017 is most pronounced in the 16- to 19-year-old age cohort across household locations.

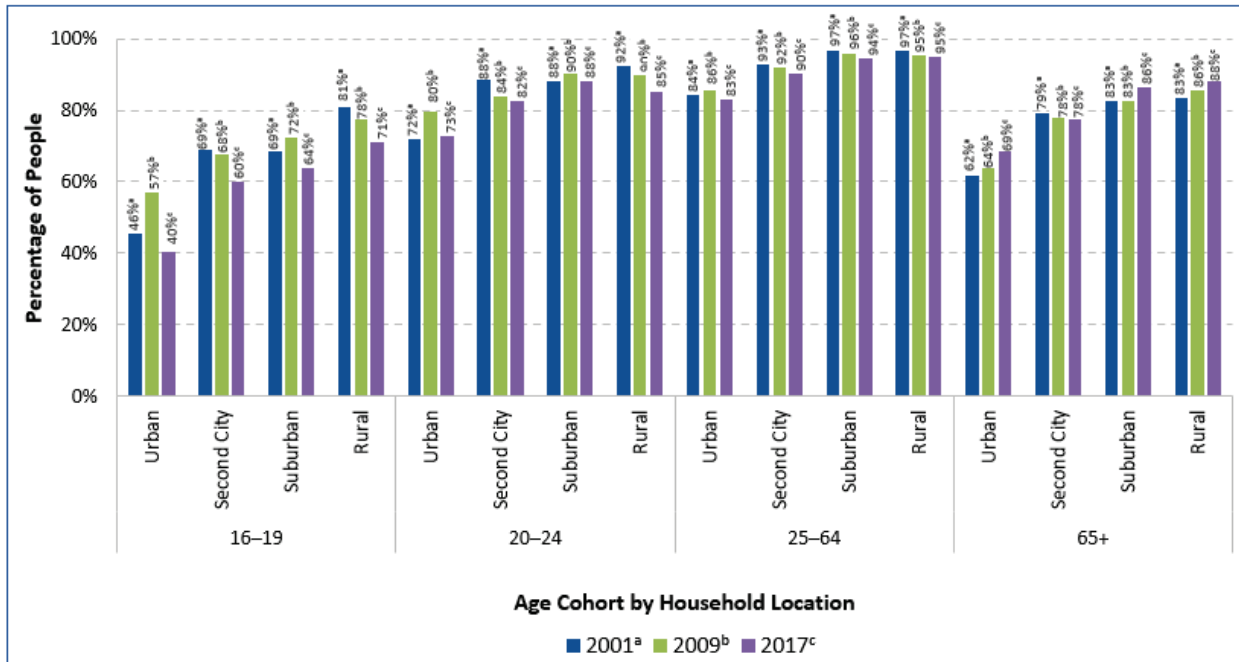


Figure 24. Percentage of people with a driver’s license by age cohort and household location (2001–2017).⁽¹⁶⁻¹⁸⁾

How Do Vehicle and Driver Trends Impact Transportation Demand?

How do changes in the average number of vehicles and drivers per household as well as vehicle age impact transportation demand? Let's explore further.

**Average of
1.88 Vehicles and
1.89 Drivers per
Household**



As the **average numbers of vehicles and drivers per household increase**, the **demand for transportation increases**.

**Average
Vehicle Age of
10.3 Years**



While households appear to be **keeping their vehicles longer**, **impacts on transportation demand are currently unclear**.

Chapter 4: Industry and Workers



Chapter 4 Highlights

Key trends from this chapter include:

- **VMT and GDP:** Total lane miles increased from 8.2 million miles in 2000 to 8.8 million miles in 2019. At the same time, total annual VMT increased from 2.8 trillion miles to 3.28 trillion miles.
- **Industry trends:** The U.S. transportation system moved 5.25 trillion ton-miles of freight valued at more than \$18.9 trillion in 2018; the highest share was moved by truck. Almost half of all ton-miles shipped by truck were at a distance under 500 miles.
- **Jobs and workers:** In 2019, 63.1 percent of the population was in the labor force. Workers ages 35 to 44 and 45 to 54 made the most daily trips (3.85 and 3.76, respectively) on average compared to other age cohorts.
- **How people work:** Just under 55 percent of workers in professional and technical occupations have the flexibility in their work start times compared to less than 30 percent of workers in manufacturing, construction, maintenance, and farming.
- **Income:** The percentage of household budget spent on transportation has increased from 15.9 percent in 2009 to 17.3 percent in 2017.

Industry and workers in the U.S. are supported by 4.2 million miles of roads which connect people and businesses to employment, communities, other modes of travel, and essential services as well as to the 11.3 billion tons of goods moving by truck.^(33,34)

VMT and GDP

Historically, GDP is a strong predictor of growth in miles traveled—as GDP grows, so does travel demand. While these indicators have diverged over the past decade, there is a strong history of a symbiotic relationship between GDP and highway passenger miles traveled (see figure 25), where highway passenger miles traveled is defined as vehicle miles by average travel party size to account for all miles traveled by persons, regardless of the trip purpose.

In 2018, total highway passenger miles exceeded 5.5 trillion miles.⁽³⁵⁾ This includes all highway modes, such as cars, buses, and trucks for personal, commercial, and freight travel.

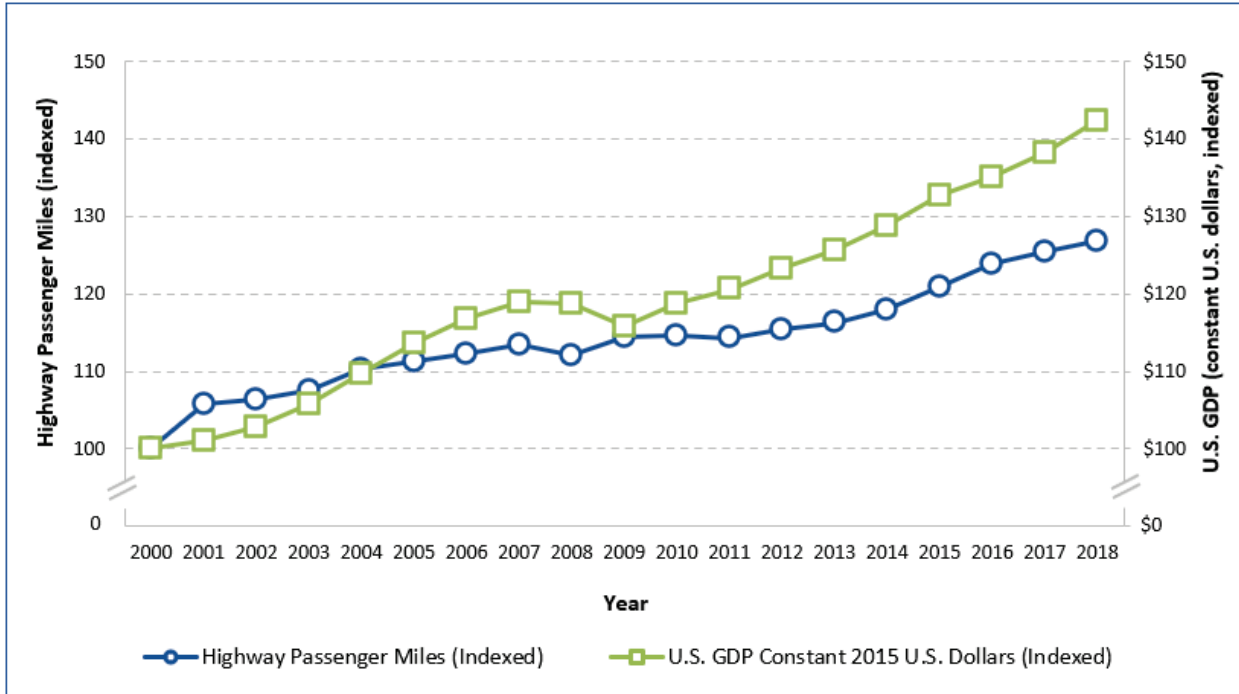


Figure 25. Trends in GDP and indexed highway passenger miles (2000–2018).^(36,37)

Transportation supply has not kept up with transportation demand. As a result, people and businesses pay more to use the system in terms of time and money, and additional costs are incurred, such as delays, crashes, and increased emissions. Figure 26 shows trends in the growth in population, VMT, and lane miles since 2000.

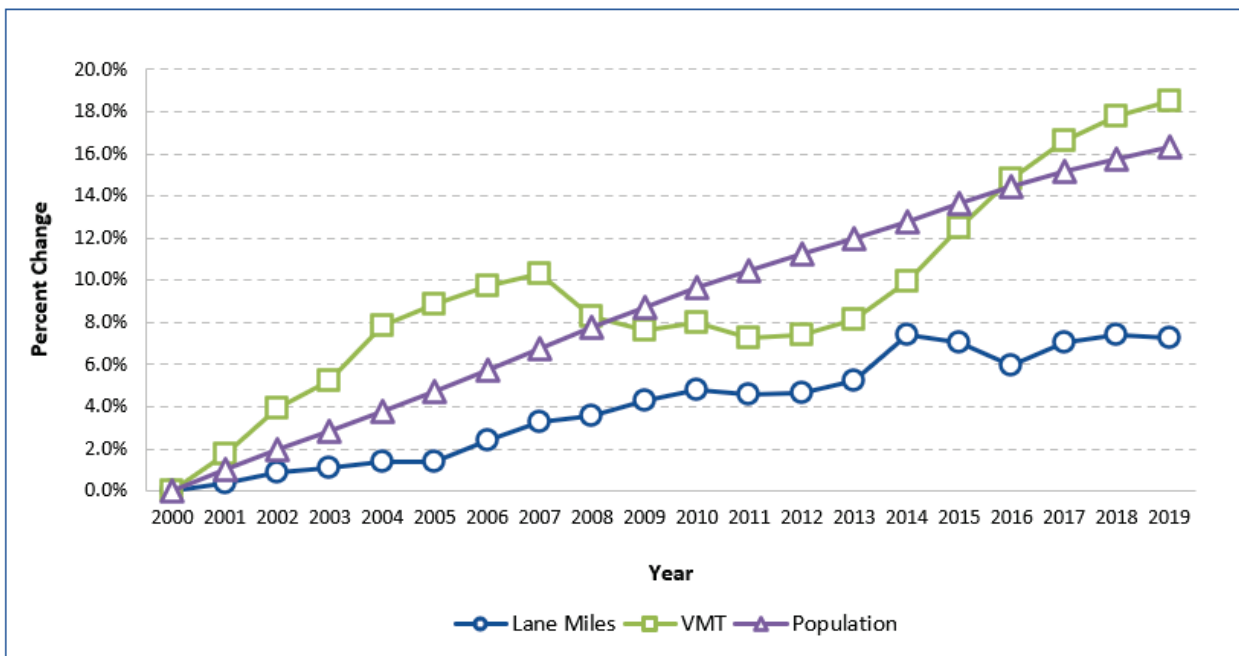


Figure 26. Percent change in total U.S. population, VMT, and lane miles (2000–2019).^(38–40)

While the growth in lane miles is small in comparison to population growth, the increase in total population from 2000 to 2019 has been accompanied by an expansion of lane miles (i.e., the total length and number of lanes) and their usage. Total lane miles the United States increased from 8.2 million miles in 2000 to 8.8 million miles in 2019 (a 7 percent increase).^(38–40) At the same time, total annual VMT increased from 2.8 trillion miles in 2000 to 3.28 trillion miles in 2019 (a 17 percent increase).^(38–40) While adding lane miles is not the only way to meet increased demand, this trend provides one explanation for the congestion and bottlenecks on our Nation’s highways. In some areas, demand is exceeding capacity.

Industry Trends

Industries across the United States rely on each other for production inputs, storage, distribution, goods and package deliveries, and passenger transport services delivered by surface transportation. Millions of U.S. businesses rely on the shipment of goods to their factories, stores, and consumers. Freight transport systems connect these businesses domestically and to global markets in an environment where freight volume and flows are susceptible to disruptions, such as trade agreements, weather events, congestion and delay, technology issues, and worker shortages. In 2019 alone, annual sales from manufacturers, retailers, and wholesalers (i.e., industries that rely heavily on goods movement) grew to over \$17.4 trillion (see figure 27). Freight shipments grew accordingly.

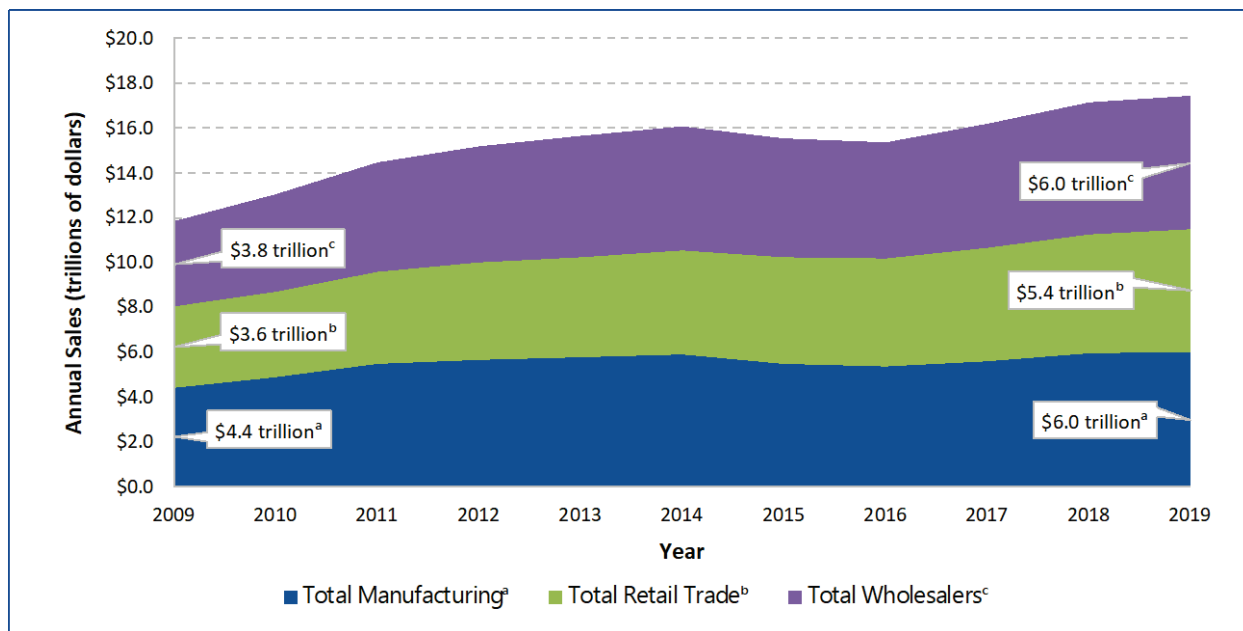


Figure 27. Annual sales for manufacturers, retailers, and merchant wholesalers (2009–2019).⁽⁴¹⁾

In 2018 the U.S. transportation system moved 5.25 trillion ton-miles of freight valued at more than \$18.9 trillion. The highest share of freight ton-miles was moved by truck (2.03 trillion ton-miles) valued at \$11.5 trillion (see figure 28).⁽³⁴⁾ Since 2012, freight ton-miles moved by truck have grown by 11.6 percent.

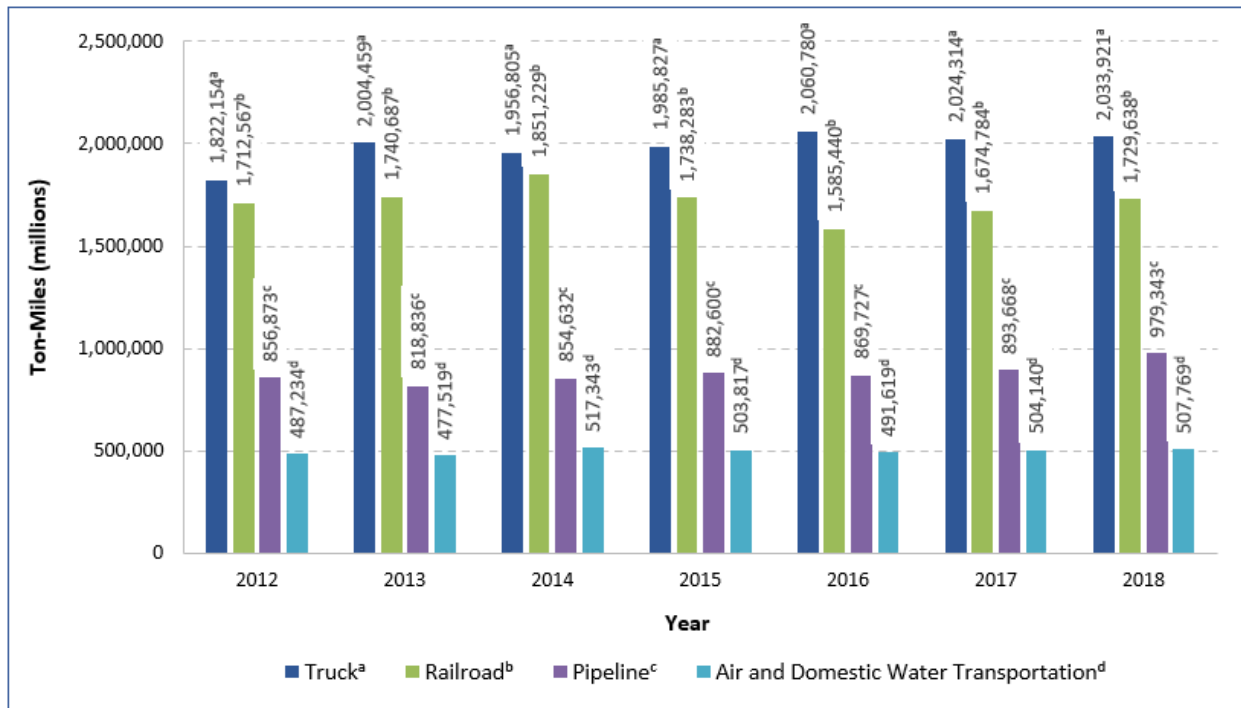


Figure 28. Annual freight ton-miles (2012–2018).⁽³⁴⁾

Technology provides efficiencies in the movement of goods, which has a significant impact on the modern economy. The length of time between ordering and delivery has decreased, distribution has decentralized, and new delivery modes are being established.

Almost half of all ton-miles shipped by truck are at a distance of under 500 miles (see figure 29).⁽³⁴⁾ There is little change from year to year.

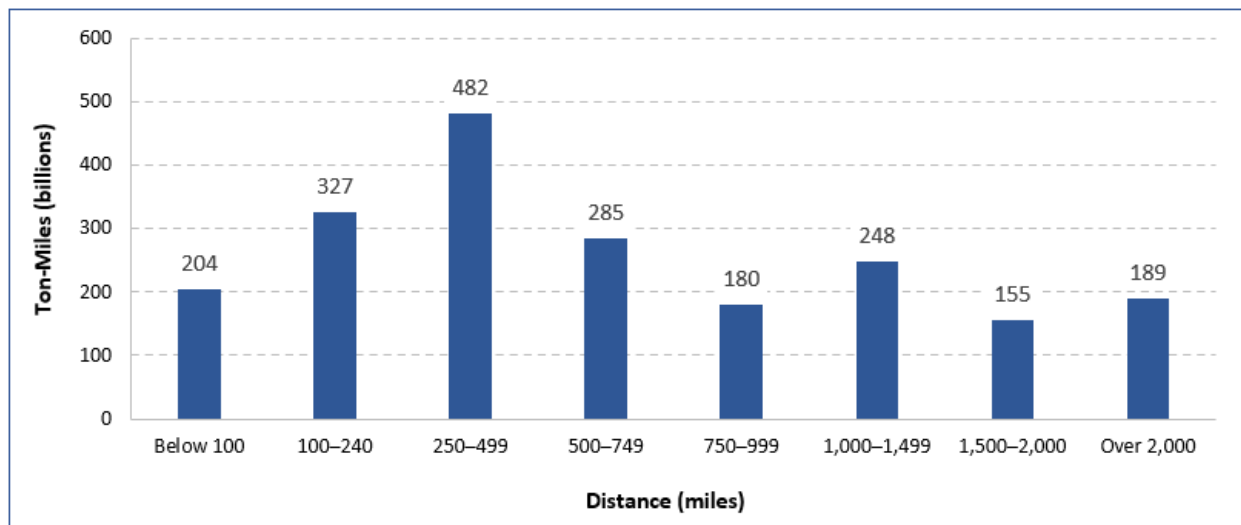


Figure 29. Freight ton-miles by truck and distance (2018).⁽³⁴⁾

Online shopping—coupled with on-demand shipping—is creating additional demand for package delivery and spurring the decentralization of warehouses and distribution centers. Since 2009, eCommerce sales as a percentage of retail sales has grown to 11.4 percent in the first quarter of 2020 (see figure 30).⁽⁴²⁾ Sales peaked at 15.7 percent in quarter 2 of 2020, further accelerating the rapid growth in eCommerce in the United States.

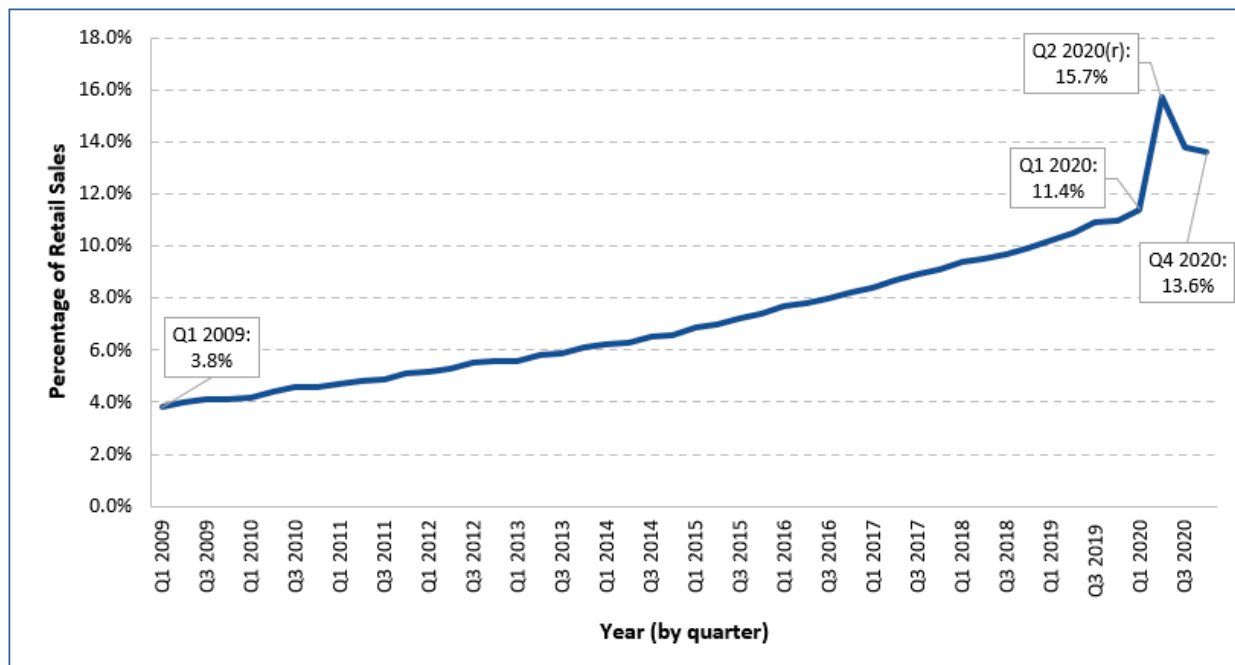
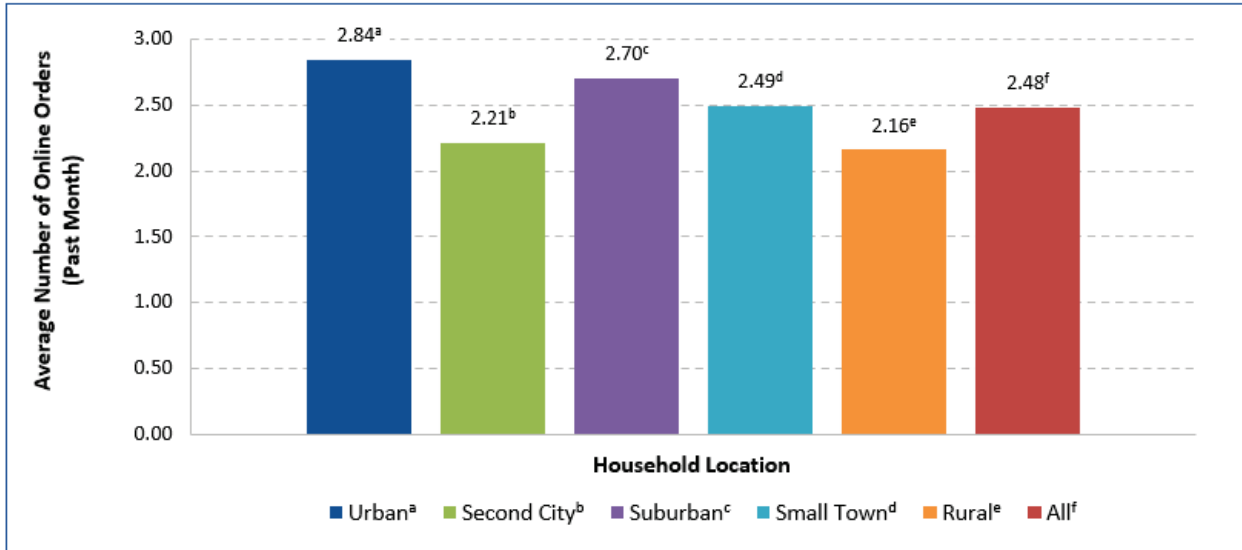


Figure 30. Trends in eCommerce—percentage of retail sales (2009–2020).⁽⁴²⁾

There is broad range in the number of online orders delivered to households each month. Overall, 45 percent of households did not have any online orders per the 2017 NHTS.⁽¹⁸⁾ In total, 36 percent of households made 1 to 4 online orders, 12 percent made 5 to 9 online orders, and 7.5 percent made 10 or more online orders in the past month.

In terms of household location, people living in urban areas did the most online shopping, with an average of 2.84 orders in the past month (see figure 31). People living in rural areas did the least online shopping, with an average of 2.16 orders in the past month. Just under 51 percent of people living in rural areas did not shop online in the past month. A larger discussion on access to broadband availability is included in chapter 5 of this report.



Note: NHTS asks for the number of online orders in the last month (i.e., last 30 days).

Figure 31. Average number of online orders over the past month by household location (2017).⁽¹⁸⁾

While creating increased demand for package delivery, the impacts of eCommerce may also be influencing change in travel behavior. Person trip rates have declined from an average of 4.1 trips per day in 2001 to an average of 3.4 trips per day in 2017 (see figure 32).

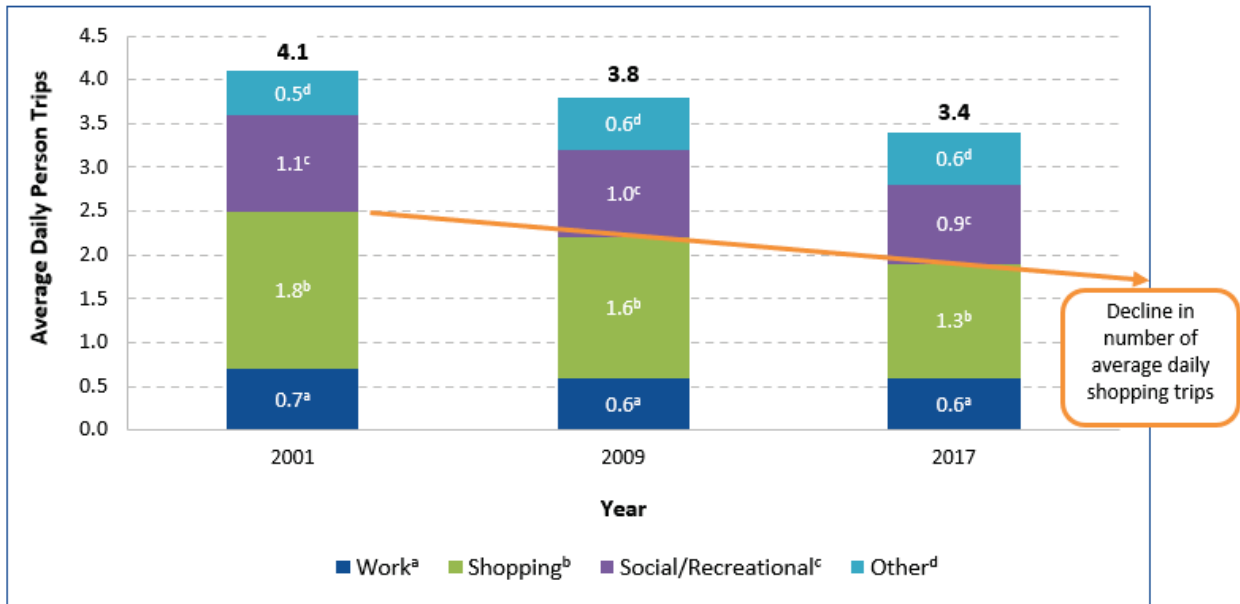
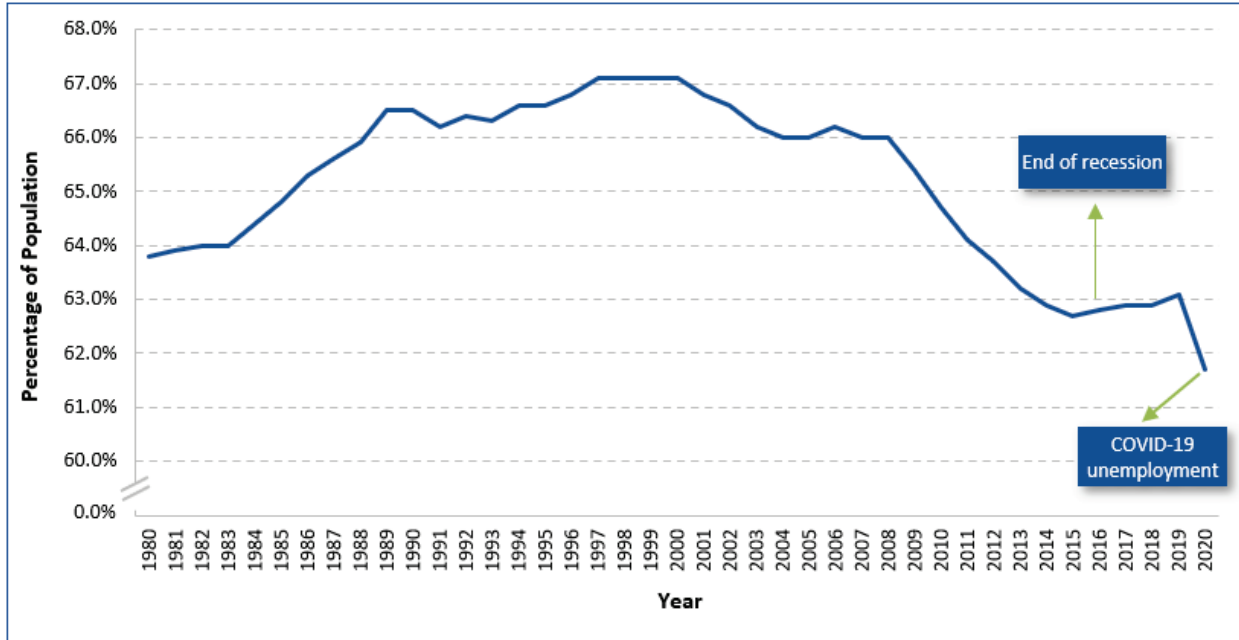


Figure 32. Average daily person trips by trip purpose (2001–2017).^(16–18)

While work, social/recreation, and other trips have remained relative constant over the past decade, the average daily number of shopping trips per person has decreased from 1.8 trips per day to 1.3 trips per day. The potential relationship between eCommerce and shopping trips warrants more rigorous analysis to better understand the impact of eCommerce on demand.

Jobs and Workers

Positive trends in GDP and employment spur increased travel. Lower unemployment rates result in a greater demand for workers to get to their jobs. As more people are employed, their purchasing power increases; this induces more shopping trips, courier delivery services, and goods shipments, as well as travel for recreation and entertainment. The percentage of the U.S. population in the workforce declined to a low of 62.7 percent in 2015 before rising to 63.1 percent in 2019 (see figure 33).



Note: Population in the workforce refers to people ages 16 and older.

Figure 33. Percent of the population in the workforce (1980–2020).⁽⁴³⁾

The decline in labor force participation in 2020 is a direct result of the pandemic. It is important to monitor labor force participation because workers historically create the most travel demand as compared to non-workers. For the 35 to 54 age cohort, people are in their peak working years, with work travel at its highest level. This cohort, however, has experienced a slight decline in labor force participation since 1999 (see figure 34). Conversely, labor force participation rates of people ages 65 to 74 and 75 and older have increased by 51.9 percent and 78.4 percent since 1999, respectively.

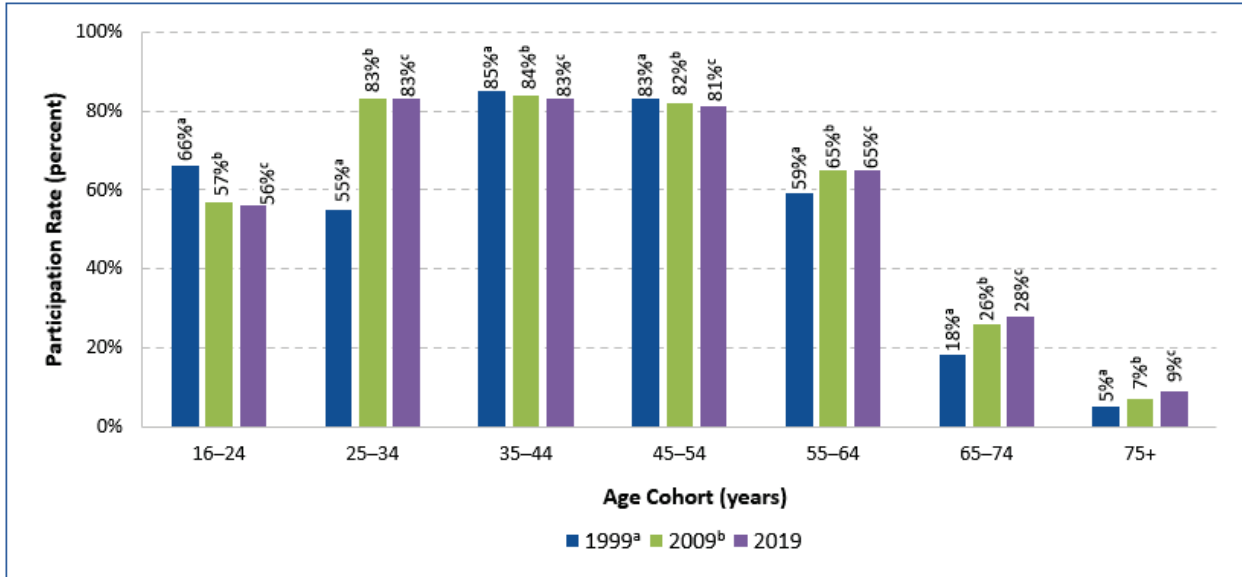


Figure 34. Labor force participation rates by age cohort (1999–2019).⁽⁴⁴⁾

In 2017, people between the ages of 35 and 44 and 45 and 54 made the most trips at 3.85 and 3.76 daily trips on average, respectively, as compared to other age cohorts (see figure 35).

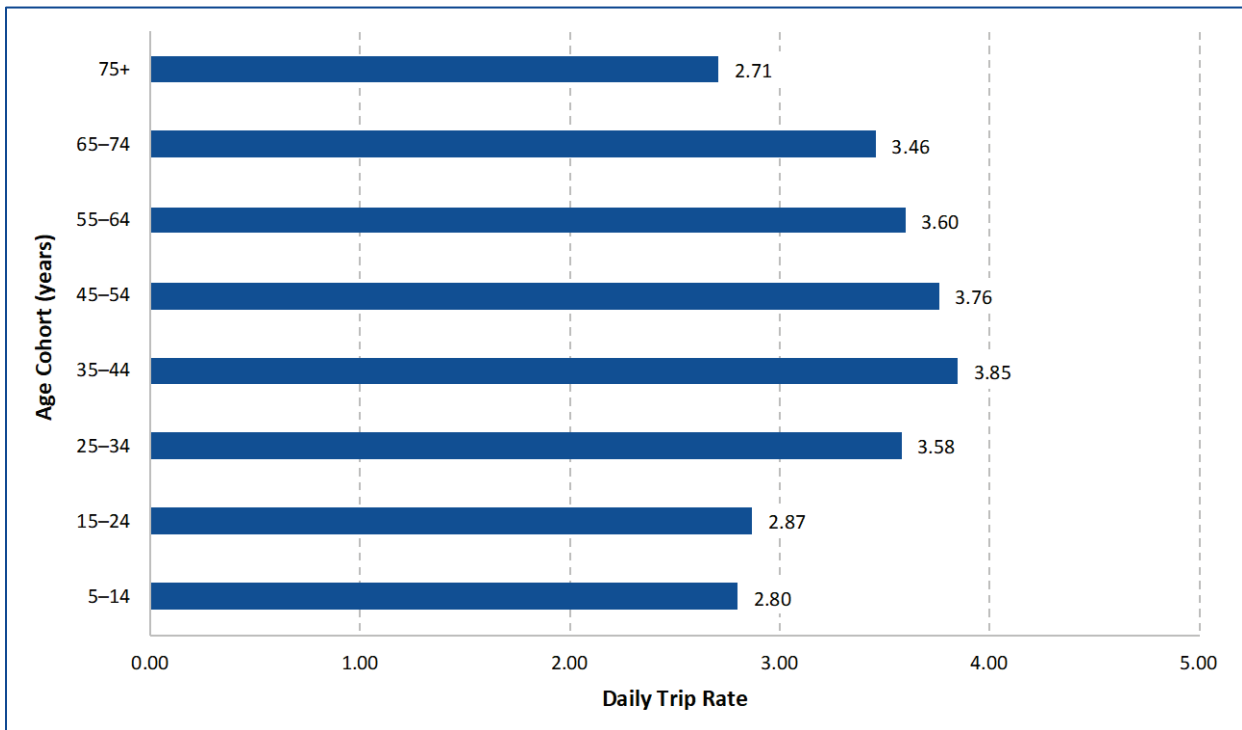


Figure 35. Average daily trip rates by age cohort (2017).⁽¹⁸⁾

Full-time workers make more trips than non-workers in every age cohort (see figure 36). The greatest difference in average daily trips per person is between workers and non-workers in the 25 to 34 age cohort.

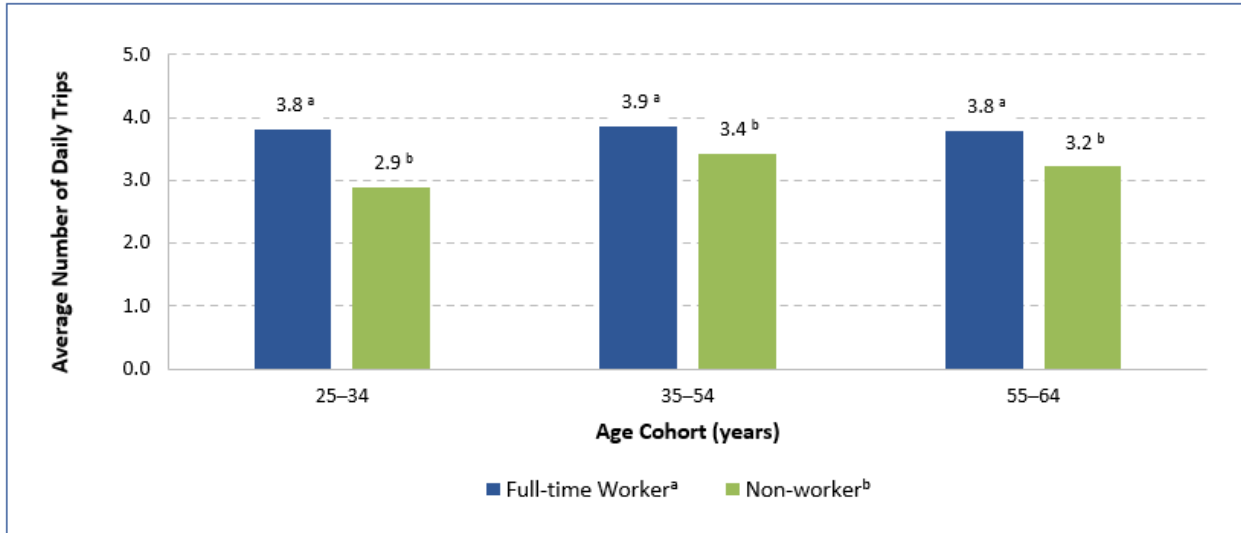


Figure 36. Average daily trips per person by worker status (2017).⁽¹⁸⁾

How People Work

Changes in who works and how they work influences the work trip and commute travel demand. For example, increased work flexibility (e.g., telework or part- and flex-time work) influences commute patterns. Also, the types of jobs often dictate people’s work schedule and flexibility. Since 2010, management, production, transportation, and service occupations have grown, while jobs in sales, office occupations, natural resources, construction, and maintenance have declined (see figure 37).

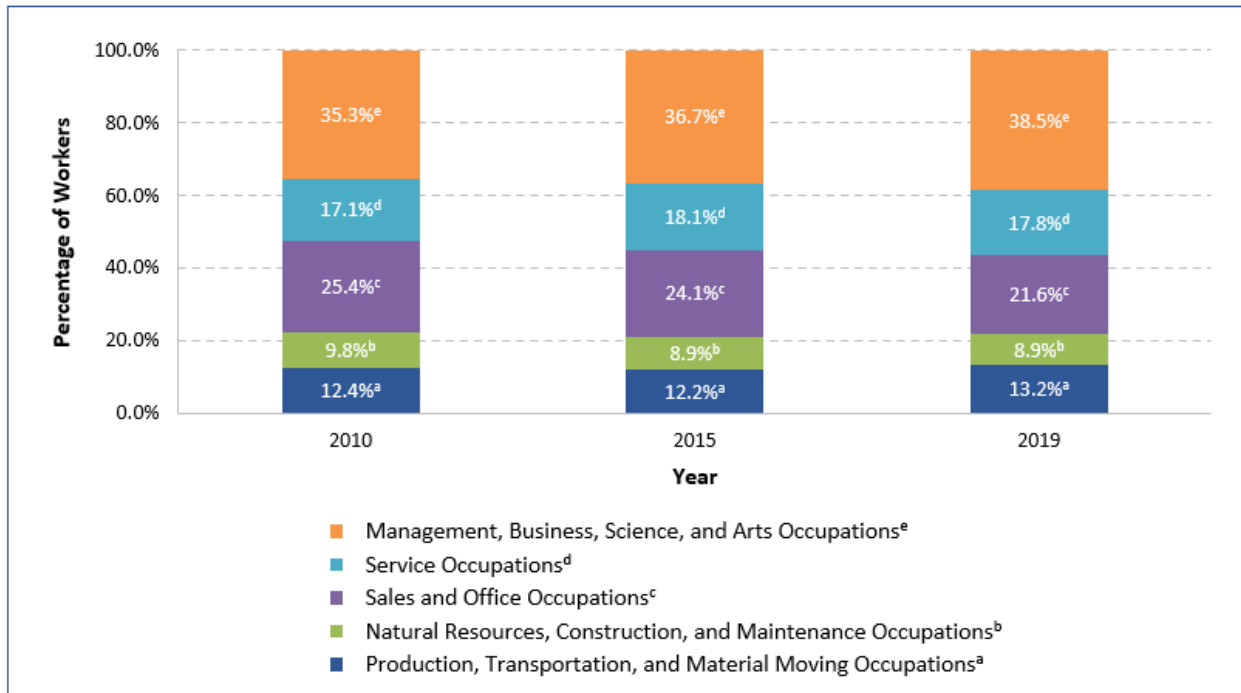


Figure 37. Percentage of workers ages 16 and older by occupation (2010–2019).⁽⁴⁵⁾

While many peak commuters can adjust their commute start times to avoid peak congestion, not all workers have that flexibility. As shown in figure 38, just under 55 percent of workers in professional and technical occupations have the flexibility in their work start times compared to less than 30 percent of workers in manufacturing, construction, maintenance, and farming.

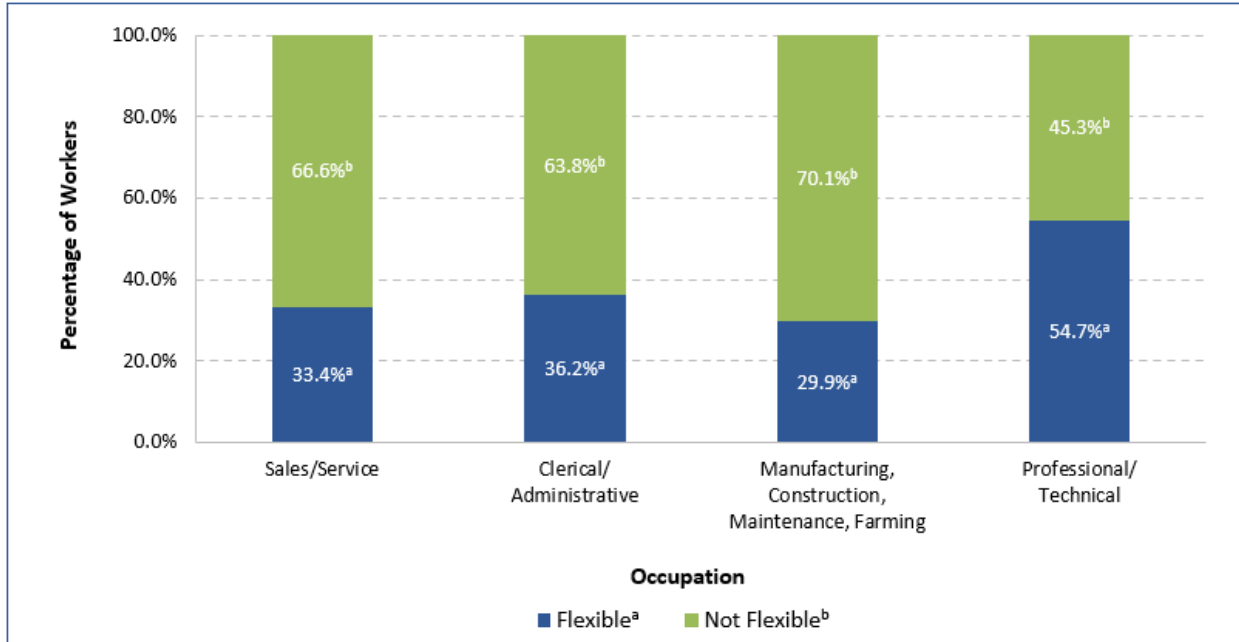


Figure 38. Work arrival time flexibility by occupation (2017).⁽¹⁸⁾

Figure 39 shows work arrival time flexibility by race and ethnicity. Across races and ethnicities, people in professional/technical fields had more flexibility in work start times than in other fields. Regardless of occupation, Black workers are less likely to have work arrival time flexibility as compared to workers of other races.

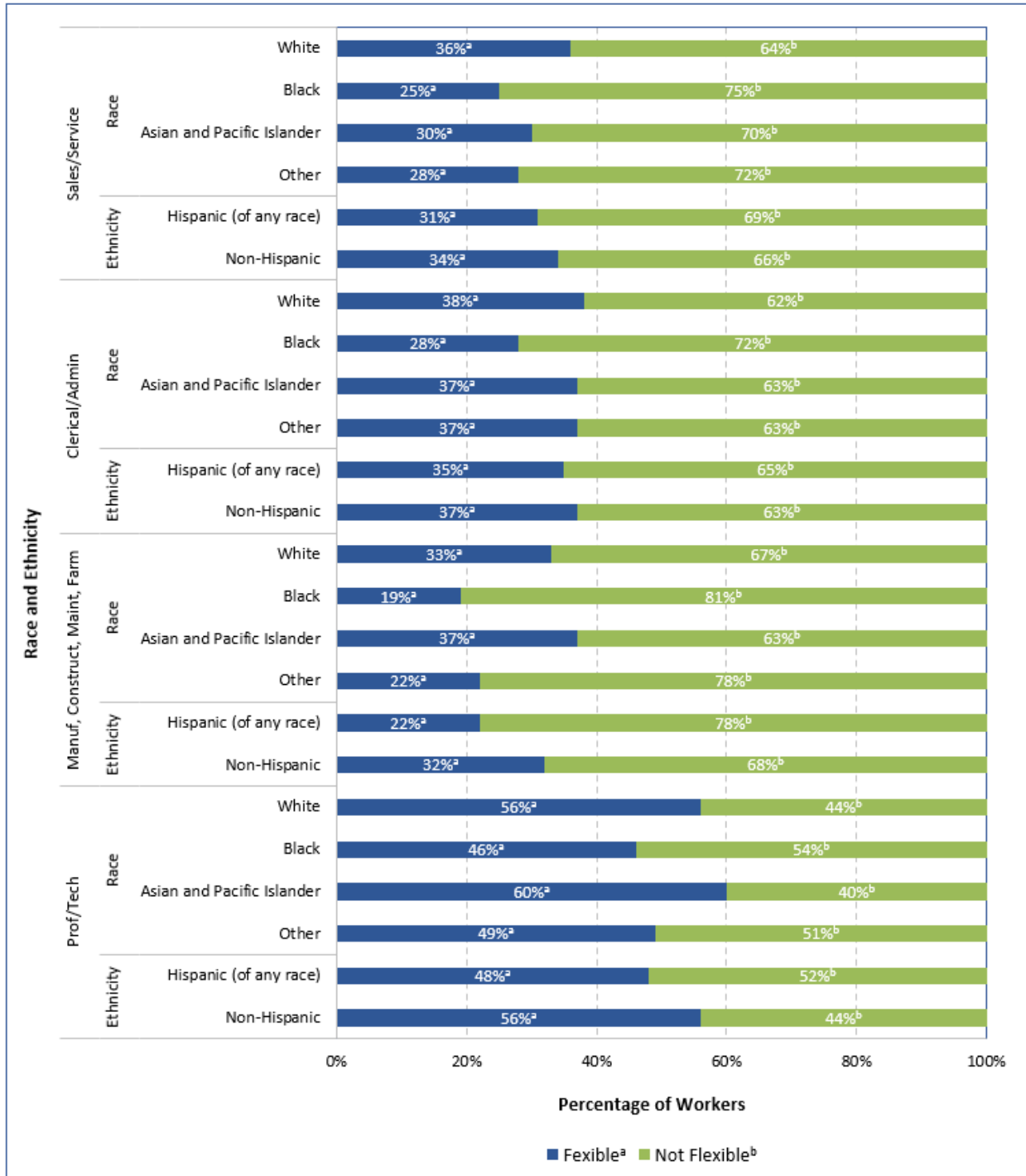


Figure 39. Work arrival time flexibility by race and ethnicity and occupation (2017).⁽¹⁸⁾

The U.S. workforce has seen tremendous growth in telework over the last few decades. The number of people who work from home has grown from 2 million in 1980 to 8 million in 2020 (see figure 40). Changes in occupation sectors and work culture as well as improvements in telecommunications speed, options, and security are likely driving this growth.

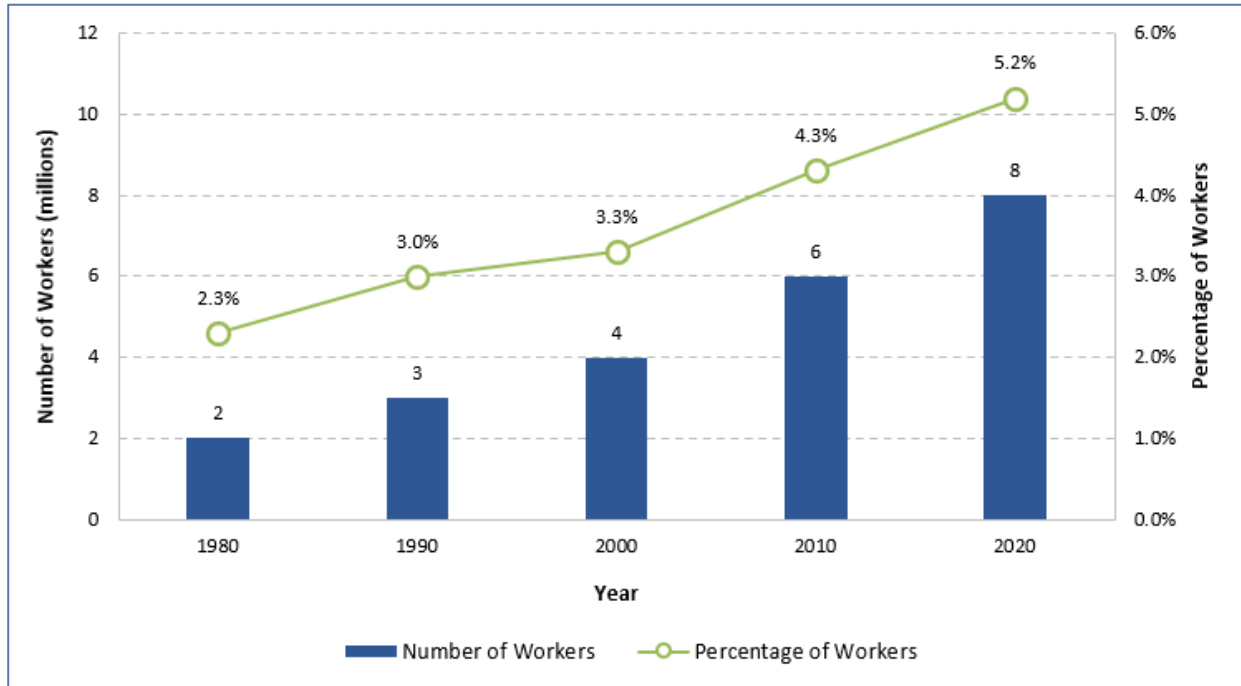


Figure 40. Trends in work from home—number and share of workers (1990–2020).⁽⁴⁶⁾

The COVID-19 pandemic and the resulting social distancing and stay-at-home orders have significantly increased the percentage of workers who worked from home in 2020. The percentage of workers working from home increased from 4.9 percent in January 2020 to a high of 40.8 percent in July and August 2020. By December 2020, 34.2 percent of all workers worked from home (see figure 41).

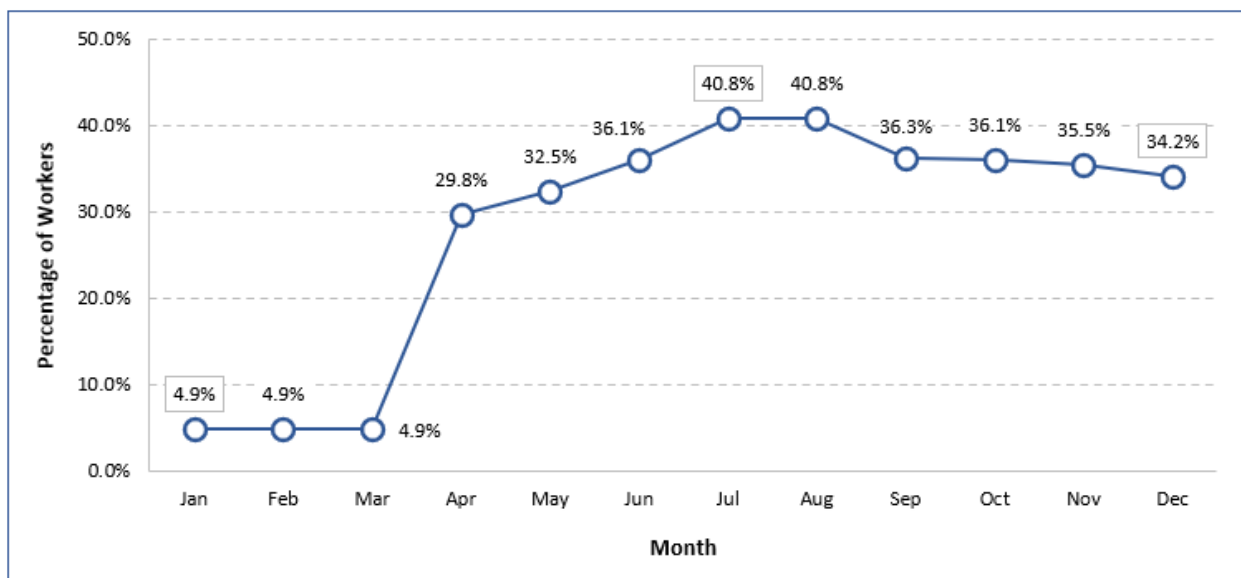


Figure 41. Percentage of teleworkers (2020).⁽⁴⁷⁾

A rising worker class in the U.S. is gig workers (i.e., independent contractors who typically do short-term work for multiple clients) (see figure 42). This is a difficult employment sector to analyze, as national data sources struggle to define and quantify this increasingly popular work arrangement. Of interest to transportation policy is the impact this employment option may have on travel, especially in the absence of a formal commute to work.

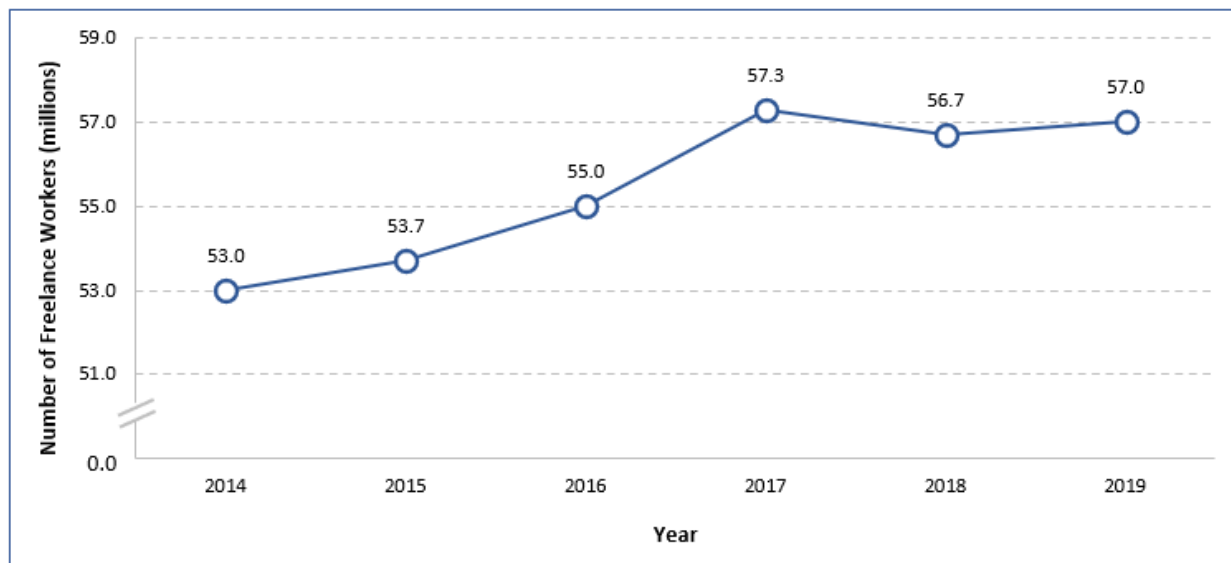


Figure 42. Number of freelance workers in the United States (2014–2019).⁽⁴⁸⁾

Income

Income affects the number of trips individuals take as well the distance traveled in each trip. Table 3 shows the average number of trips by household income per day and the average length of those trips.

Higher-income households made substantially more trips and traveled more miles on average than lower-income households. Households in the highest income quintile made 22.10 percent more trips than those in the lowest income quintile, and, on average, those trips were 71.25 percent longer.

Table 3. Number of person trips and average trip length by income (2017).⁽¹⁸⁾

Household Income	Average Number of Trips per Day	Average Trip Length (miles)
\$0–\$24,999	3.0	8.13
\$25,000–\$49,999	3.4	9.67
\$50,000–\$74,999	3.4	11.29
\$75,000–\$99,999	3.5	12.70
\$100,000+	3.6	13.93
Total	3.4	11.56

While personal vehicles were used for the majority of trips across all incomes in 2019, lower-income households were more likely to use public transit, walk, and bicycle for their travel (see figure 43). The lowest-income households (i.e., under \$10,000 per year), for example, walked for a large percentage of their trips (21.2 percent) and had the highest level of transit use at 9.1 percent of all trips.

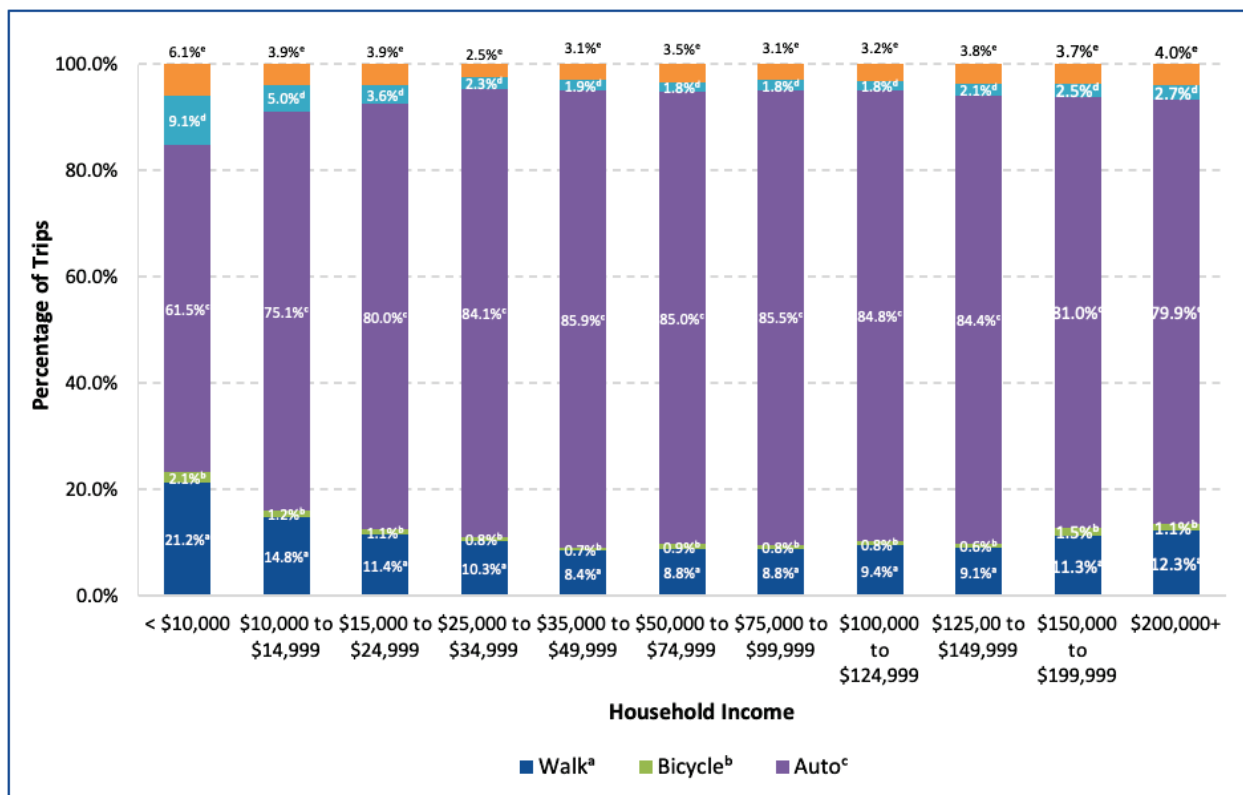
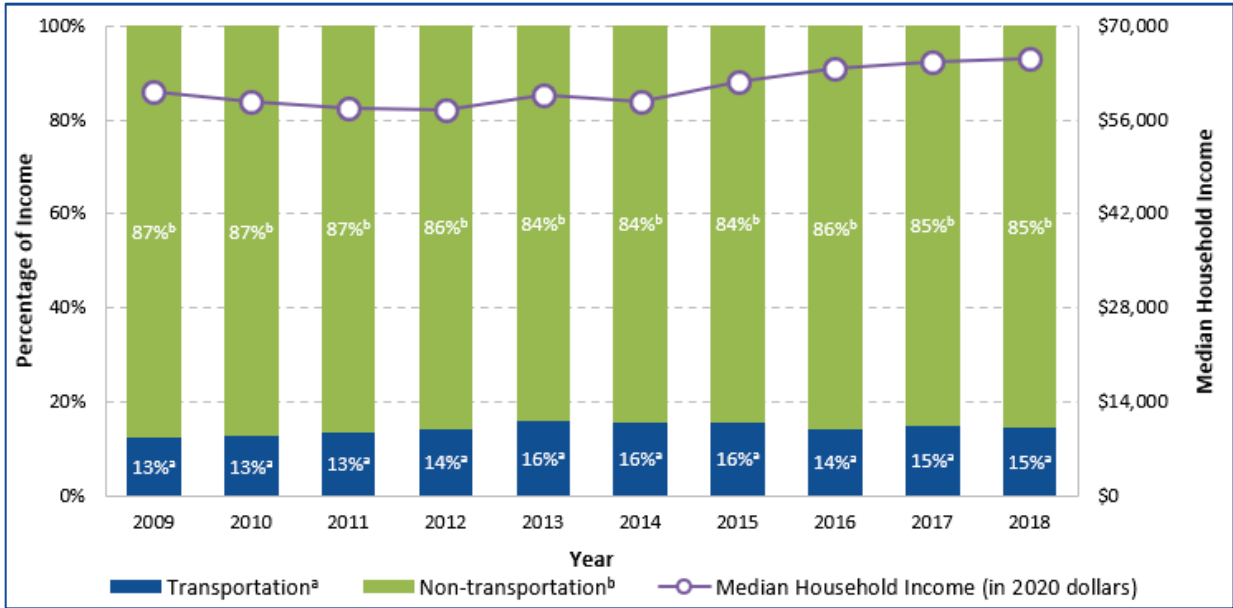


Figure 43. Percentage of trips by household income and mode of travel (2017).⁽¹⁸⁾

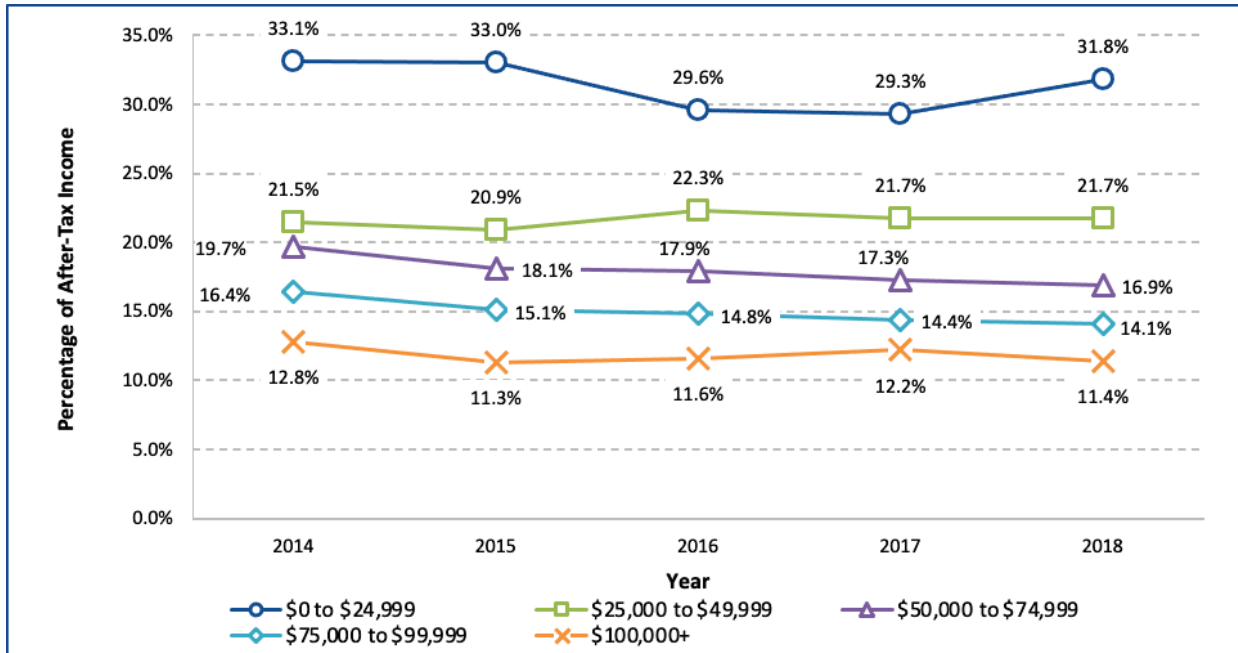
Transportation expenditures are a large portion of the household budget. From 2009 to 2018, the percentage of the household budget spent on transportation increased from 13 percent to 15 percent (see figure 44).⁽⁴⁹⁾ Expenses for transportation include things like vehicle purchases and maintenance, public transit fares, fuel, and insurance.



Note: Non-transportation category represents expenditures and non-expenditures.

Figure 44. Household income and transportation expenditures (2009–2018).^(49,50)

Low-income households pay a larger share of their income on transportation expenditures as compared to high-income households. In 2018, transportation expenditures made up 31.8 percent of household income for low-income households in the first income quintile (see figure 45). In contrast, transportation expenditures made up 11.4 percent of household income for high-income households in the fifth income quintile during this same time period.



Note: The income quintiles are rough estimates. For accurate income cut-offs of each year, refer to the “Quintiles of income before taxes” table from the Consumer Expenditure Surveys.

Figure 45. Percentage of income used for transportation by income quintile (2014–2018).⁽⁴⁹⁾

How Do Industry and Worker Trends Impact Transportation Demand?

Trends in industry and workforce, such as percentage of freight ton-miles by truck, labor force participation rate, and household income, can impact transportation demand. Let's take a closer look.

**38.7% Increase
in Freight
Ton-Miles**



Freight ton-miles (i.e., 1 ton of freight moved 1 mile) **by truck has increased**; these additional trips **drive transportation demand**.

**Labor Force
Participation
Rate Decreased
to 61.7%**



A **decline in labor force participation decreases transportation demand**. While the proportion of teleworkers has increased to 5.2% in recent years, its impact on overall demand is unknown.

**\$63,179 Average
Household
Income**



The average U.S. household income is \$63,179. As income increases, so does demand for transportation.

Chapter 5: Travel Demand

Chapter 5 Highlights

Key trends from this chapter include:

- **Household travel demand:** Over the past five decades, household travel demand has consistently outpaced population growth.
- **Travel characteristics:** In 2017, the average trip length for all trips was 11.6 miles. The average work commute was slightly longer at 12.2 miles. Travel party size for work trips has increased slightly from 1.14 in 1995 to 1.18 in 2017.
- **Commute to work:** The commute travel time increased slightly from 25.2 minutes in 2010 to 26.9 minutes in 2019. Carpooling to work decreased from 10.4 percent to 9.0 percent, while working from home increased from 4.1 percent to 5.2 percent in the same time period.

The United States relies on its highway system to connect people to their jobs, their communities, and essential services. Transportation is also especially critical for personal and business mobility by connecting people and their goods. In 2019 alone, total VMT approached 3.3 trillion miles.⁽⁵¹⁾

Historically, factors that influence growth in travel beyond population growth include many factors, such as the age distribution of the population, vehicle ownership, licensure rates, household size, labor force participation, and income. All of these factors influence travel demand; travel demand characteristics such as mode, distance, and purpose; and travel demand distribution across population groups and geographic areas.

Household Travel Demand

Over the past five decades, household travel demand has consistently outpaced population growth. It is measured in person miles traveled (PMT), which accounts for travel on all modes of transportation, and VMT, which accounts for travel by personal vehicle. Figure 46 compares trends in PMT and VMT from 2001 to 2017.⁽²⁸⁾ The growth in PMT has outpaced the growth in VMT. This means that travel via other modes has grown faster than travel by personal vehicle.

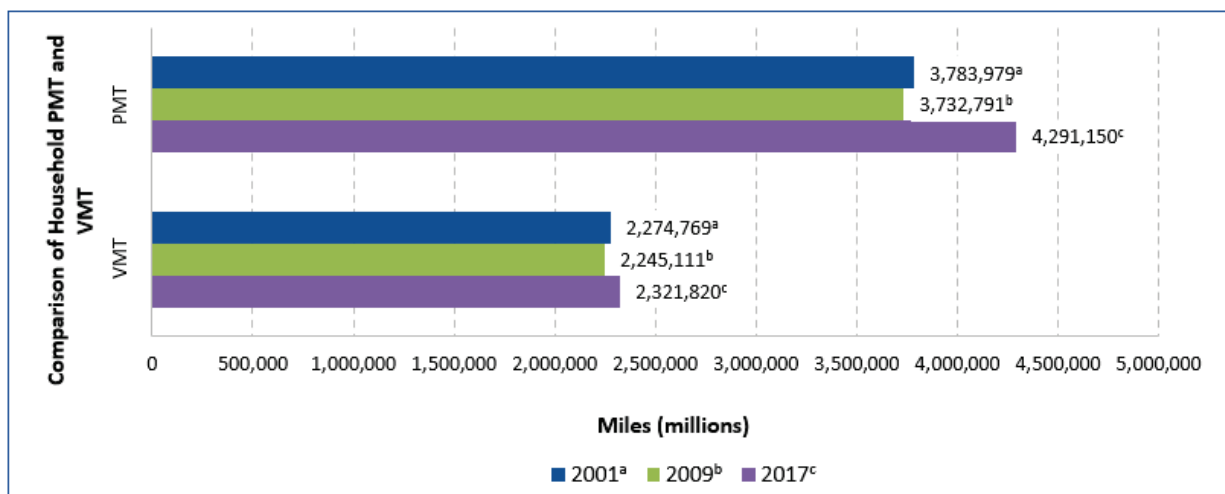


Figure 46. Household PMT and VMT trends (2001–2017).⁽²⁸⁾

Figure 47 shows trends in PMT and VMT per person and per household. While PMT (all travel modes) has increased, VMT per person and per household has decreased. The average annual miles per person (PMT) across all modes in 2017 was 14,228 miles, while the average annual VMT per person was 7,698 miles.

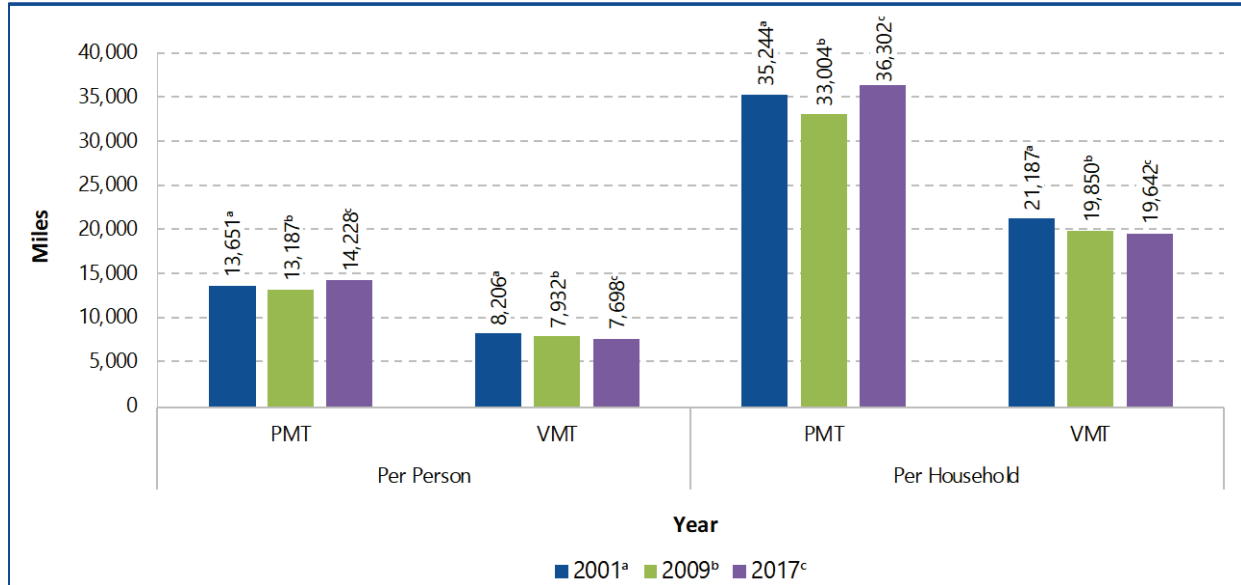


Figure 47. PMT and VMT per person and per household (2001–2017).⁽²⁸⁾

The amount of travel by U.S. households increases as income increases. The increase in travel, as measured by the average number of trips per household, is pronounced across years. In 2017, the travel gap between the lowest and highest income households averaged 1,819 trips per household per year (see figure 48).

By the Miles

Assuming an average trip length of 11.6 miles (see figure 50), high-income households travel 21,100 miles more per year than low-income households.

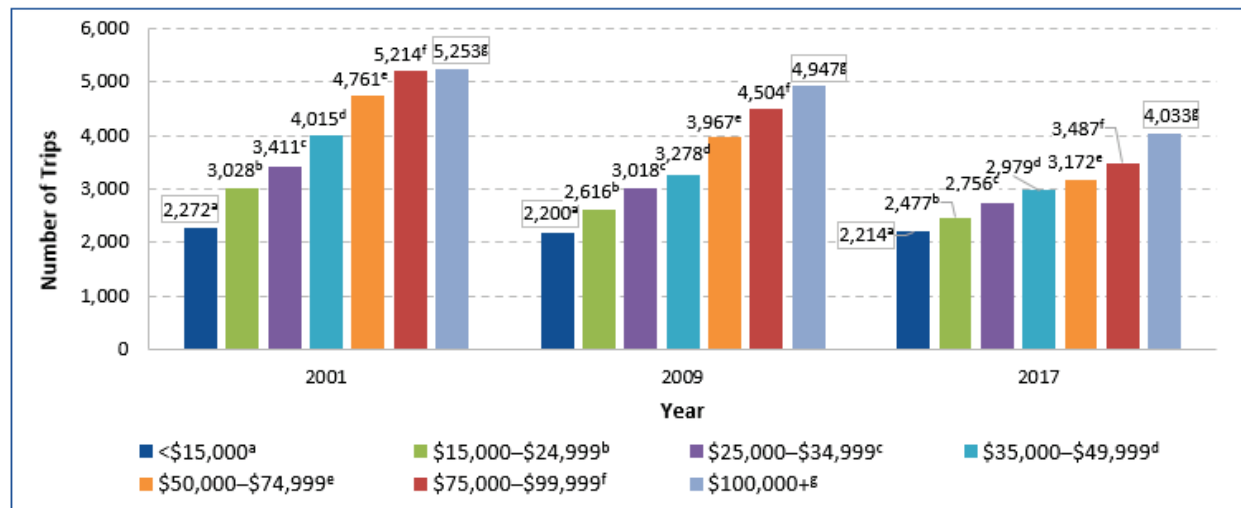


Figure 48. Average number of annual household trips by household income (2001–2017).^(16–18)

Travel Characteristics

While much attention is focused on the commute trip, people travel the most for social and recreational purposes. In 2017, over a quarter of all trips (28 percent) were for social/recreational purposes (see figure 49). This is followed by other family/personal business (20 percent) work trips (19 percent) and shopping trips (18 percent). Trips for work, school and places of worship, and social/recreational remained relatively unchanged from 2001 to 2017, while trips for shopping and family/personal business decreased from 2001 to 2017.

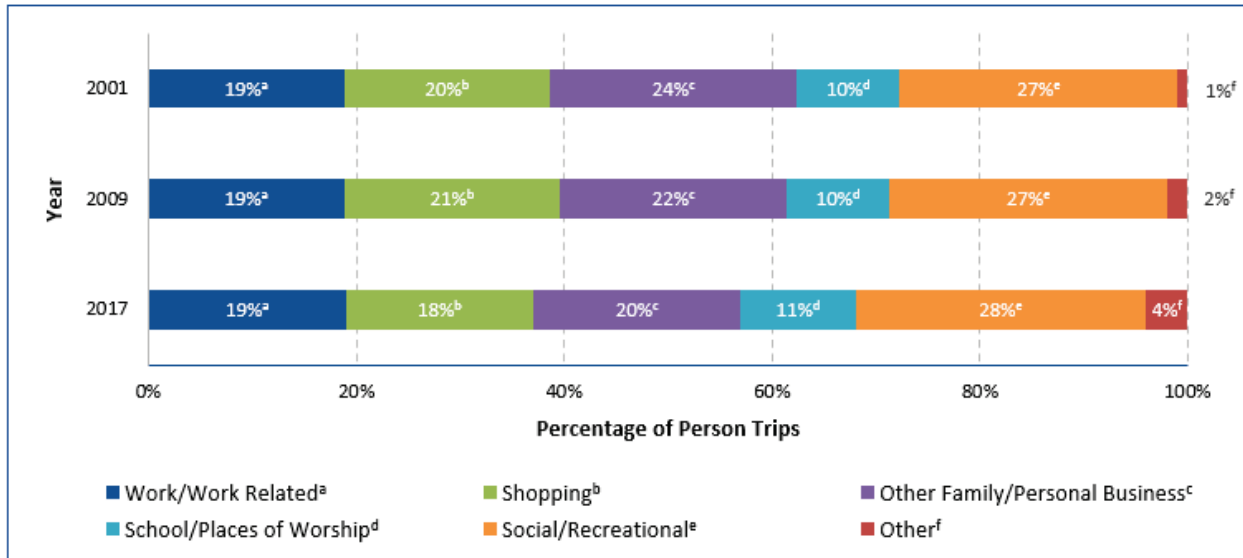


Figure 49. Percentage of person trips by trip purpose (2001–2017).^(16–18)

In 2017, the average trip length for all trips was 11.6 miles. (see figure 50). The average work commute was slightly longer at 12.2 miles. While shopping trips may have decreased in the share of total trips, the average trip length of shopping trips has increased since 1995. People are making less shopping trips; however, they are traveling further on average to shop.

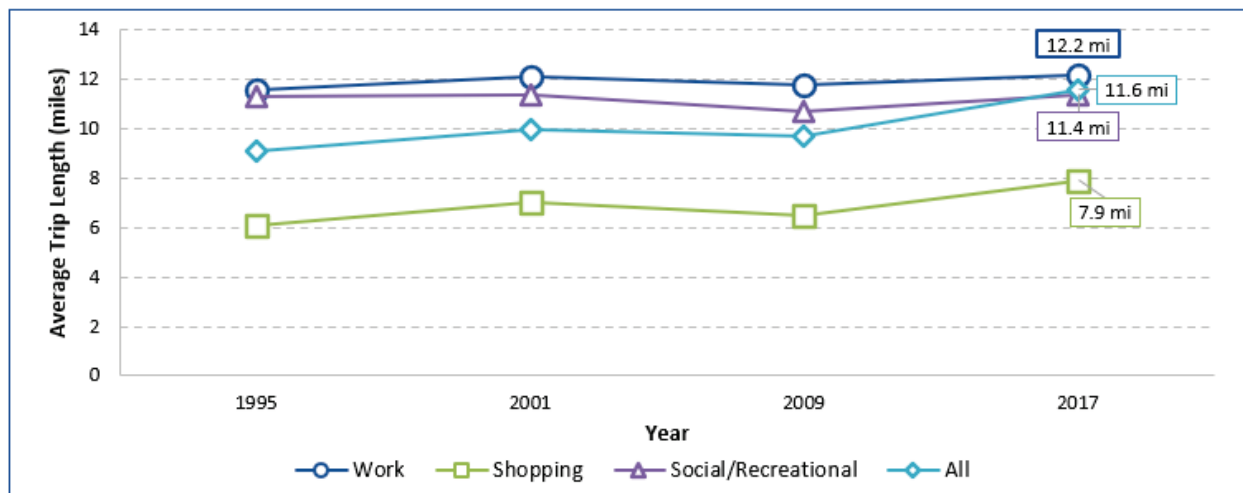


Figure 50. Average trip length by trip purpose (all modes) (1995–2017).⁽²⁸⁾

As expected, average trip length varies by household location, as shown in figure 51. The average trip length is similar for those living in urban and second city environments, increases for those living in suburban and small towns, and is longest for people living in rural areas.

Did You Know?
 People living in lower-density rural areas travel 77 percent further on average per trip than urban travelers.

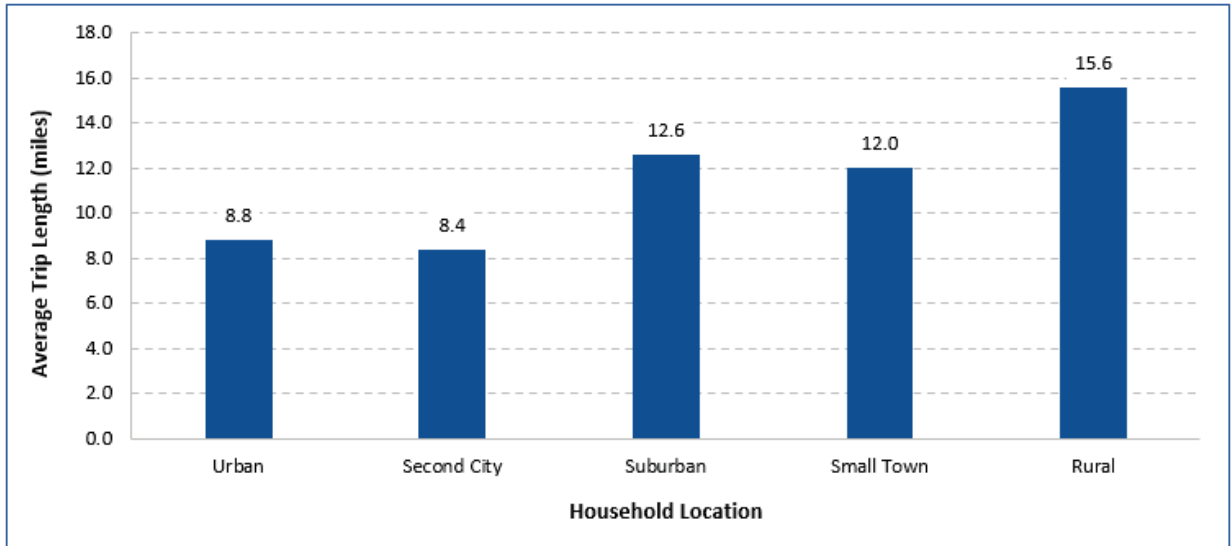


Figure 51. Average trip length by household location (2017).⁽¹⁸⁾

Encouraging carpooling and ride sharing is a common strategy to reduce congestion and emissions and improve travel times. However, very little has changed with respect to travel party size. Overall, there was no change in travel party size for all trips between 2009 and 2017 (see figure 52). Work trip travel party size increased only slightly from 1.14 in 1995 to 1.18 in 2017.

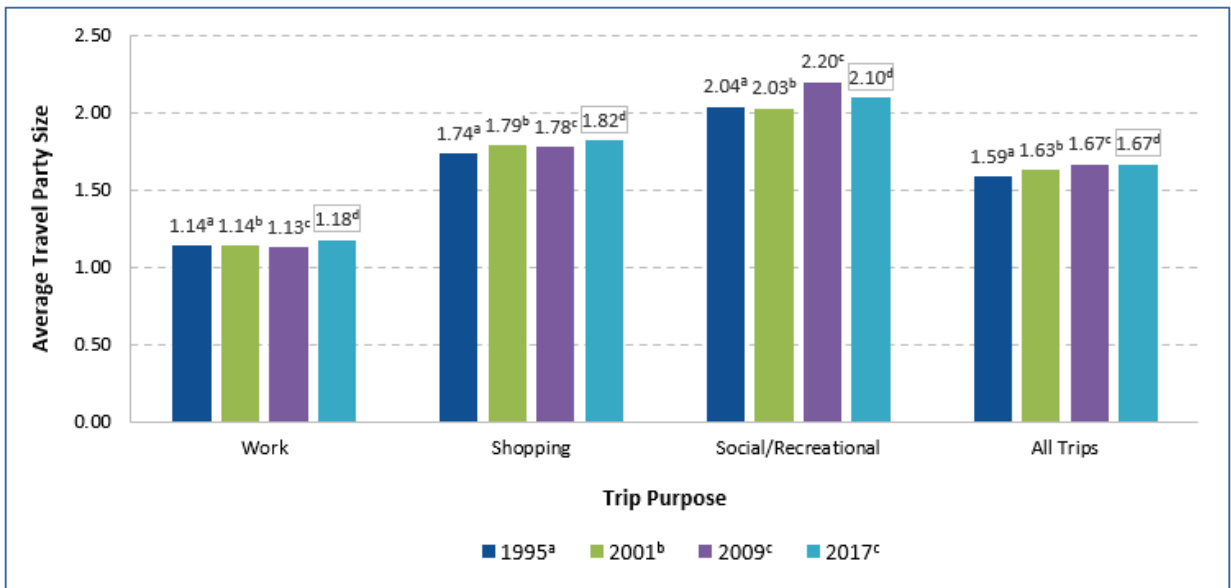


Figure 52. Average vehicle trip travel party size by trip purpose (1995–2017).⁽²⁸⁾

There is little difference in travel party size across household locations (see table 4). The only exception is rural areas, where the average travel party size for vehicle trips is slightly higher at 1.74 persons per vehicle.

Table 4. Average vehicle trip travel party size by household location (2017).⁽¹⁸⁾

Household Location	Average Travel Party Size
Urban	1.65
Second city	1.63
Suburban	1.65
Small town	1.67
Rural	1.74
All	1.67

Mode share is the percentage of all travel that each mode is used for. This is often relayed in terms of percentage of all trips. Personal vehicles were used for 82.6 percent of trips in 2017—a slight decrease from 83.6 percent in 2009. The share of public transit trips increased from 1.9 percent in 2009 to 2.5 percent in 2017 (see table 5).

Table 5. Changes in travel mode choice (2009 vs. 2017).^(17,18)

Travel Mode	2009	2017
Walk	10.5%	10.5%
Bicycle	1.0%	1.0%
Personal vehicle	83.6%	82.6%
Public transit	1.9%	2.5%
Other	3.0%	3.5%
All	100.0%	100.0%

The mode choice of people living in rural areas is very similar to people living in second cities, suburbia, and small towns. Approximately 88.4 percent of trips made by those living in rural areas were made by personal vehicles. Similarly, 82.9 percent of second city, 87.2 percent of suburban, and 88.9 percent of small-town trips were made by personal vehicles. Only 63.4 percent of trips were made by personal vehicles for people living in urban areas.⁽¹⁸⁾

Urban travelers were much more likely than other household location areas to choose walking (22.2 percent) and transit (9.2 percent) for travel (see figure 53).

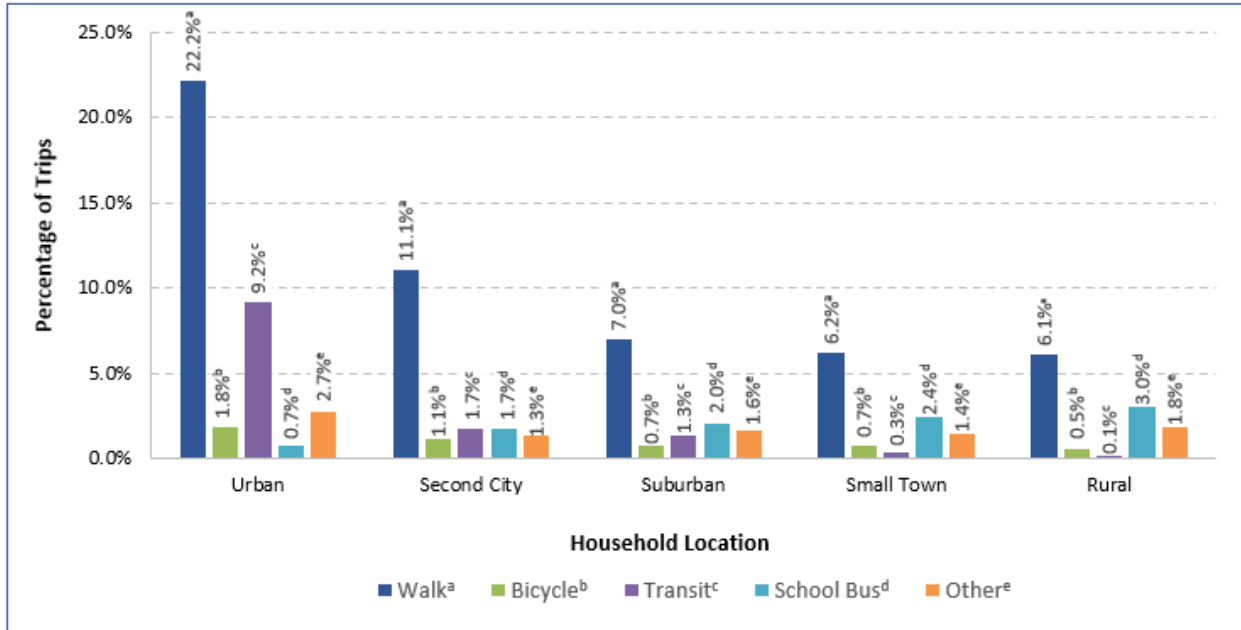


Figure 53. Mode choice by household location (2017).⁽¹⁸⁾

Commute to Work

The commute to and from work is a critical component of overall transportation demand. On average, in 2017, workers made more trips per day than non-workers (see figure 54). Workers ages 35 to 54 made the most trips per day on average.

Commutes often occur during peak travel periods, and trips to and from work are often partnered with other trips, such as dropping off kids at school, shopping, or other types of activities.

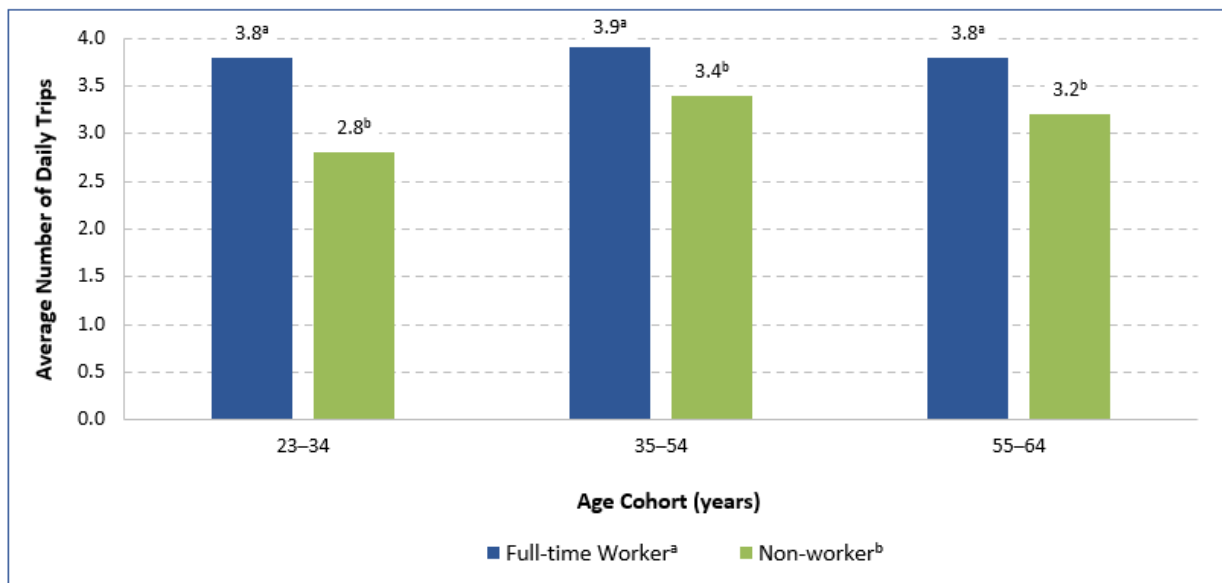


Figure 54. Average daily number of trips by worker status (2017).⁽¹⁸⁾

The average trip distance to work has not changed since 2001 (12.1 miles in 2001 and 12.2 miles in 2017). However, as expected, trip distance to work does vary across household locations. As shown in figure 55, in 2017, people living in urban areas traveled shorter distances to work (8.9 miles) compared to those living in rural areas, who traveled on average 14.8 miles for their one-way work trip.

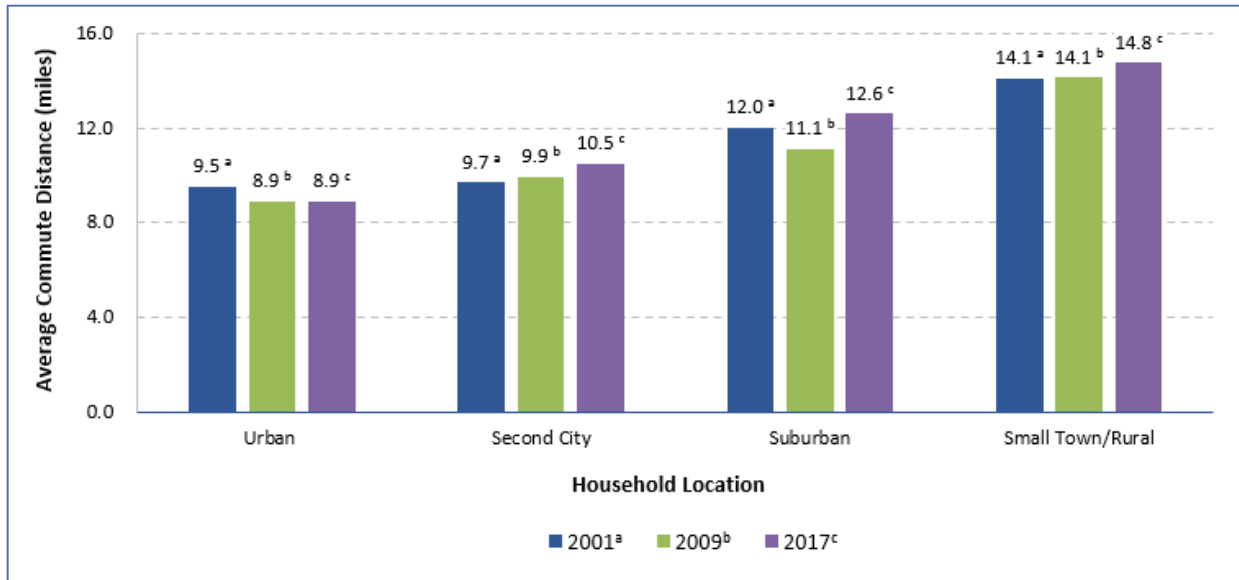


Figure 55. Average commute distance to work by household location (2001–2017).^(16–18)

In contrast, people living in urban areas experienced the longest work commute time on average. In 2017, urban workers spent an average of 30.6 minutes traveling to work (see figure 56), while rural workers spent an average of 24.8 minutes commuting each way.

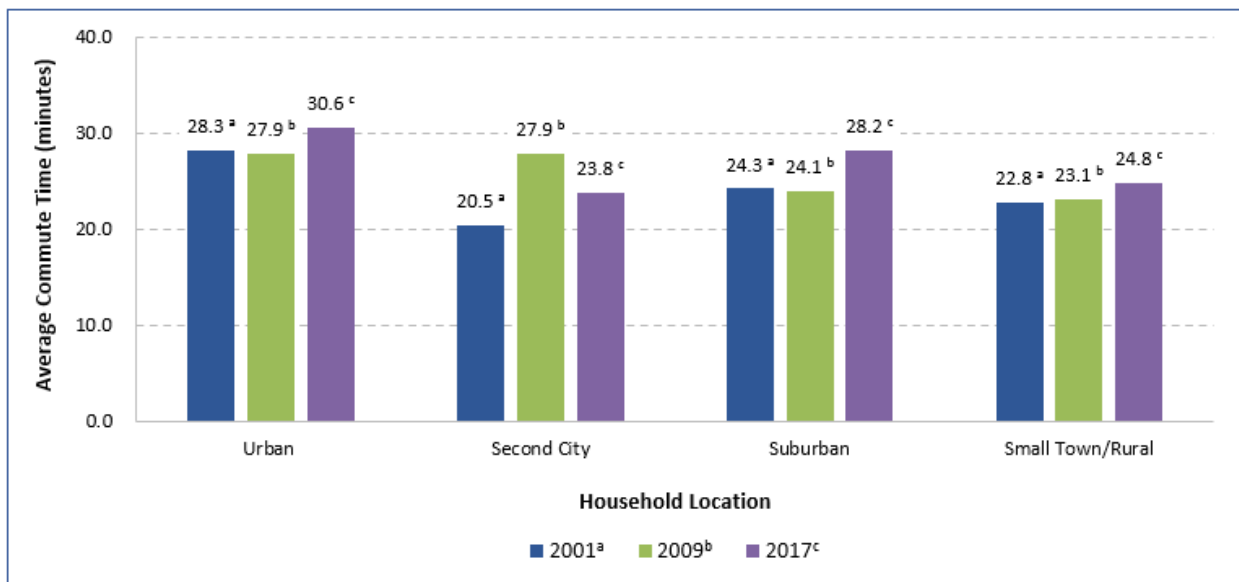


Figure 56. Average travel time to work by household location (2001–2017).^(16–18)

Urban commuters have the shortest average commutes by distance, but the longest average commutes based on time traveled. The long travel time for urban workers stems from a combination of urban congestion and longer transit travel times. As shown in figure 57, travel time to work via transit averaged 50.6 minutes each way in 2019. This time is almost double other popular commute modes, such as driving alone (26.4 minutes) and carpooling (28.5 minutes).

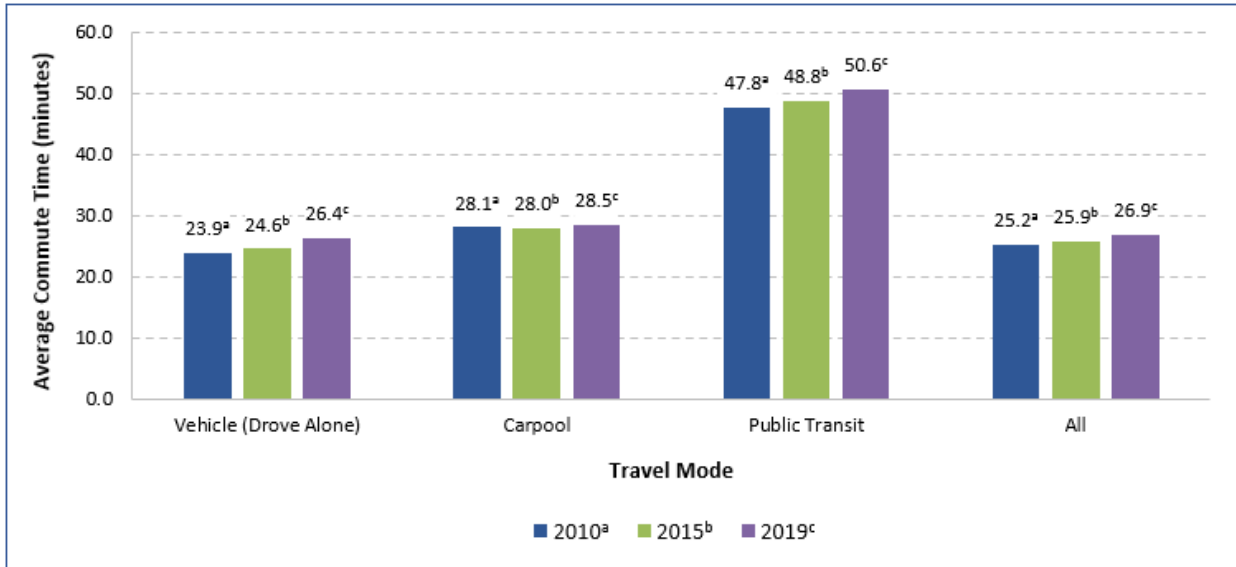


Figure 57. Average travel time to work by travel mode (2010–2019).⁽⁴⁶⁾

There are some interesting trends happening in typical mode to work (see figure 58). Public transit, walk/bicycle, and other modes have seen little change over the past decade. Drive alone to work increased slightly (76.0 percent in 2010 to 76.3 percent in 2019). Conversely, carpooling and work from home have changed significantly. Carpooling to work decreased from 10.4 percent in 2010 to 9.0 percent in 2019, while work from home increased from 4.1 percent to 5.2 percent during this same time period.

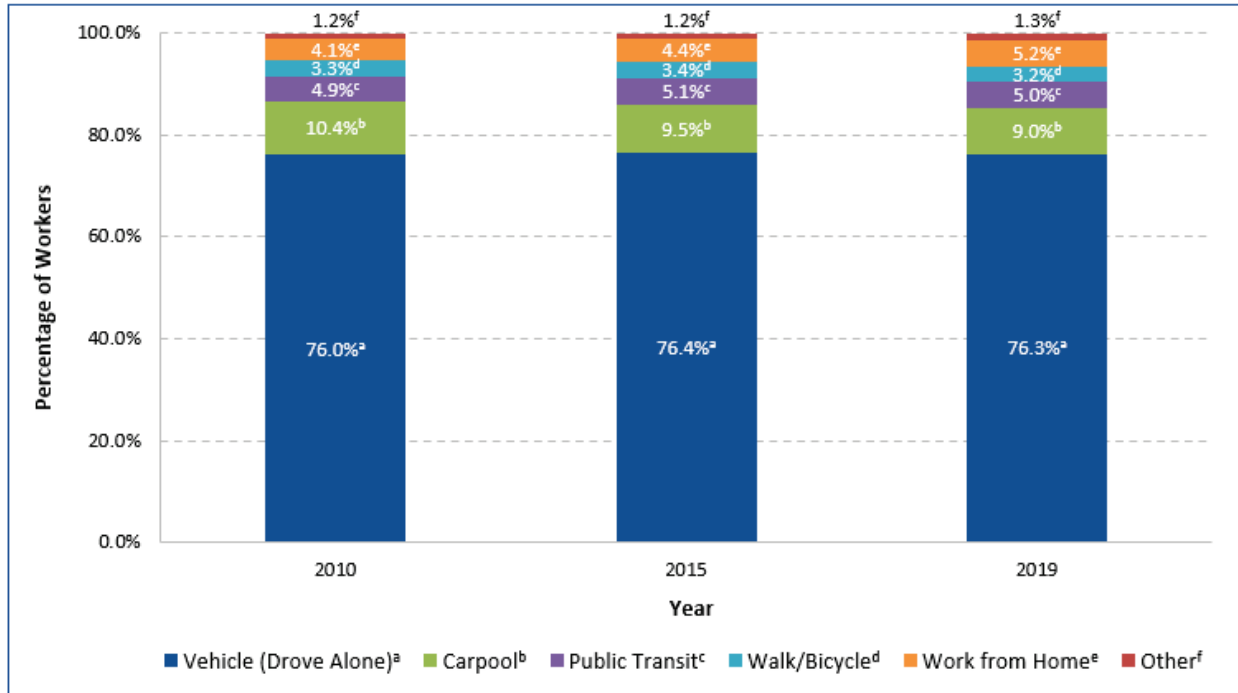


Figure 58. Percentage of workers by commute mode (2010–2019).^(52–54)

How Do Trends in Travel Impact Transportation Demand?

It is important to study trends in travel, like PMT, VMT, travel party size, and average commute distance, to better understand impacts on transportation demand. For example:

14,228 Miles of PMT and 7,698 Miles of VMT



PMT per person has increased across all transportation modes; this **drives transportation demand**. Concurrently, **VMT per person has decreased**, indicating **decreased demand for auto travel**.

Average Travel Party Size of 1.67 People



Average travel party size has decreased to 1.67 people per trip. This indicates an **increased demand for transportation**.

Average Commute Distance of 12.2 Miles



Average commute distance has been **relatively stable over time**, so it does **not have an impact on demand**.

Chapter 6: Technology Trends



Chapter 6 Highlights

Key trends from this chapter include:

- **High-speed telecommunications:** High-speed Internet service is available to 97 percent of Americans in urban areas, 65 percent in rural areas, and 60 percent on tribal lands.
- **Innovation in transportation services:** More change has occurred in the last 6 years than in the last 60 years in terms of transportation options.
- **Shared mobility:** In 2019, there were 136 million trips using shared micromobility.; 63 percent of those trips were made using e-scooters.
- **Mobility hubs:** Mobility hubs, an emerging transportation service, provide an integrated suite of mobility services, amenities, and supporting technologies.
- **Vehicle technologies:** In 2018, there were around 208,000 new registrations of EVs and HEVs, twice the registrations in 2017.

Now more than ever, advances in technology are transforming transportation. Internet access, information technology, and new transportation service models are facilitating the emergence of new modes of travel and innovative use of traditional modes. Technology is enabling alternative transportation options, such as autonomous movement of goods and people, to become a more likely possibility. These advances in how people and goods move through the system provide new opportunities and challenges for improved transportation safety, access, and mobility.

Technology is also changing the interface between users and the transportation system. Wireless connectivity has made the sharing of information across modes of travel more timely, accurate, and user friendly.

Traveler information encompasses a wide variety of media, modes, and types of information. From its roots in radio, television, and telephone, traveler information has evolved at a rapid rate over the past decade, a trend that is expected to continue toward increasingly real-time with multiple information access options.



What Are Examples of Traveler Information?

A wide range information is available to system users, in most cases, at the touch of a button in real time! Examples may include:

- ▶ Predicted travel times
- ▶ Travel speeds
- ▶ Service schedules/wait times
- ▶ Areas of congestion
- ▶ Alternative routes to a destination
- ▶ Presence of tolls
- ▶ Work zone locations
- ▶ Crash/incident locations
- ▶ Special events
- ▶ Weather conditions/alerts
- ▶ Road/facility closures
- ▶ Location of cameras, police, school zones, etc.
- ▶ Snowplow status
- ▶ Wait times
- ▶ Vehicle location and availability
- ▶ Planned limited services (e.g., transit)
- ▶ Unplanned service interruptions
- ▶ Alternative modes of travel
- ▶ Nearby services (e.g., gas stations, charging stations)
- ▶ Shipment and delivery status
- ▶ Parking availability
- ▶ Fitness goals
- ▶ Walking distance/time
- ▶ Emissions/fuel usage

High-Speed Telecommunications

It is often access to high-speed telecommunication that makes new and emerging transportation services possible. This includes traveler information (e.g., congestion and work zone alerts, transit arrival times, and trip emissions impacts), access to new modes of travel (e.g., shared bicycles, cars, or scooters), and integration and interoperability for trip planning, seamless modal transfers, and fare and toll payments.

These same enhanced communication capabilities also enable people and businesses to substitute communication for travel. Be it eCommerce, distance learning, telehealth, telework, or remote banking, one of the most pervasive influences of communication capabilities on travel has been the opportunity to not travel and to use communication tools instead.

Internet access is virtually a requirement for participating in the modern global economy, and broadband Internet has become an increasingly important factor in the economic health and sustainability of a region.

Nearly 30 million Americans do not have access to transportation services and transportation alternatives (such as eCommerce) enabled through the Internet.

Change is happening rapidly in telecommunications. Different organizations provide different estimates of access to high-speed Internet. The basics, however, are still the same. Access to high-speed Internet is growing every year, with “access” defined as whether or not someone in the household uses or connects to the Internet regardless of whether or not they pay for the service. In 2015, only 77.3 percent of U.S. households had access to high speed Internet; by 2018, that number was over 85 percent (see figure 59).⁽⁵⁵⁾ More recent data from 2020 estimate high-speed Internet access at over 93 percent of all households.⁽⁵⁶⁾

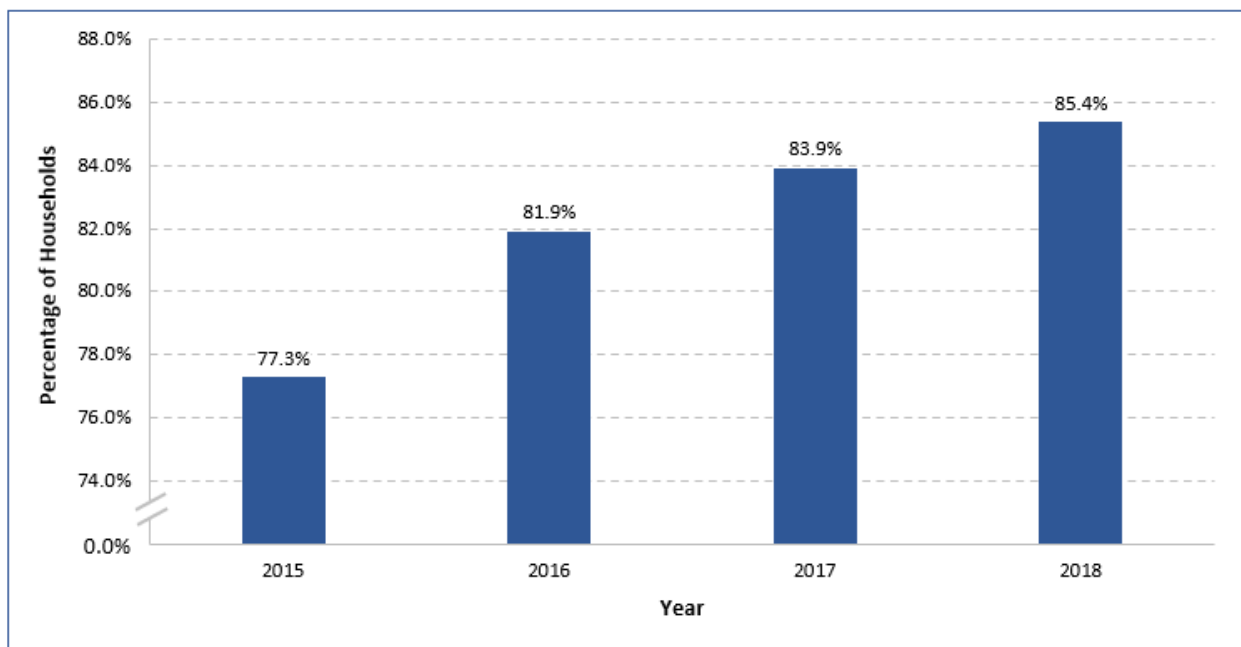


Figure 59. Percentage of U.S. households with Internet access (2015–2018).⁽⁵⁵⁾

According to the Federal Communications Commission (FCC), 97 percent of Americans in urban areas have access to high-speed fixed service.⁽⁵⁷⁾ In rural areas, that number falls to 65 percent. That number continues to decrease to 60 percent on tribal lands. In total, nearly 30 million Americans do not have access to transportation services or alternatives to transportation (such as eCommerce and remote learning) that the Internet enables. Access and connection speed are central to the new and emerging transportation service and modal options that can serve to improve access and mobility of underserved populations.

Communities without access to high-speed Internet are more likely to have lower-than-average population size, lower population density, and lower personal and household income as compared to communities with access to high-speed telecommunications (see table 6). In order to close the digital divide between urban and rural areas, the FCC authorized funding beginning in 2019 and continuing over the next decade with the goals of maintaining, improving, and expanding affordable rural broadband for 455,334 homes and businesses served by 171 carriers in 39 States and American Samoa, including 44,243 locations on tribal lands.⁽⁵⁸⁾

Table 6. Demographics for Census block groups with and without access to broadband (2018).⁽⁵⁸⁾

Broadband Access	Average Population Size	Average Population Density	Average Per Capita Income (2018 Dollars)	Average Median Household Income (2018 Dollars)
United States				
With	1,544.5	7,940.4	\$34,174.45	\$69,911.65
Without	1,502.4	1,497.4	\$28,194.59	\$56,344.62
Rural Areas				
With	1,533.0	196.4	\$33,855.27	\$69,510.34
Without	1,446.0	90.1	\$28,489.00	\$57,330.60
Urban Areas				
With	1,545.6	8,643.9	\$34,203.40	\$69,948.42
Without	1,577.0	3,357.1	\$27,802.86	\$54,998.17

Innovation in Transportation Services

During the latter half of the 20th century, transportation policies emphasized personal vehicle ownership and use and, to a lesser extent, the use of other modes such as transit, walking, bicycling, and taxis. However, recent technology innovations have expanded beyond traditional transportation and ownership models; more change has occurred in the last 6 years than in the last 60 years in terms of transportation options (see figure 60). The expansion of technology innovations into the transportation space is enabling new business models and increasing the private sector’s participation in for-profit transportation services.

Through innovations in transportation services, travelers can request a ride; access a shared car, bicycle, or scooter; ride a private shuttle on-demand; and have groceries, packages, or take-out food delivered, all using Internet-enabled smartphones and tablets.

Advancements in Transportation Modes and Services Over Time

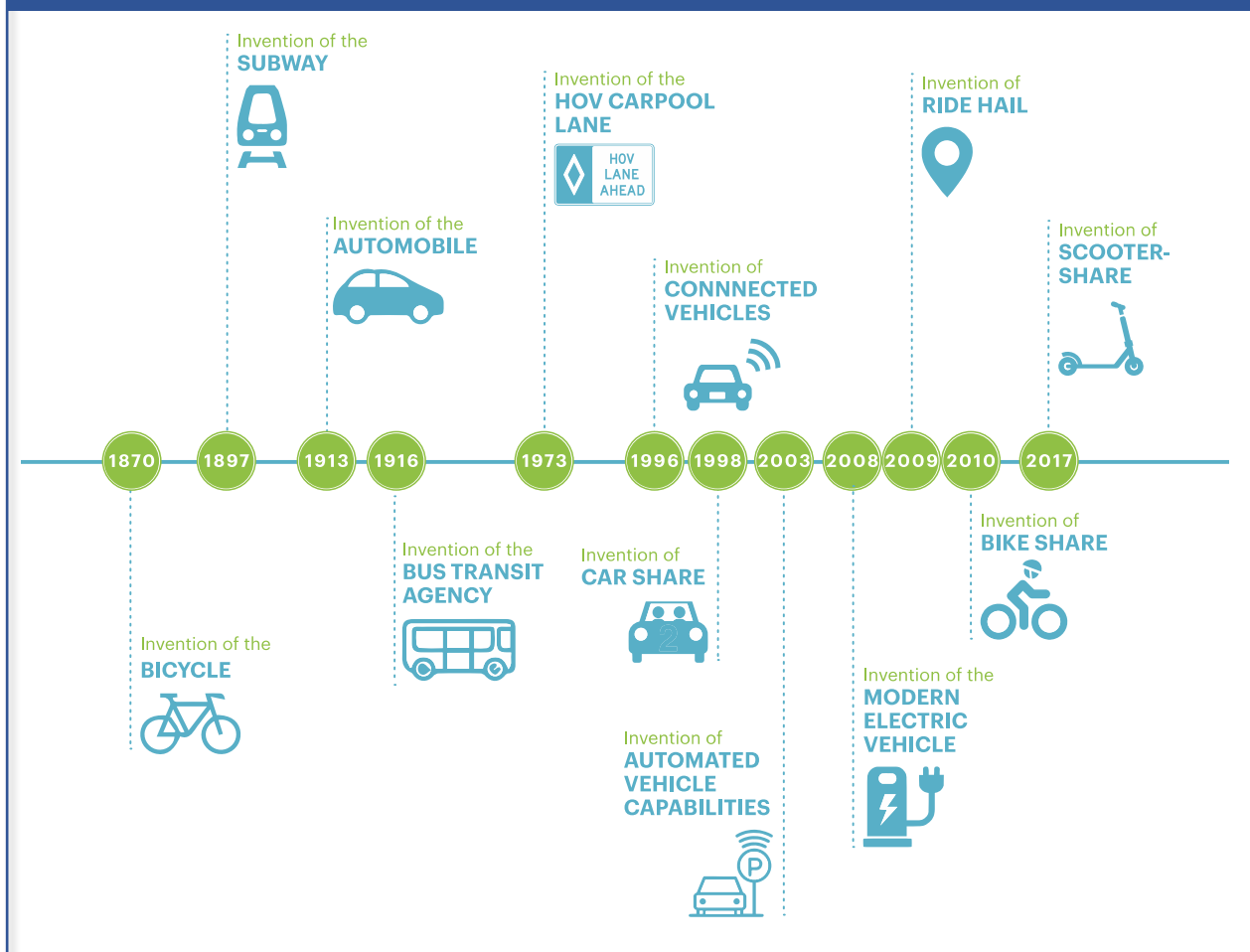


Figure 60. Advancements in transportation modes and services over time.

Shared Mobility

Shared mobility is a term used to describe motorized or nonmotorized vehicles that are shared among users. Technically, any mode shared by users for travel, including transit, commuter buses, passenger rail, and airplanes, are shared modes of travel. In this context, however, shared mobility refers to new and emerging business models that provide personal access to transportation modes that before could only be used if owned, borrowed, or formerly leased by the traveler. Shared mobility is having a transformative impact on many cities by providing new ways to access goods and services. The services are provided mainly in urban areas, where density is higher, and most trips involve shorter distances compared with those in suburban or rural areas.

Shared mobility includes a variety of service models and transportation modes that meet the diverse needs of travelers such as car sharing, bicycle sharing, and scooter sharing. Shared

mobility—in particular, car sharing—fundamentally changes the cost structure of travel: instead of using a private auto with fixed costs, car share users access a shared vehicle with variable costs. This “pay as you go” pricing model provides vehicle access on an as-needed basis without the cost of ownership.

Micromobility includes any small, low-speed, human or electric-powered transportation device, including bicycles, electric-assist bicycles (e-bicycles), scooters, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances. Cities across the Nation have witnessed increasing deployment of shared micromobility, such as bikeshare (with and without docking stations) and e-scooters. In 2019, there were 136 million trips using shared micromobility, with 63 percent made using e-scooters (see figure 61). In comparison, 84 million trips using shared micromobility were taken in 2018 and 46 percent of those trips made using e-scooters.

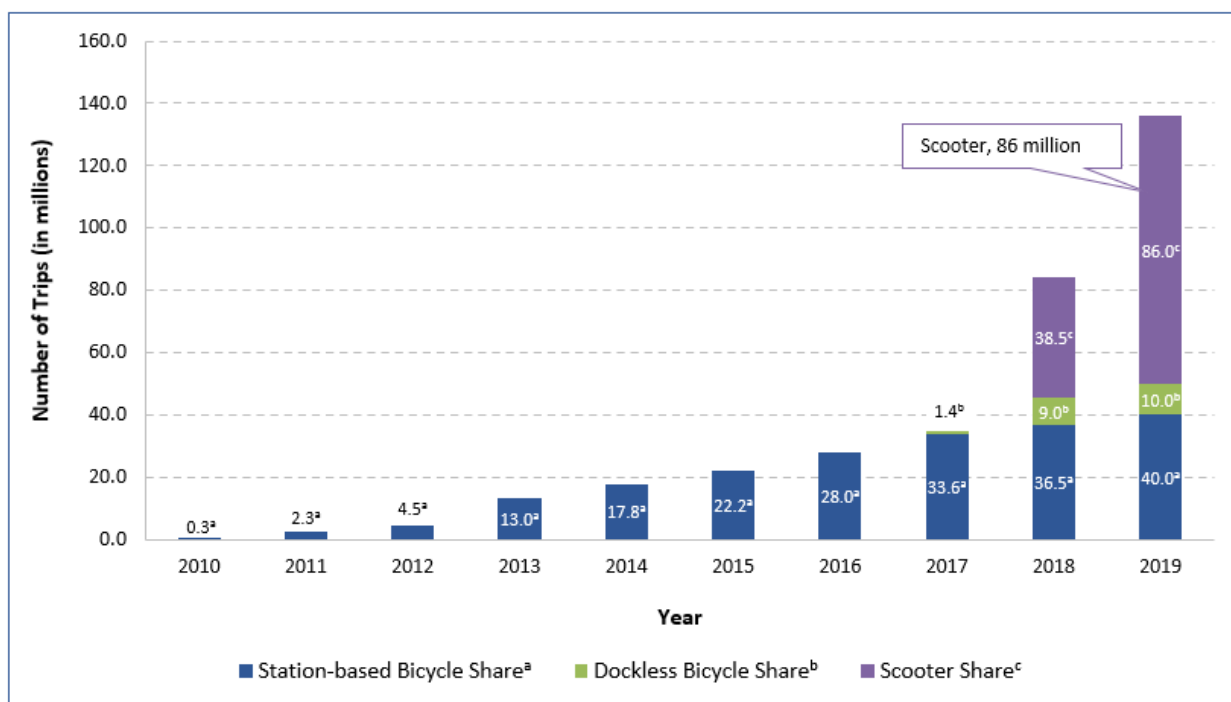


Figure 61. Number of micromobility trips by mode (2010–2019).⁽⁵⁹⁾

The number of cities with micromobility increased annually from 2015 to its peak in 2019 (see figure 62). This trend reflects both the introduction of dockless and scooter providers. Early indications show that in 2020, the number of cities with shared micromobility decreased slightly due to pauses in operations because of the pandemic. However, bicycle purchases soared during the COVID-19 pandemic, creating a global backlog in supply.⁽⁶⁰⁾

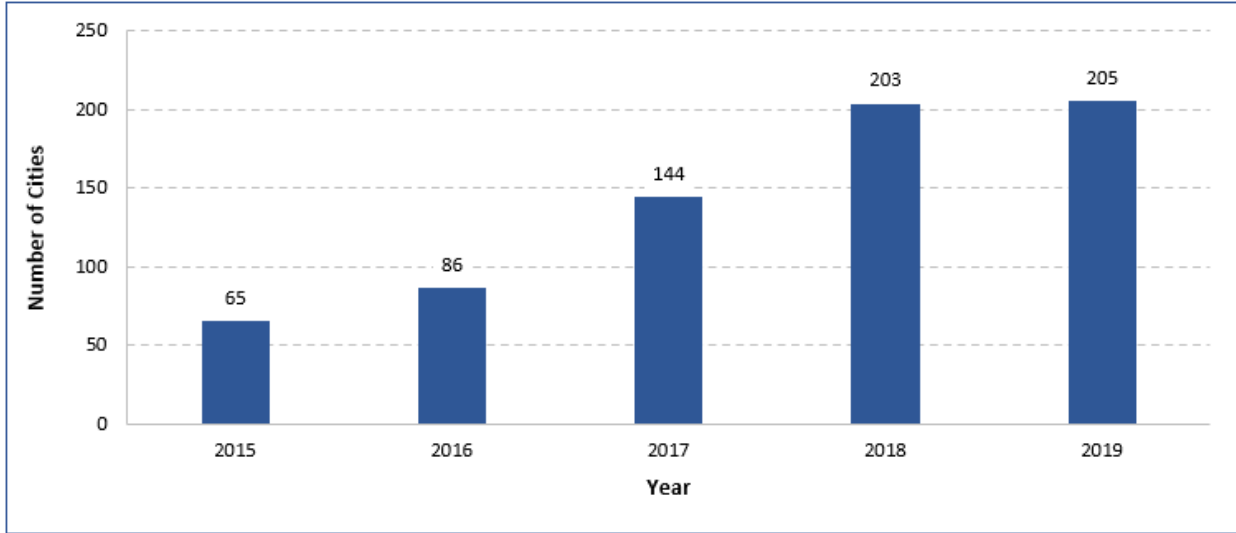
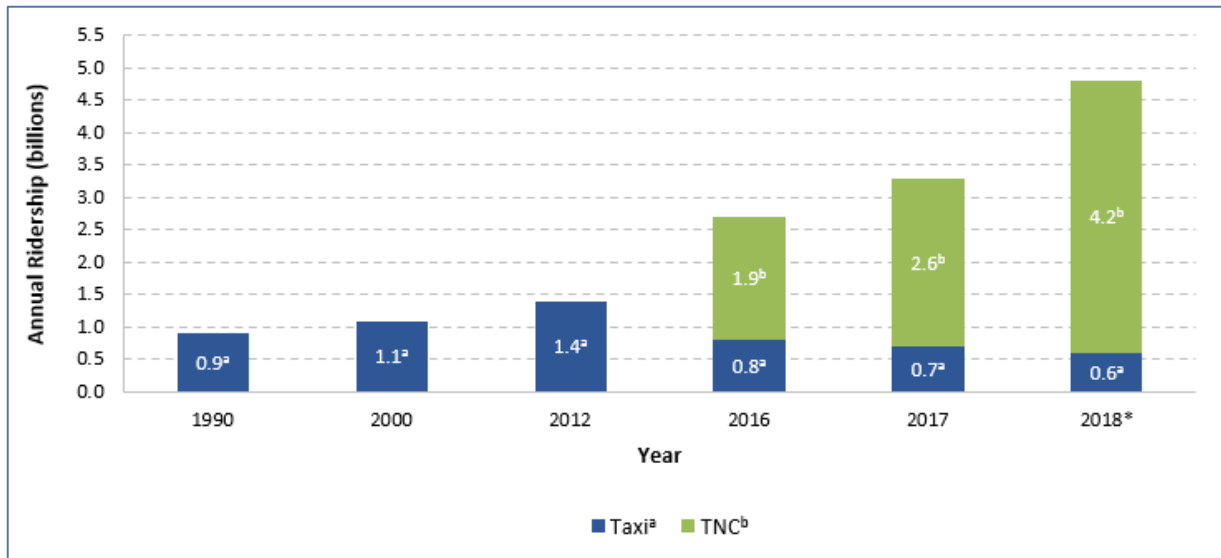


Figure 62. Number of U.S. cities with shared micromobility (2015–2019).⁽⁵⁹⁾

On-Demand Ride Services

Transport network companies (TNCs) provide on-demand ride services (i.e., ride hailing) that offer app-based on-demand transportation. Travelers request a ride through a smartphone app that connects a driver to a traveler’s location for pickup. Location, destination, time, payment, and basic safety functions are all integrated into a single application.⁽⁶¹⁾

By providing access to rides and riders at low cost, on-demand ride services lower the entry barriers for both travelers and drivers. Since 2016, TNCs have taken mode share from traditional ride-hailing services (e.g., taxis) and almost tripled the annual ridership for on-demand transportation service (see figure 63).



*Indicates projected data.

Figure 63. TNC and taxi ridership in the United States (1990–2018).⁽⁶²⁾

The percentage of people using ridesharing apps has increased rapidly. For example, in 2015, only 15 percent of Americans used ridesharing services. By fall 2018, this number increased to 36 percent.⁽⁶³⁾ In 2018, the reported net revenue for Uber and Lyft, the largest rideshare companies, were \$11.3 billion and \$2.6 billion, respectively.

The demand impacts of on-demand transportation service are uncertain. As with the shared mobility service model, it is unclear whether on-demand transportation will help to fill mobility gaps for traditionally underserved populations, for whom the availability and accessibility of new travel modes and transportation services is especially important. It is also too early to predict the impacts on travel behavior such as travel party size and mode choice. Some local studies indicate that ride hailing increases congestion and detracts from other modes such as walking, bicycling, and transit.⁽⁶⁴⁾ The limited information available suggests that TNCs primarily serve users who are younger, more educated, and have higher incomes. Information on shared micromobility shows a similar user profile. In the nine densest metropolitan areas (i.e., Boston, Chicago, Los Angeles, Miami, New York City, Philadelphia, San Francisco, Seattle, and Washington, DC), TNC use is highest among the following:⁽⁶²⁾

- Those ages 25 to 34, followed by those ages 18 to 24 and 35 to 54.
- Residents with a college degree.
- Residents living in households with incomes of \$50,000 or more.

A related business model that is gaining popularity is paired on-demand passenger ride and courier services, in which on-demand transportation service providers (e.g., TNCs) also provide package deliveries. Deliveries via these modes can either be made in separate trips or with mixed-purpose trips (e.g., for-hire drivers can transport packages and passengers in the same trip). Three major TNC operators have in some form expanded their ride services to include package/item delivery, food delivery, or both.

Mobility Hubs

Mobility hubs (see figure 64) are places of connectivity where different travel options—walking, bicycling, transit, and shared mobility—come together. As a relatively new concept, there are many definitions for mobility hubs. The common attribute is that mobility hubs provide a dedicated location for switching modes of transportation. They can range from an integrated suite of mobility services, amenities, and supporting technologies to a bus stop with parking for shared bicycles by a cycle route.⁽⁶⁵⁾

Transportation agencies across the United States are beginning to include mobility hubs in their planning. One example is San Diego, CA, where the region’s 2021 Regional Plan includes a network of mobility hubs near residential areas and work and activity



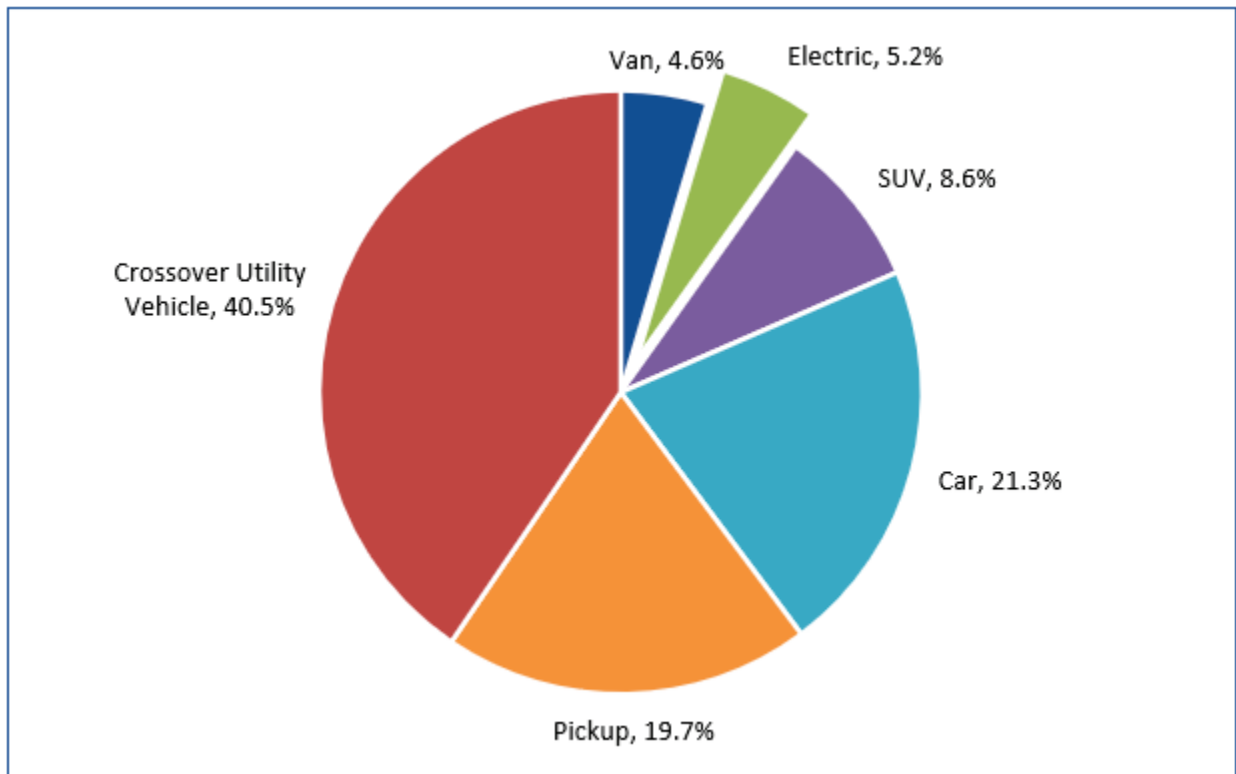
Figure 64. Mobility hub.

centers.⁽⁶⁶⁾ Another example is Columbus, OH, where, through the Smart City Challenge, the city plans to create smart mobility hubs, which can include expanded bus service, shared bicycles, scooters, EVs, and ride share services.⁽⁶⁷⁾

Vehicle Technologies

In addition to widescale Internet availability and related technology that change how Americans work, technology advancements have also been made in the type and functions of vehicles on the roadways today.

Concerns about carbon dioxide emissions, fuel economy, and vehicle performance have led to the development of vehicles with cleaner alternative fuel and advanced power systems.⁽⁶⁸⁻⁷⁰⁾ Among all alternative fueled vehicles, EVs and HEVs have become the most prominent (see figure 65).⁽⁷¹⁾ From 2011 to 2018, the types of EV/HEV models offered increased from 2 models to 57 models.⁽⁷²⁾ In 2018, there were approximately 208,000 new registrations of EV/HEVs, which was twice the number of new registrations in 2017.⁽⁷³⁾



Note: The Electric category includes all EVs and HEVs. EVs alone comprised 2 percent of all auto sales in 2020.

Figure 65. Share of model year 2020 sales by vehicle type.⁽⁷⁴⁾

EVs and HEVs made up 5.2 percent of model year 2020 sales, surpassing gasoline-powered vans and knocking on the door of gasoline-powered SUVs. Decreased cost and improved range have impacted EV popularity. For example, the Tesla Model 3 has the greatest fuel range of all

electric-only models at 330 miles (see figure 66). With that range, travel from Washington, DC, to Philadelphia, PA, and back can be made on one charge.

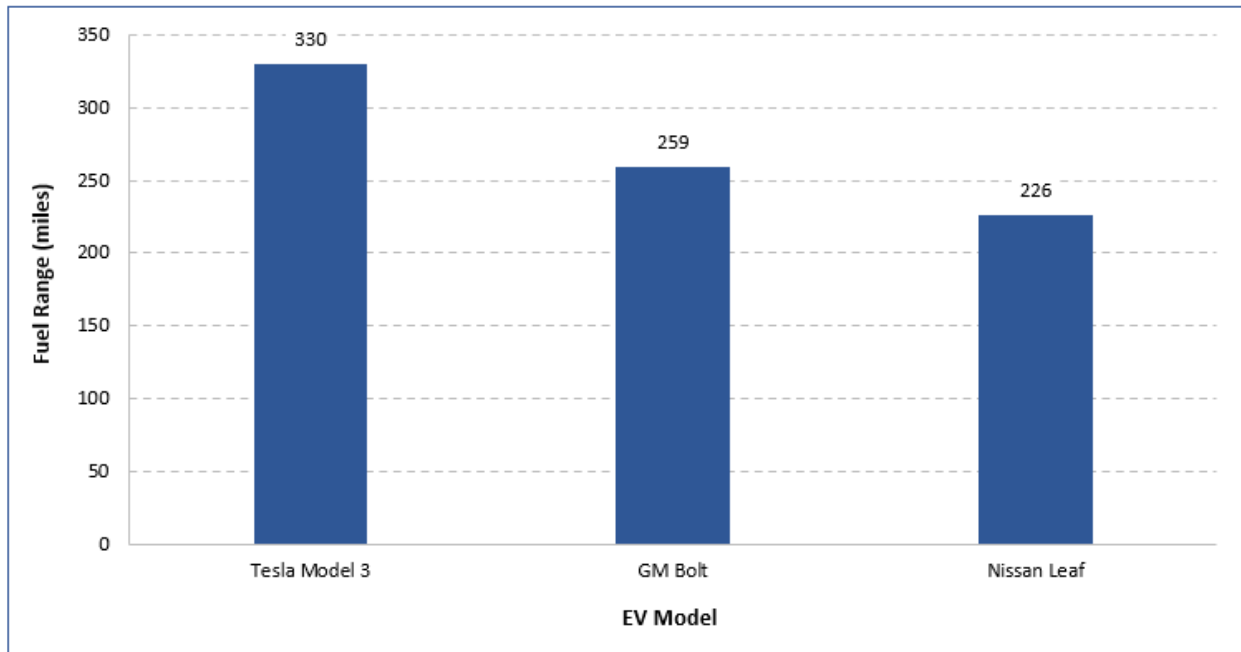


Figure 66. Alternative fuel range by EV model (2020).⁽⁷⁵⁾

The adoption of EVs is not evenly distributed across the country, with most growth concentrated in States that have launched the Zero Emission Vehicle program (ZEV). ZEV is a California regulation, adopted by other States, that requires automakers to sell EVs in the State. These States include California, Colorado Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont.⁽⁷³⁾ In 2018, California alone represented 46 percent of new EV registrations.⁽⁷³⁾

Connected and Automated Vehicles

The auto industry has been envisioning self-driving cars for over 80 years. The 1939 World’s Fair famously unveiled General Motors’ Futurama concept that featured an automated highway system using pavement-embedded magnets and radio communication to guide vehicles without driver control.⁽⁷⁶⁾ The autonomous vehicle features discussed in this section have the potential to influence a broad range of travel options, from personal vehicles, to robotaxis and transit or micro-transit shuttles, to vehicles used for long-haul and last-mile freight. One category of interest is the development of small autonomous delivery vehicles, which range in size from vehicles designed to use sidewalks and bicycle lanes to larger vehicles sharing the road with other travelers. This technology is rapidly evolving in where and how it can transportation options in the future.

ADS technology has been slowly but steadily adopted into consumer vehicles for several decades now, beginning with driver-assistance features like an antilock braking system (ABS) and adaptive cruise control (ACC).⁽⁷⁷⁾ Emerging and developing vehicle and transportation technologies have

the potential to improve the equity, efficiency, and safety of highway transportation. The United States has long been a leader in vehicle technology and transportation systems research, including ITS, connected vehicle systems, and ADSs. Numerous technologies have emerged from such research efforts to become commercial and consumer products, especially ITS and advanced driver assistance systems such as automated emergency braking (AEB) and ACC. Such efforts are likely to continue to improve transportation systems safety in the United States as technologies continue to develop and become further integrated into modes of transportation.

Industry and governments have generally adopted the automated vehicle framework provided by SAE International’s standard SAE J3016.⁽⁷⁷⁾ Its taxonomy defines six levels of driving automation, ranging from no driving automation (level 0) to full automation (level 5). Under this framework, even level 0 vehicles may include automated intervention features such as ABS and AEB that do not operate on a sustained basis. The most capable ADSs (levels 4 and 5) require no human intervention or attention while in automated operation. Testing and pilot sites are shown in figure 67.

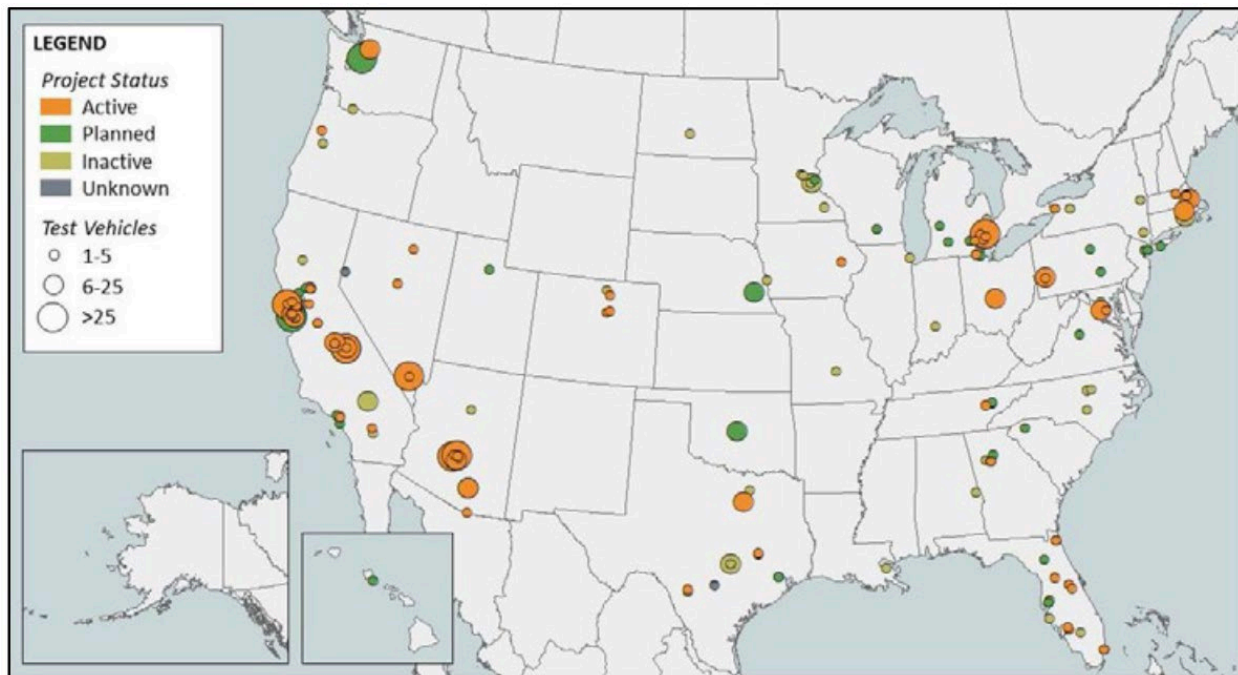


Figure 67. Automated vehicle test sites in the United States.⁽⁷⁸⁾

As of 2020, level 3 and level 4 automated vehicles remained limited to research projects and controlled pilot deployments. A variety of private entities are partnering with local jurisdictions to participate in the deployment and testing of level 3 and 4 vehicles across the Nation, with more than 500 active domestic testing demonstrations. Some examples of private sector deployments are WAYMO in Maricopa County, AZ; Drive.ai in Frisco, TX; Uber in Pittsburgh, PA; and Ford in Washington, DC.^(79,80) Level 5 ADSs do not yet exist.

Driver Assistance Systems

While fully self-driving vehicles are in testing and pilot deployments, driver assistance systems have increased in prevalence, as shown in figure 68.

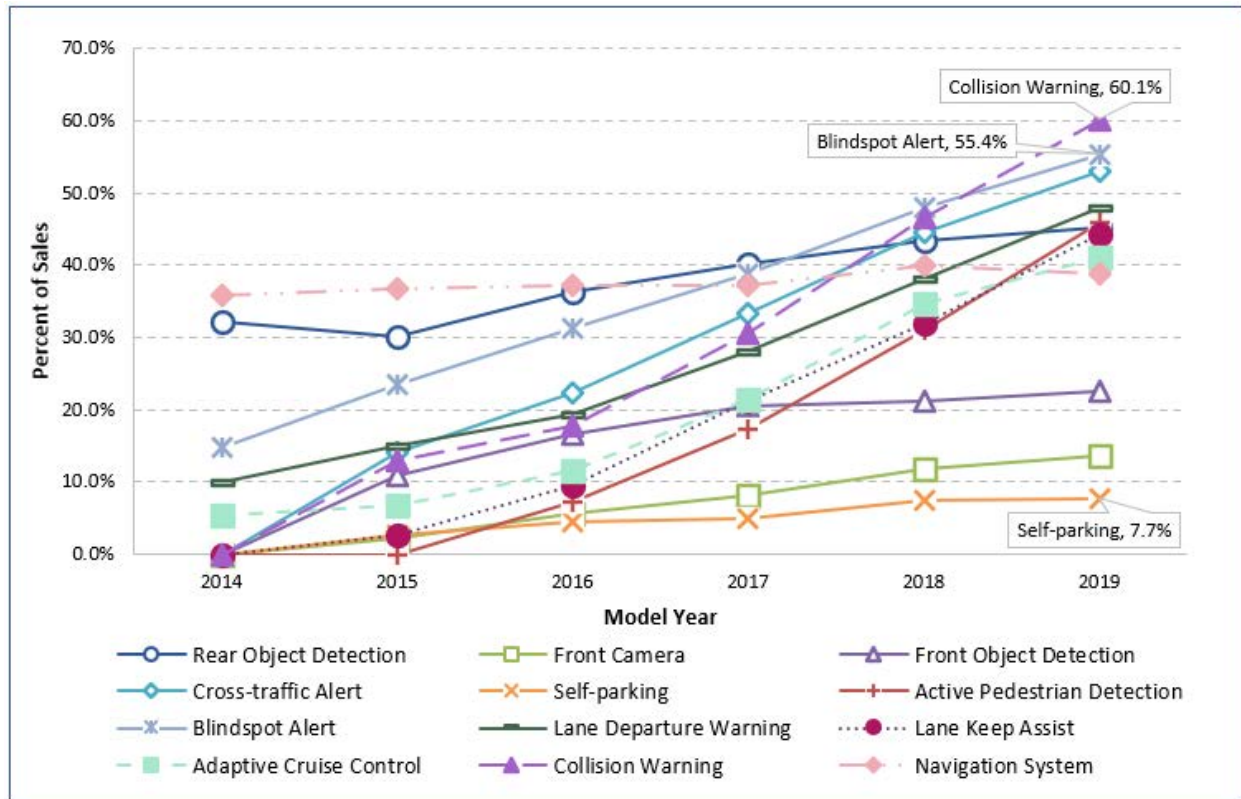


Figure 68. Percentage of sales with advanced driver assistance systems per model year (2014–2019).⁽⁷⁴⁾

While many of these applications are convenience features, others are effective safety features. The most popular and effective safety-focused driver assistance systems are collision avoidance systems or AEB and blind spot alert. AEB alone has shown to reduce injury/death insurance claim frequency by 3 percent to 25 percent depending on claim type.⁽⁸¹⁾ Other automated driver assistance systems for model year 2019 sales are self-parking (7.7 percent), front cameras (13.6 percent), and front object detection (22.6 percent).⁽⁷⁴⁾

UASs

The adoption of UASs is growing rapidly among both consumers and companies. Initially applied in the transportation sector for bridge inspections, the retail industry is leading the way in commercial applications. There are also potentially new opportunities with air rights with interest in leasing airspace over highways.⁽⁸²⁾

Through the UAS Integration Pilot Program, the Federal Aviation Administration (FAA) is issuing air carrier certificates to selected commercial applications.⁽⁸³⁾ United Parcel Service (UPS) Flight

Forward was the first company to receive an air carrier certificate to operate a drone aircraft. UPS Flight Forward is focusing on drone delivery in healthcare operations, where the shorter transit times can have a large impact on healthcare.⁽⁸⁴⁾ Wing Aviation, a Google company, also received FAA approval to operate drone aircraft and is currently offering trial drone deliveries in Christiansburg, VA.

Often, the challenge with new technologies is the general lack of data that would indicate trends or outcomes. The analyst is challenged to discern trends from other data sources that may be indicative of demand trends. Anecdotal data suggest that the use of drones, for example, is expanding. UPS plans to deploy drones for package delivery, and Amazon seems to be establishing its own air traffic control system with the use of artificial intelligence to manage traffic of its own drones. Other companies such as Walmart, Domino's, and FedEx are working on approaches to drone-based package delivery. Amazon Prime Air is a service that aspires to deliver packages up to 5 pounds in 30 minutes or less using small drones.⁽⁸⁵⁾

Drone registration data, collected from FAA-mandated registrations for drones exceeding a certain weight, indicate that there is an increase in the use of drones for commercial purposes, though they likely extend beyond just package delivery, to include surveying crops, medical samples, and bridge condition surveys, among many other applications.

Chapter 7: Emerging Themes and Considerations

Trends in demographics, economics, and technologies all impact the amount and distribution of transportation demand. Some trends create demand, while others suppress it. Often several trends are happening at the same time. As a result, a focus on one trend in isolation will rarely tell the whole story. It is the interactions across trends that provide insights into future transportation needs. This final chapter briefly discusses broader emerging themes across demographic, economic, and technological trends and potential corresponding policy research questions.

Urban, Rural, and Suburban

Research, policy, and planning often frame transportation in the context of the urban versus rural dichotomy. However, much of the U.S. population is not located in a rural community or an urban core. In fact, 42.6 percent of the population lives in the suburbs and small towns.⁽¹⁸⁾ This is an important distinction, as suburban and small-town travel may be more like rural travel than central city travel. These lower-density areas are more auto-dependent and offer fewer transportation options as compared to central cities. In addition, many new and emerging transportation modes and services, such as shared mobility, micromobility, connected vehicles, and automation, are often provided in high-density urban areas. If and how we can apply these transportation innovations to less dense communities may be critical to achieving equity in access, mobility, and safety among transportation system users.

The population of large suburban counties has increased by 25 percent since 2000, outpacing the Nation's overall population growth of 16 percent.⁽⁸⁶⁾ Housing affordability (especially in urban cores), growing megaregions, broadened availability of technologies (such as high-speed Internet and EV charging stations), and increased levels of telework may accelerate the already growing suburban and small-town populations. As suburban and small-town areas become more diverse, urban-centric policies may exacerbate mobility and access gaps for underserved populations.

Policy questions to consider include:

- What are the projected trends in demographics and transportation demand across urban, suburban, and rural areas over the short-term and long-term planning horizons?
- How well do new business models and emerging transportation innovations meet suburban and rural transportation needs?
- How do current federal policy and investment strategies align with mobility, access, and safety needs across geographies?

Telecommunications as a Travel Mode

A growing number of activities that have traditionally required travel can now be accomplished virtually. The use of telecommunication technologies, such as broadband, allows people and businesses to conduct everyday activities—like shopping, attending meetings, teleworking, learning, and receiving medical care—without the need to travel. Likely, the use of telecommunications for these activities, and more, is here to stay and is growing.

This does not mean, however, that the use of technology as an alternative to travel decreases travel demand. Research in this area has produced mixed results. Often, trips are being substituted and generated at the same time. One example is shopping. While online shopping may replace some shopping trips, eCommerce creates additional demand for home deliveries including meals, packages, and groceries. In addition, online searches allow shoppers to locate products outside of their normal shopping geography, potentially creating new, longer-distance shopping trips. This may be one reason the average length of shopping trips is increasing (see figure 50).

While trip lengths are increasing, the total number of trips per person per year is declining. According to FHWA's NHTS, in 2017, people made an average of 3,140 trips per year; this is down from an average of 3,466 trips in 2009 and 3,581 in 2001.^(16–18) Understanding the opportunities and impacts of potential shifts from travel to telecommunications for some activities can inform planning and policy in areas such as access to goods and services, mobility, sustainability, and equity.

Policy questions to consider include:

- How can technology and transportation work cooperatively to provide improved access to jobs, education, essential services, and goods?
- Is technology impacting travel demand and travel demand characteristics? If so, how? And how can we account for this impact in estimating future demand and transportation needs?
- Where are the gaps in access and mobility? How can technology be applied as a means to fill those gaps?

Integration and Interoperability

Technology has created the opportunity for transportation users to have a single, connected, and efficient transportation system that facilitates seamless transitions between modes, roadways, and jurisdictions. This opportunity, however, is not without its challenges, especially given the current governance compartmentalization across modes and jurisdictions.

New technologies can provide transportation features and systems that are not constrained by mode or jurisdiction and that need to work together to achieve optimal results. Whether it is integrated payment systems, vehicle to infrastructure connectivity, automation capabilities, or

mobility information, the ability of transportation systems to work together across regions, roadways, and modes of travel is becoming increasingly important.

While the technology barriers can be substantial, interoperability and compatibility of software systems, infrastructure, standards, and “rules of the road” create a challenge for transportation agencies. Coordination across modal silos and regions is difficult and is often a lower priority in an environment of constrained budgets. This is a significant barrier to achieving the vision of a seamless transportation system. New ideas, resources, and tools are needed to facilitate regional and modal coordination of policy, investments, information, and maintenance.

Policy questions to consider include:

- What are interoperability and integration priorities for the U.S. transportation system and its components across jurisdictions, roadways, and modes?
- What are current and future barriers in regional and modal coordination of transportation information, operation, and performance?
- What are the financial, institutional, and competitive barriers? What are potential strategies to overcome these barriers to address national goals?

Public and Private Sector Roles

As technology drives innovation in transportation information, systems, and services, public and private sector roles are changing. Many of the traditionally public transportation services, maintenance, and management functions on roads and highway rights of way are being privatized. For-profit transportation services are commonplace for virtually every transportation mode and often utilize public roads and rights of way to serve their customers. Traffic management and transportation information have been privatized and crowdsourced. Systems, programmed by the private sector, protect safety, manage system efficiency, and prioritize access. However, not all public and private sector goals are in alignment. For example, the safest or most efficient route may not necessarily be the most profitable route for a private company. Other factors, such as marketing or sponsorship, may factor into traffic management functions.

In addition, the provision of transportation service is not always profitable. For example, many of the new and emerging transportation modes and services, such as shared mobility and micromobility, are only available in densely populated areas. The market is not sufficiently large or densely populated to be profitable in many, if not most, suburban or rural communities.

It may be a challenge to balance the public good with the innovation and efficiency that private enterprise brings to the transportation sector. Policy tools, such as regulations and standards, as well as engagement with private operators may help improve this balance through risk sharing, innovative services, data sharing, and a willingness to try new approaches to solving mobility problems.

Policy questions to consider include:

- Where are private and public sector objectives in and out of alignment?
- What are the benefits, changes, and unintended outcomes of privately owned and operated transportation services? What are the agency and user impacts?
- How are the direct and indirect costs of private sector use of public infrastructure measured and accounted for?

Closing Thoughts

This is a transformational time in transportation, with many changes and technological advancements underway that will influence future travel demand. Understanding how people might travel and where they might live helps planners and policymakers decide what policies and investments may be needed to ensure the performance of our transportation system. The trends in population, geography, technology, and travel demand reviewed in this report begin to demonstrate the challenges and opportunities that face us in the coming years. The future requires flexibility and resilience.

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