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TRANSPORTATION AND CLIMATE CHANGE: THE PATH FORWARD—URBAN MOBILITY IN A CLIMATE-SENSITIVE, POST-COVID WORLD

PART 3 OF 3

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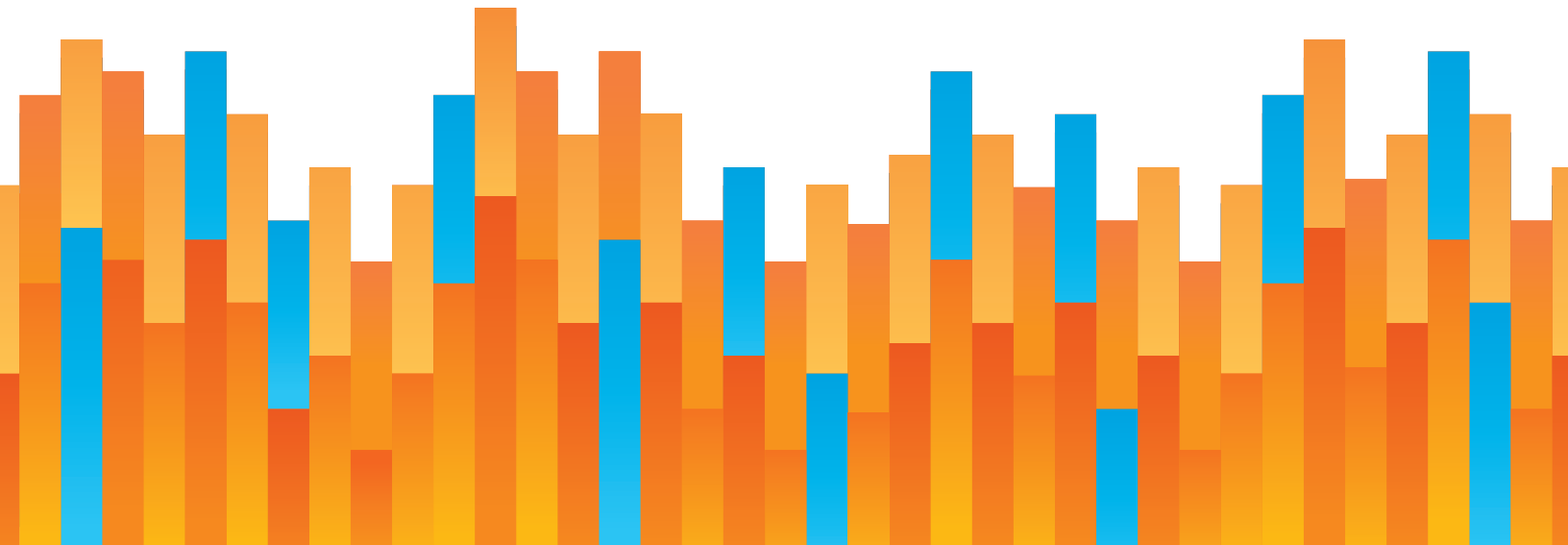

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PART 1

INTRODUCTION

This report is the third and final report of a research initiative that explores the evolution of travel in meeting urban mobility needs given rapidly changing technology and greater sensitivity to climate change. The first report, "Transportation's Role in Climate Change," focuses on the role of transportation in greenhouse gas (GHG) emissions. The second report, "Public Transit and Climate Change," focuses specifically on the influence of public transportation. This final report in the series explores the challenges and issues facing urban travel going forward as demographic, economic, technological, and cultural/political conditions evolve.

This report examines the current and forthcoming challenges with a specific focus on the potential influence of technological advancements and evolving travel behaviors on the trajectory ahead. The analysis first delves into the core attributes of travel decision-making, followed by an overview of pivotal issues that will shape the course of urban transportation in the years ahead. It concludes with observations about planning and policy strategies to help address these challenges.

THE CONTEXT

Transportation is undergoing its most profound changes in over half a century. Significant technological changes coupled with the COVID-19 pandemic, growing concerns over climate change, and greater sensitivities to equity in mobility are affecting multiple aspects of every mode of travel. The COVID pandemic served as an accelerant to the adoption of technologies and behaviors that fundamentally change the travel choices individuals make.

Ranging from the rapid embrace of telework to the more subtle shifts in activity and settlement patterns, to the movement to electrification of transportation, virtually every aspect of travel is changing.

> *Transportation is undergoing its most profound changes in over half a century*

PART 2

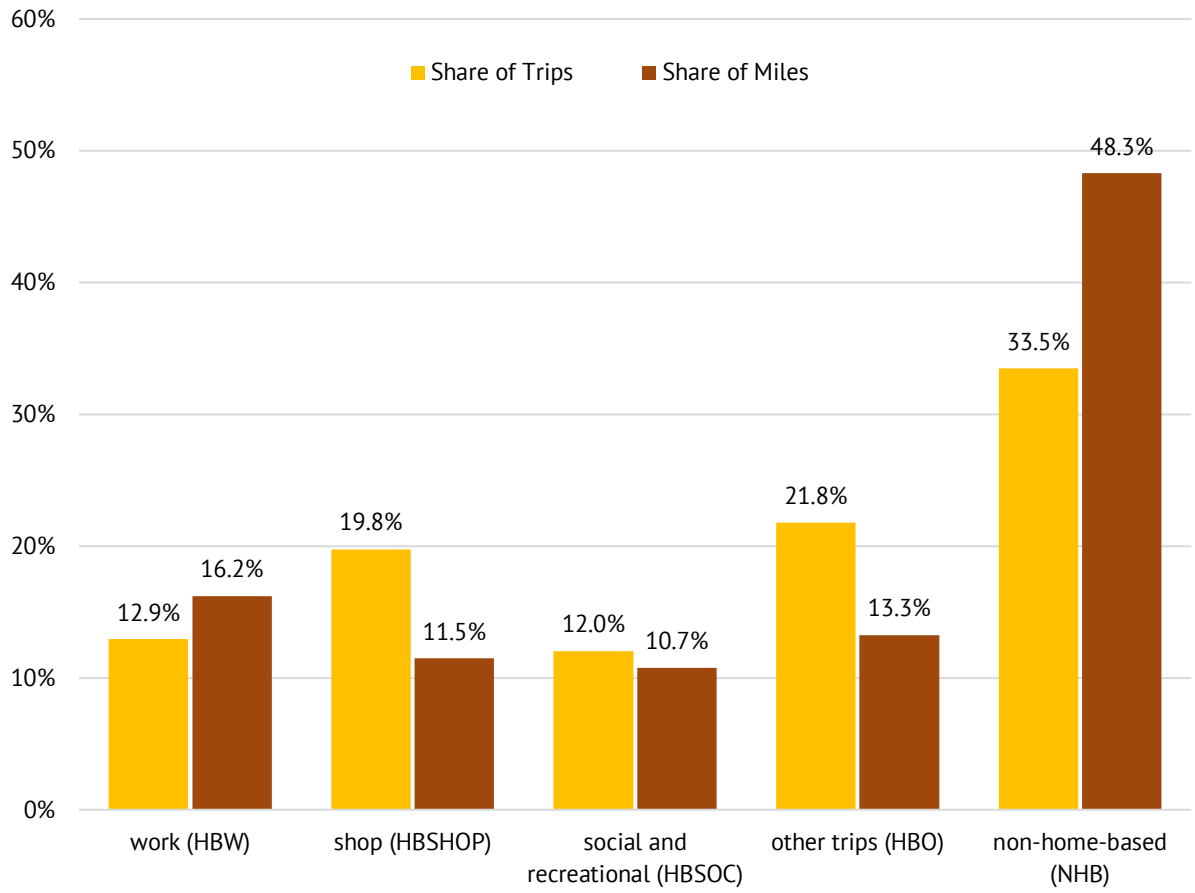
A DESCRIPTIVE PORTRAIT OF U.S. PERSON TRAVEL

The figures that follow provide a portrait of urban travel in the United States. These numbers rely on pre-COVID conditions from the 2017 version of the National Household Travel Survey (NHTS). The NHTS survey has been carried out approximately every seven years, starting in 1969. It is currently in transition to a smaller sample survey meant to be augmented on a biannual basis. The first household travel survey in the NextGen NHTS was collected in 2022 and its results reported in 2024 and remain under exploration by analysts.[1] This data provides a reference point for a discussion of urban mobility moving forward. COVID and technologies have changed travel, but it's important to recognize that many attributes of travel are very resilient to change. The geographic distribution of trip origins and destinations is dramatically influenced by the building infrastructure that defines places. The transportation network similarly is dramatically influenced by the physical network of infrastructure, and travel choices are significantly biased by the investment in vehicles. Thus, change is inherently incremental, and insight can be gained from available historical data recognizing that changes are underway.

1 Federal Highway Administration, "2022 National Household Travel Survey," U.S. Department of Transportation. https://nhts.ornl.gov (accessed 3 Feb. 2025).

Figure 1 shows the distribution of urban travel by trip purpose expressed both in terms of a count of trips and in terms of the passenger miles of travel. This includes long-distance trips by all modes originating within the urban area.

FIGURE 1: URBAN TRIP PURPOSE DISTRIBUTION



Source: ASU analysis of NHTS 2017 trips for urban households. The "other" means of travel category includes longer air, rail, and roadway trips originating in urban areas. Data available at National Household Travel Survey (ornl.gov)

Both shop and work trips have been impacted by the ability to telecommute and conduct e-commerce or procure delivery services; thus, their shares are likely to have declined since 2017. Work trips have historically been the foundation for travel demand modeling and are often the basis for defining the capacity of transportation system elements. Peak periods and commute corridors are typically the most congested and receive significant attention for both roadway and public transit capacity. With an estimated 14 to 18% decline in

average weekday commuting travel due to telework and hybrid telework, and that decline concentrated in office-rich locations, urban travel patterns and priorities may be shifting.[2]

Social recreation and other trips, including school and medical trips, also offer some opportunities for virtual substitution. Travelers often have choices as to both the timing and the destination of social/recreation trips. These trips are more likely to involve multiple people and to occur in off-peak periods when transit service options are less available. Accordingly, these trips are more difficult to attract to non-auto modes.

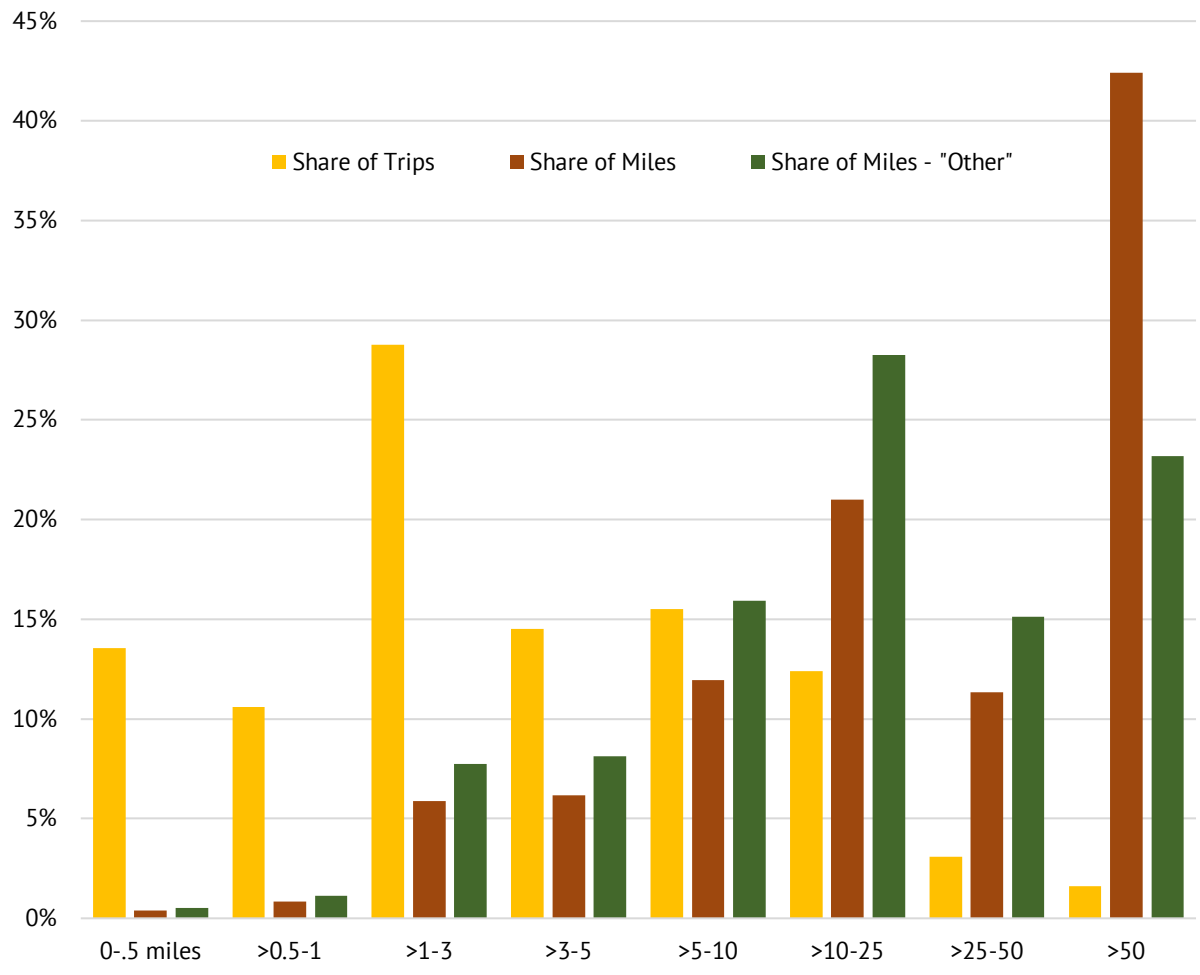
The non-home-based trips refer to trips between subsequent activities after one has already left their place of residence. This could be work meetings, going out to lunch at work, traveling between a series of destinations to carry out various errands, or sequential visits with friends and colleagues. The magnitude of the non-home-based trip category is important in that the travel choices for subsequent trips in a chain of activities are significantly influenced by the choice made when leaving home, particularly for trip chains that are wholly local trips. A person is generally captive to or biased by the mode by which they left home. For example, someone would seldom take transit to work and drive home as their vehicle is at home. Thus, understanding opportunities for influencing travel requires a great deal of sensitivity to the travel choices someone is faced with at their home or trip chain origin. Trip chains are also conducive to favoring travel choices that offer a great deal of flexibility as a person might add stops in the trip tour; for example, not finding what they were looking for at one store and choosing to try subsequent stores.

Figure 2 shows the trip length distribution for trips originating in urban households. The trip length influences the mode choice, particularly for bike and walk trips that have slower travel times and potentially stamina constraints precluding their use for longer-distance trips. Very long trips introduce trade-offs between personal vehicles and airline or intercity bus and rail choices. Reviewing the differences between the share of trips based on count versus person miles reveals the importance of trip length when trying to understand the infrastructure, energy, and emissions implications of travel. A single annual 2,300-mile round trip vacation is the passenger mile equivalent of a full-time commuter living five miles further from their job. Figure 2 shows that about 17% of passenger miles by urban

[2] In 2019 the "American Time Use Survey" indicated that slightly under 7.8% of full-time workers work from home on a given weekday. The 2022 data indicates that 24.2% work from home on an average weekday. Experts speculate that this number may decline slightly in the near term but over time will resume and upward trend as information jobs conducive to telework become a larger share and accommodations of work from home capabilities improve.

residents are incurred on trips of less than 5 miles whereas 32% occur on trips of 50 or more miles. Thus, changing the energy/emissions efficiency of vehicles for long-distance trips or influencing the mode choice for these trips can have a greater overall direct impact.

FIGURE 2: URBAN TRIP LENGTH DISTRIBUTION

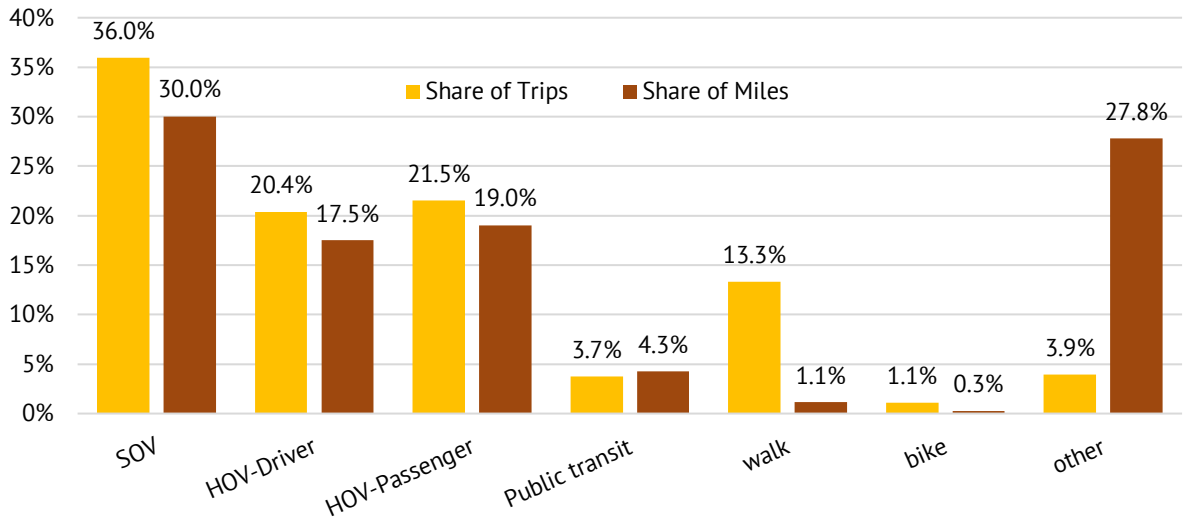


Source: ASU analysis of NHTS 2017 trips for urban households. The "other" means of travel category includes longer air, rail, and roadway trips originating in urban areas. Data available at National Household Travel Survey (ornl.gov)

Changing the characteristics of or influencing the mode choice of short trips can have a modest direct impact and an indirect impact as better accommodations for more benign modes for short trips can influence the probability of those options enabling different choices for longer trips. For example, adequate e-bike access to commuter rail may result in a longer-distance auto commute being shifted to a bike-to-rail commute trip.

Figure 3 shows the mode distribution for urban household trips. The most distinctive observations are the pronounced difference in count versus person-mile shares for walk trips reflecting their generally short length. The second observation is the large share of person miles attributed to the "other" mode. This reflects the inclusion of air trips originating in the urban area and perhaps some respondents placing Amtrak, intercity bus, or camper in the "other" category. Biking constitutes 1.1% of urban trips but is only responsible for 0.3% of urban person miles. Collectively, bike, walk, and public transportation constitute less than 6% of urban person miles of travel in 2017. The declines in transit ridership since that point in time, put downward pressure on the composite share.

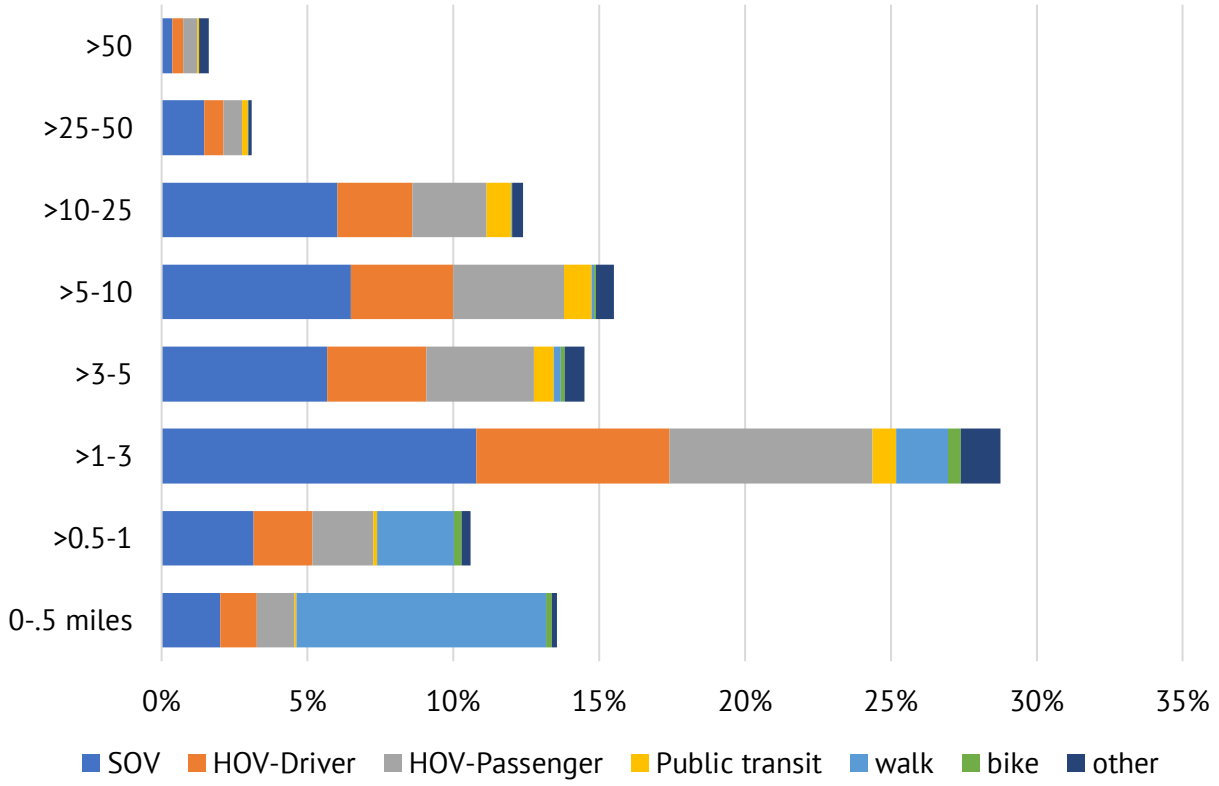
FIGURE 3: MODE DISTRIBUTION FOR URBAN HOUSEHOLD TRIPS



Source: ASU analysis of 2017 NHTS trips for urban households. Data available at National Household Travel Survey (ornl.gov)

Figures 4 through 7 provide information on the distribution of travel modes for urban trips of various trip lengths. Figure 4 presents the mode shares for all trip lengths such that the sum totals 100% of the trip count. Figure 5 shows the same data but presents the mode shares as a percentage of trips for the given trip length. Walk constitutes a majority of trips of less than 1/2 mile. Some share of the remaining trips are parts of trip chains where the mode choice was influenced by the available options for subsequent trips in the trip chain. Similarly, for single-occupant vehicle (SOV) driver and SOV passenger categories, if one or more of the occupants were unable to use an alternative mode such as walking, there are no additional energy, emissions, or infrastructure implications associated with the other occupant(s) sharing the vehicle for the passenger trip.

FIGURE 4: TRIP COUNT SHARE OF ALL URBAN HOUSEHOLD TRIPS BY MODE BY TRIP LENGTH



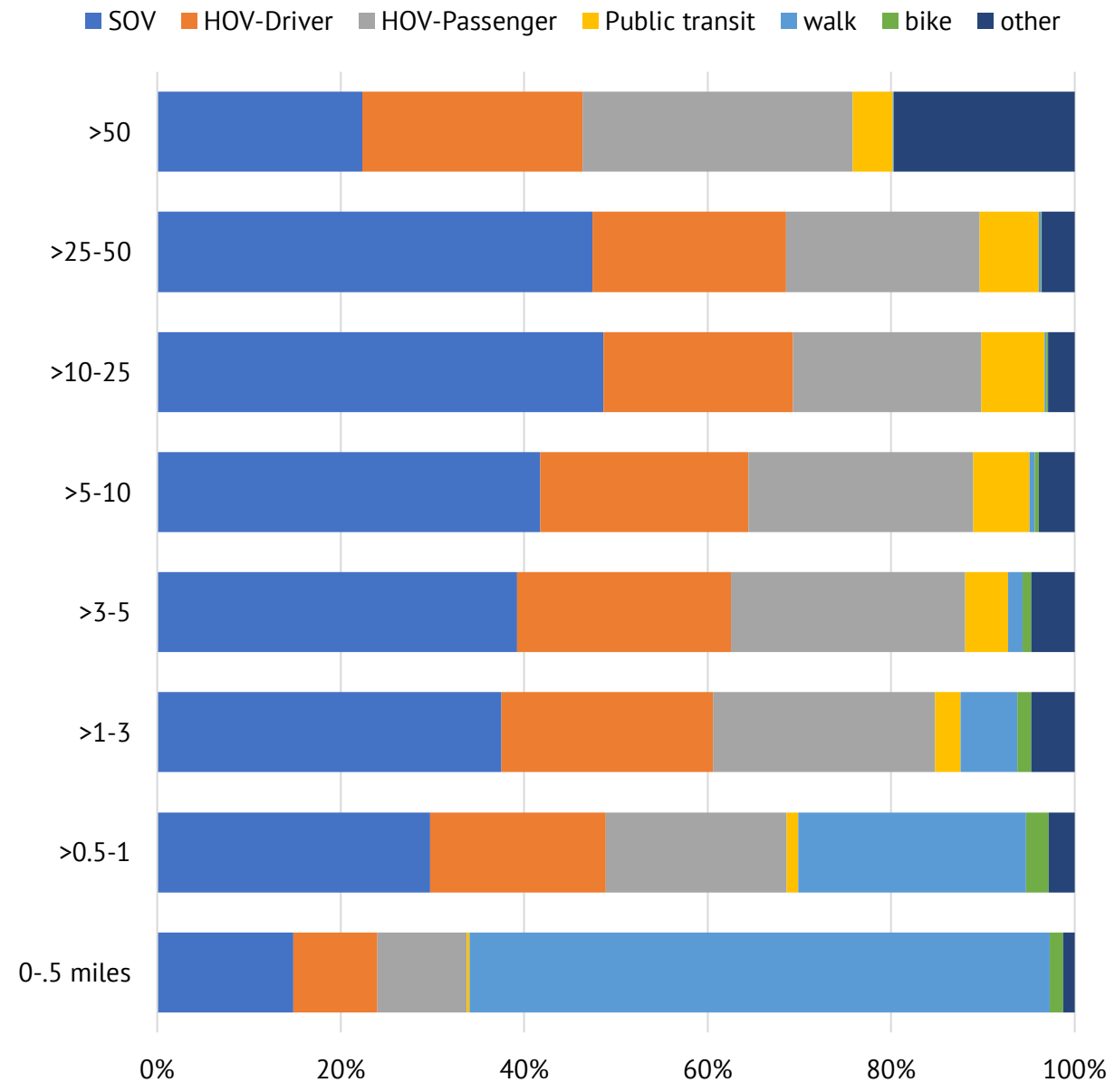
Source: ASU analysis of 2017 NHTS trips for urban households. Data available at National Household Travel Survey (ornl.gov)

Attracting travelers to alternative modes of travel for persons traveling in a group is only meaningful in reducing vehicle miles traveled (VMT) if all group members are able to make the mode switch. While service availability in the case of public transit and infrastructure availability in the case of bike and walk might be among the reasons for not choosing these options, several other considerations such as crime exposure, weather exposure, personal stamina or disability status, time availability, available travel options for subsequent trip chain segments, and luggage/packages are all relevant considerations.

Nearly 53% of all person trips are three miles or less. This relatively large share may be conducive to alternative modes, in addition to walking, bike e-bikes, scooters, and other micro-mobility options like mini cars/carts or various electrified trikes. In addition, electric vehicles and plug-in hybrids would not incur the cold start emissions inefficiency of traditional internal combustion vehicles when used for short trips.

Figure 5 suggests that SOV trips in the 3-50-mile trip length categories might be the most beneficial target for influencing travel behavior. This category is also one where telework and communication substitution for travel are likely to have had the greatest impact since 2017.

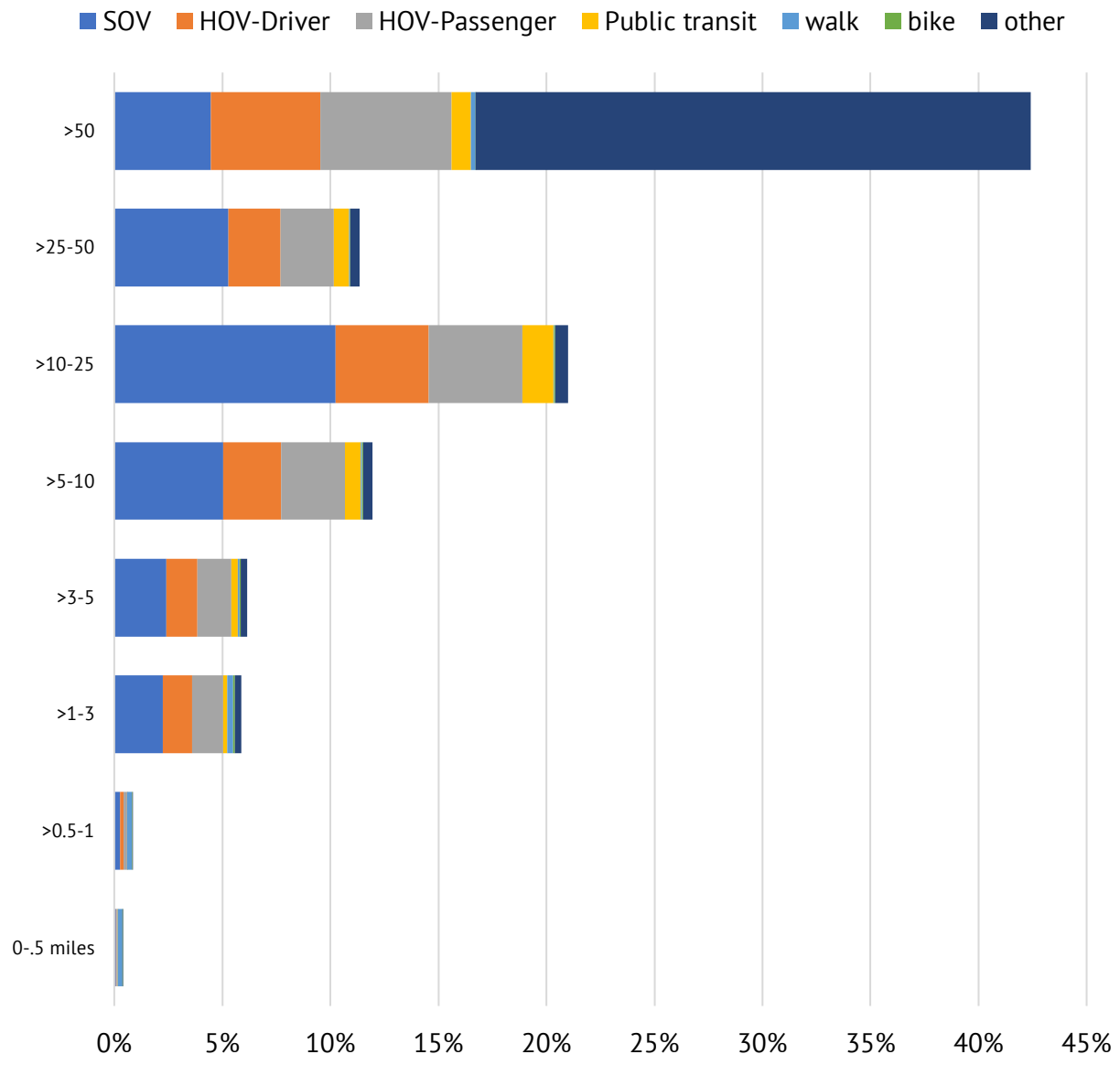
FIGURE 5: TRIP COUNT SHARES BY MODE FOR EACH TRIP LENGTH



Source: ASU analysis of 2017 NHTS trips for urban households. Data available at National Household Travel Survey (ornl.gov)

Figures 6 and 7 present the same data but focus on passenger miles rather than trips. The focus on mileage provides a greater sensitivity to the energy, infrastructure, and impact consequences of travel. Figure 6 reveals that over 25% of person miles by urban residents are for trips longer than 50 miles and on "other" modes, which indicates air or other long-distance non-auto modes.

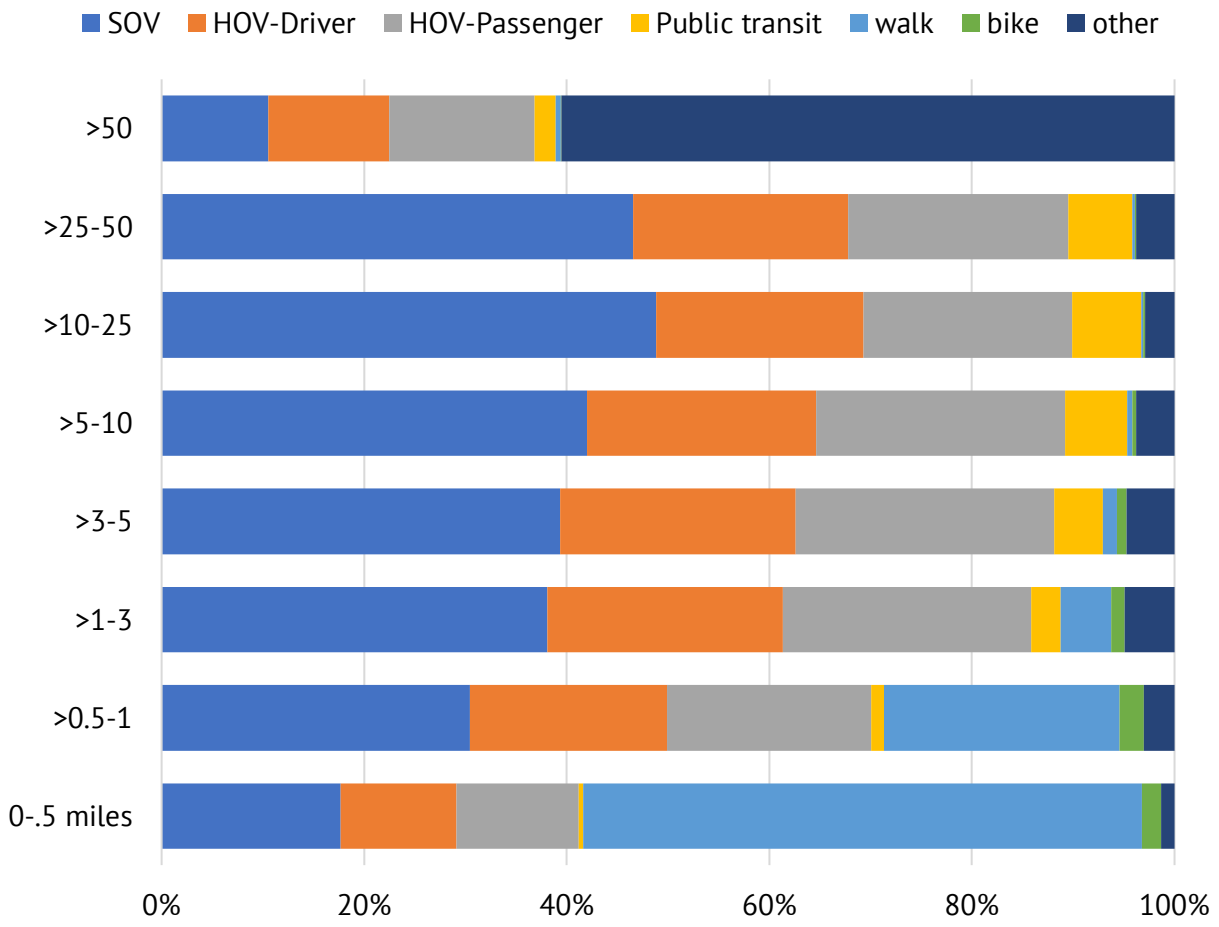
FIGURE 6: PERSON MILES SHARE OF ALL TRIPS BY MODE BY TRIP LENGTH



Source: ASU analysis of 2017 NHTS trips for urban households. Data available at National Household Travel Survey (ornl.gov)

Figure 7 reveals the role of various modes for each trip length category. Interestingly, single occupant vehicles constitute only approximately 10% of urban originating person miles for trips greater than 50 miles. Single occupant vehicles do comprise approximately 40% of all person miles traveled for trips between 3 and 50 miles.

FIGURE 7: PERSON MILES SHARE OF ALL TRIPS BY MODE BY TRIP LENGTH



Source: ASU analysis of 2017 NHTS trips for urban households. Data available at National Household Travel Survey (ornl.gov)

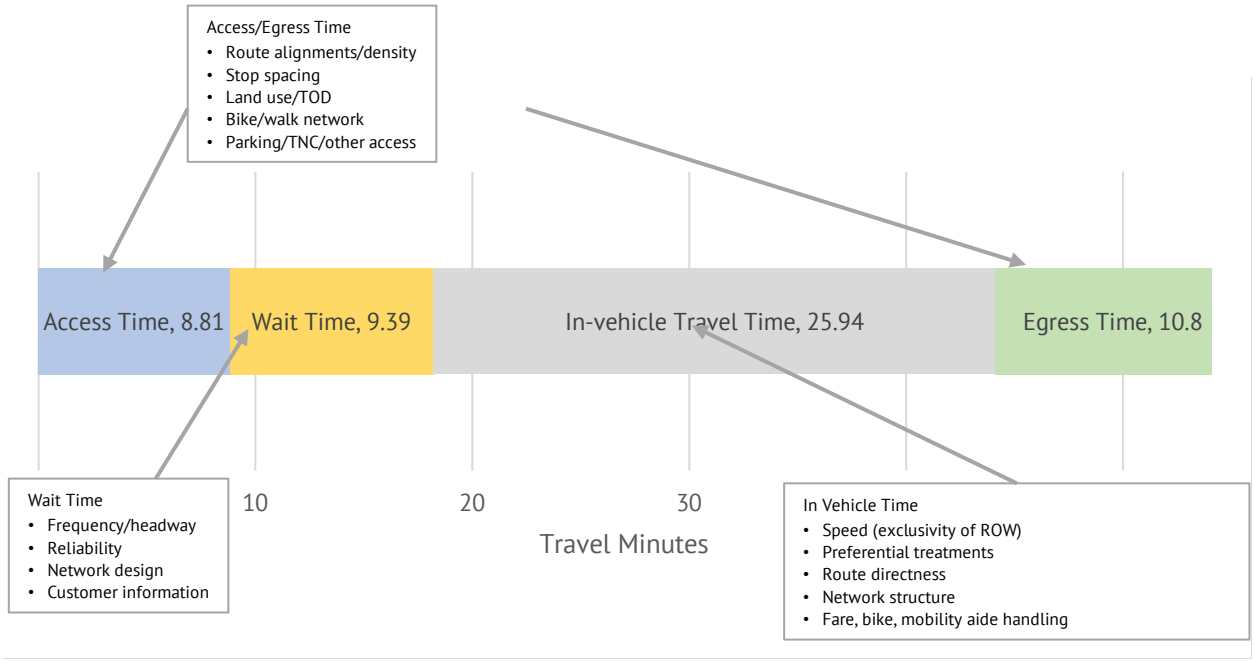
The collective information embodied in the data reported in this section provides an analyst with an understanding of the opportunity or potential influence associated with policies or investments targeting specific markets or actions. It allows one to gain a perspective of their significance and hence prioritize resources to targeting meaningful opportunities while enabling the planner to estimate impacts of successful initiative to address the respective markets.

PART 3

THE CHALLENGE OF EXPANDING TRANSIT SERVICE

Figure 8 includes data on the average U.S. transit trip from the 2017 NHTS. For this average trip which totals 55 minutes, less than half the time is spent in the vehicle. Access and egress time are each significant components, as is average wait time. Travelers aspire to minimize access, wait, and egress times as it is time-consuming, onerous, and risks weather and crime exposure. Individualized modes like bike, walk, scooter, and personal vehicle trips are typically not subject to these time components. These components, in addition to the in-vehicle operating speed associated with stop-and-start transit options, make it very challenging for public transit to compete on travel time except in the most congested conditions.

FIGURE 8: TRANSIT TRIP TIME COMPONENTS

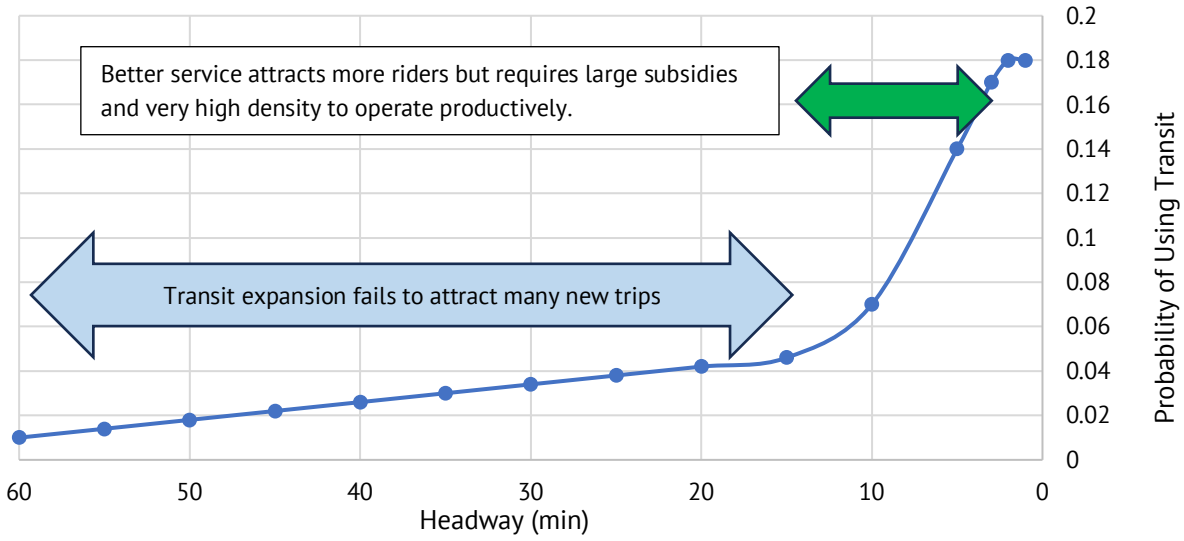


Source: ASU Analysis of NHTS 2017 data. Data available at National Household Travel Survey (ornl.gov)

The text boxes identify the types of actions that could be taken to influence each trip time component. Keep in mind that the average transit trip length is four to six miles, excluding commuter rail. Making transit more competitive for travelers that have alternative travel options would involve substantial changes across a multitude of attributes. For perspective, the average U.S. transit trip duration is almost four times the target trip duration in the often aspired to 15-minute city vision that some planners advocate, where the majority of household activities can be carried out with a bike, walk, or transit trip of 15 minutes or less.

Figure 9 is a characterization of the probability of using transit as a function of the service frequency. The dilemma for public transportation in most U.S. metropolitan areas is that the levels of service (route density and frequency of service) required to be sufficiently attractive to entice travelers who have other options available would require a frequency that dramatically oversupplies the capacity needs in all but the densest urban corridors in the densest urban areas. Even with very high levels of public transit use, services would not operate productively in the absence of very high densities. Only in scenarios with far smaller vehicles and with capital and operating costs scaled proportionally would attractive levels of service be viable in most American metropolitan areas.

FIGURE 9: CHARACTERIZATION OF TRANSIT CHOICE PROBABILITY



Source: Author characterization.

PART 4

THE CONSEQUENCES OF CHANGES

Technology is influencing the nature of work and the settlement patterns of the population. With a growing share of employment and economic activity involving information, corporate locations are no longer as tethered to convenient physical access to raw materials, or markets, or workforce talent, enabling greater location choice flexibility.[3] The workforce is less tethered to access to a central office location, collectively enabling both regional migration and more dispersed urban settlement patterns. Access to information, entertainment, and products that a generation or so earlier might have required proximity to a large metro area is now accessible through the web, a mere click away.

Accessibility now means more than just physical access to activities and destinations. Verbal and virtual interactions can be used to participate in many activities that previously would have required personal travel. Social media, chatting, gaming, and streaming entertainment have been evolving for the past few decades. More recently, online communication advances in coworking spaces and package receiving rooms in multiunit residences and businesses have led urban planners to greater consideration of curb space management. The pandemic accelerated market growth for telemedicine, distance learning,

[3] Katherine Haan, "Remote Work Statistics and Trends in 2024," *Forbes Advisor*, https://www.forbes.com/advisor/business/remote-work-statistics/ (accessed 18 Oct. 2024).

online worship, business transactions via secure portals, digital document signing, money transfers and remote check depositing, and a host of other interactions.

Beyond the dramatic opportunities to forgo traditional travel, technology is influencing every attribute of travel choices. The choice of modes and the business models by which they can be procured are changing. Ridehailing services such as Uber and Lyft, electric bikes, scooters, and various vehicle-sharing businesses are now widely available.[4] Various configurations of wheeled electric vehicles are showing up on city streets, some as delivery robots, and an even larger variety of vehicles—including aerial vehicles—are being designed for a possible future deployment.

The features of travel modes are also changing. The way someone plans, schedules, and pays for travel are changing. The comfort, safety, amenities, convenience features, and environmental impacts of the modes are changing. The historic pattern of personal vehicle ownership with relatively high fixed costs and modest marginal trip costs is now augmented with multiple pricing and ownership options. Driver-assisting technologies, navigation, Wi-Fi hotspots, and enhanced safety features have changed personal vehicles. Other modes have similarly utilized technologies to improve the safety, comfort, and convenience they offer travelers.

“The historic pattern of personal vehicle ownership with relatively high fixed costs and modest marginal trip costs is now augmented with multiple pricing and ownership options.”

Important changes in demographic, economic, and environmental conditions are simultaneously changing behaviors—not just for individual travel choices but in both policy and transportation infrastructure and service resource allocation decisions that influence travel choices. The dominance of mobility, safety, and affordability as the foundational goals for transportation is giving way to a more comprehensive set of expectations, some of

[4] “157 Million Trips Across the U.S. and Canada in 2023,” National Association of City Transportation Officials, https://nacto.org/wp-content/uploads/2024/08/Shared-micro-in-2023-snapshot_FINAL_July22-2024.pdf (accessed 18 Oct. 2024)

which conflict or compete with these historic aspirations. Factors such as equity and climate concerns are shifting transportation policy decision-making away from a strong reliance on market demand as the primary driver of investment priorities. Instead, decisions of both individual travelers and policy decision makers are being influenced in ways that might trade off cost or productivity against equity considerations or forecast GHG impacts.[5] Considerations like personal crime and accident risk exposure, on-time and on-budget project delivery, inflation, workforce availability and competencies, financial sustainability, resilience, and partisan political posturing are among the other factors that frame the context confronting urban transportation decision making.

Visions of automated vehicles for personal use and product delivery, a growing portfolio of micro-mobility technologies, mobility-as-a-service and related business models for sharing vehicles and/or trips, and electrification of modes coupled with the sustainable electric generation altering the environmental impacts of transportation, are among the anticipated changes going forward. Inevitable unforeseen changes may further reshape the landscape of transportation.

[5] Ben Clark, Kiron Chatterjee, Steve Melia, "Changes to commute mode: The role of life events, spatial context and environmental attitude," *Transportation Research Part A: Policy and Practice*, Volume 89, 2016, https://doi.org/10.1016/j.tra.2016.05.005

PART 5

A FRAMEWORK FOR THINKING ABOUT TRAVEL BEHAVIOR

Transportation planning professionals have often thought about personal travel decisions by decoupling the admittedly interrelated elements into four decisions: trip generation (a decision to participate in an activity that requires travel), trip distribution (where to go), mode choice (what means of travel), and route selection (what route/road to take). While this four-step travel demand analysis process has been eclipsed in recent decades by personal and commercial activity-based analyses, the model offers a conceptual way to think about how travel choices are changing.

Each of the four steps now entails more choices, as well as choices with different attributes, many of which were not previously differentiators or whose significance was not appreciated. In addition, the dominance of time and money criteria in making travel choices appears to be becoming more nuanced as security, personal health, environmental impact, travel time reliability, and other factors are playing a larger role in or are recognized as important to individuals' decisions. Travel context is also a significant factor, as household characteristics and numerous decisions, such as residential location and vehicle ownership choices, frame the actual choices available for given travelers for a given trip. This results in a more complex, more uncertain, and more difficult to estimate measure of future travel demand and future urban mobility needs and performance.

Table 1 characterizes the changes that are affecting travel decisions.

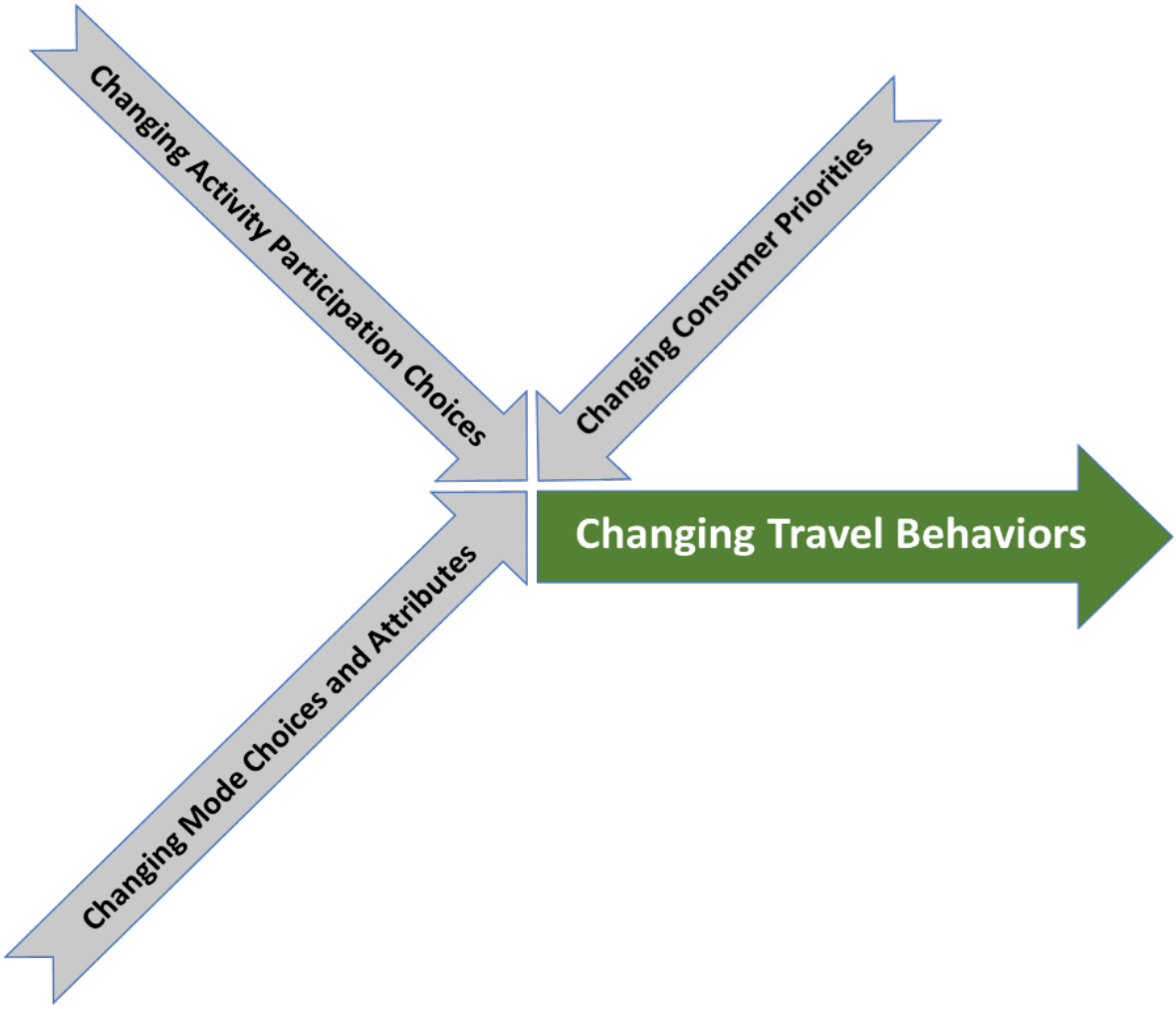
TABLE 1: THE CHANGING TRAVEL DECISION CHOICE SET

Decision	Historical Response	Current Choice Set	
Participation in an activity	• Generate trip	• Information and Communications Technology (ICT) Substitutions (telework, distance learning, e-commerce, etc.) • Outsource travel and/or activity through service providers (grocery and meal deliveries and other services.) • Make a trip	
Activity, good, or service location	• Use historical knowledge and traditional media to determine destination(s)	• Use web resources to identify activity location options both with (for physical access) and without (for digital access and delivery) respect to distance: check inventory, prices, customer feedback, etc. • Review travel and delivery options: time, service schedules, fares, parking availability, etc. • Use historical knowledge and traditional media to determine destination(s)	
Mode of travel	• Walk • Bike • Drive/passenger • Taxi • Public transit • Intercity air/rail/bus • Other	• Walk • Bike/e-bike • Bikeshare/e-bikeshare • Ridehailing • Ridesharing • Drive personal auto	• Carshare/short-term rental • Scooter/scootershare • Public transit • Intercity air/rail/bus • Other
Route choice	• Use historical knowledge and traditional media to determine travel path/route	• Use navigation apps/online resources • Use historical knowledge and traditional media to determine travel path/route	

Figure 10 characterizes the changes taking place. Table 1 shows how the choice set confronting travelers has expanded with additional choices and more distinct attributes of those choices. In addition, the values and resultant criteria that travelers consider in making choices have expanded. Travelers have gained a richer understanding of the full range of attributes of the choices and their consequences on societal concerns, such as

physical health and climate change, as well as personal concerns like reliability, flexibility, stature or status, comfort, and convenience. Thus, urban travel faces dynamic conditions that have the potential to result in meaningfully different travel behaviors with the pace of changes well beyond those witnessed in the past few decades (see Figure 1). If an individual needs to carry out an activity, there are now convenient mechanisms for them to, in effect, subcontract that activity to a service provider, carry out the activity virtually, or choose among a broader array of travel choices including such options as ridehail or e-bike. There are new ways to plan and pay for necessary travel and travelers may be sensitive to such attributes as the climate change impacts of their travel choices or the opportunity for physical exercise or social interaction as part of their travel. Old strategies, methods, and behavioral responses may be different, creating uncertainty and dynamic conditions moving forward.

FIGURE 10 FACTORS CONTRIBUTING TO CHANGING TRAVEL BEHAVIORS



PART 6

CHOICES

Examining options for accommodating future travel through the perspective of climate change sensitivity suggests some relatively simple potential accommodations. Table 2 frames those actions in simple terms.

TABLE 2: KEY EMISSIONS REDUCTION OPTIONS

Tactic	Action	Example Methods
1. Find a way to carry out the activity that doesn't require travel	Substitute communications for travel	Facilitate internet and cellular connectivity. Enhance capabilities to carry out activities remotely by improved interfaces.
2. Minimize travel by carrying out the activity at a location closer to the origin and/or chaining trips	Change origin or destination	Transportation pricing strategies to minimize travel. Changes in land use and urban design to accommodate or encourage activity densification.
3. Minimize emissions by selecting a means of travel that minimizes emissions	Provide and encourage more emissions-efficient travel choices	Enhance emissions efficiency of transportation technologies. Encourage availability and use of emissions efficient travel choices.

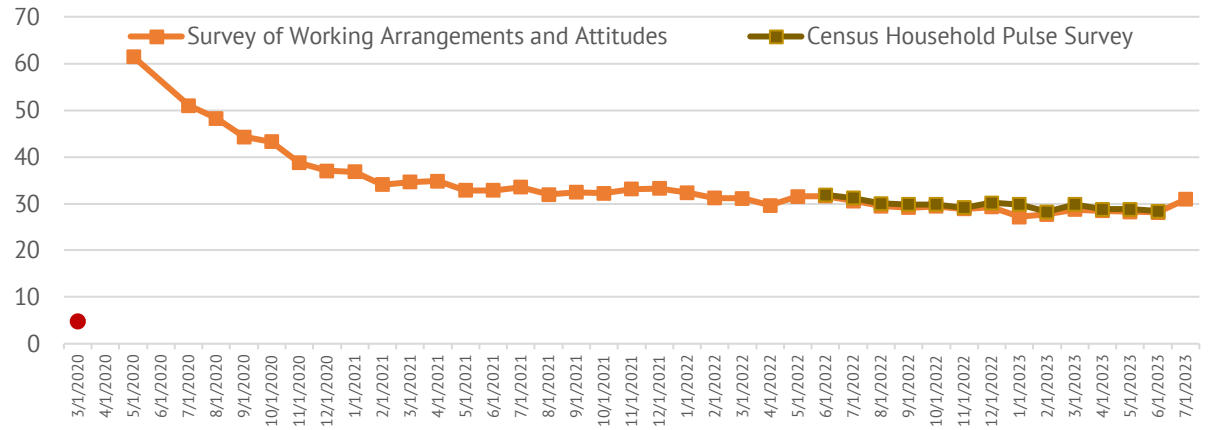
Understanding the implications of various actions is enabled by insight into the nature and characteristics of person travel. Understanding how travel varies by trip purpose and length gives insights that can inform strategies to reduce emissions.

THE CHOICE TO NOT TRAVEL

The concept of substituting communications for travel merits far greater attention as it relates to understanding the future of transportation and its emissions impacts. Information and communications technology (ICT) offers compelling benefits. A great deal of transportation stakeholders' attention is directed toward mitigating the negative externalities of travel, particularly personal vehicle travel. This includes not only the high-profile attention to greenhouse gas emissions but also attention to other vehicular emissions, vehicle noise, travel-associated safety risks, and disruptions to communities natural and built environment and social fabric. The opportunity to substitute communications for travel reduces to virtually zero the negative externalities of that "would-have-been travel." COVID supercharged the development of supportive technologies for online engagement, increased the market penetration of communications capabilities, expanded access to electronic payment opportunities, and motivated individuals and businesses to adopt and upgrade their technological tools and software.

The magnitude of the opportunity is significant. As shown in Figure 11, various data sources suggest that the post-COVID share of telework is as much as 30% on an average workday. Figure 12 shows that the share of retail sales via ecommerce was 15.4% of retail sales in the first quarter of 2023 and was on an upward trend. While analysts will use emerging data to sort out the net Vehicle Miles of Travel (VMT) impacts and understand the full consequences of both trends, their significance on urban travel and their persistence are increasingly appreciated by analysts as recovery from COVID moves forward.

FIGURE 11: PERCENTAGE OF PAID FULL DAYS WORKED FROM HOME

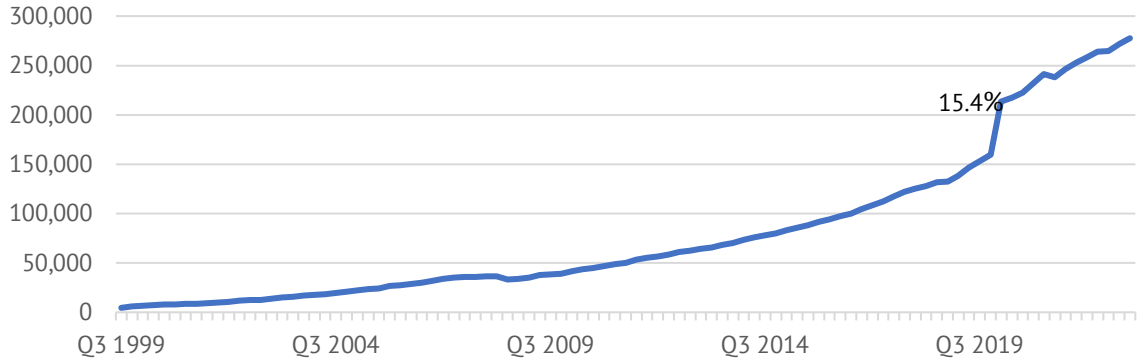


Source: Survey of Working Arrangements and Attitudes (SWAA), Data sourced at www.wfhresearch.com

While telework and e-commerce are the most striking examples, multiple other trip purposes are also being substituted with ICT. For example, telehealth trends spiked to 70 percent during the worst of the pandemic and have normalized to levels of telehealth visits in 2021 in the teens to low 20% range–still an order of magnitude higher than the pre-COVID numbers. Medical community analysts expect that enhancements in technologies, protocols, and culture will occur over multiple years and the share of virtual visits will move toward 50 percent.[6]

Distance learning is another area where there will continue to be opportunities to reduce travel. While educators and individuals sort through how and when online learning can be effectively executed, it is likely to continue to play a significant role both in formal academic education as well as in workforce training and related activities. For example, the Fall 2023 enrollment data for Arizona State University, something of a pioneer in distance learning, indicated 80,000 on-campus students and 64,000 online-only students.[7] Online learning programs are expanding and additional enhancements like integration of artificial intelligence are anticipated to continue the growth and evolution of online education or eLearning[8]. As with other online applications, enhancements in technologies and protocols and a richer understanding of the topics, types of people, and best practices will continue to evolve, but, inevitably, more travel will be saved by virtue of distance learning.

FIGURE 12: E-COMMERCE RETAIL SALES: $M, QUARTERLY, SEASONALLY ADJUSTED



Source: Federal Reserve Economic Data, Economic Research Division, https://fred.stlouisfed.org

6 Oleg Bestsennyy, Greg Gilbert, Alex Harris, and Jennifer Rost, "Telehealth: A quarter-trillion-dollar post-COVID-19 reality?," McKinsey and Company, 9 July 2021, https://www.mckinsey.com/industries/healthcare/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality.

7 Marshall Terrill, "ASU projects record enrollment for fall 2023," *ASU News*, August 14, 2023, https://news.asu.edu/20230814-sun-devil-life-asu-projects-record-enrollment-fall-2023

8 Imed Bouchrika, "10 Online Education Trends: 2025 Predictions, Reports & Data," Research.com, January 8, 2025, https://research.com/education/online-education-trends

Social online engagement continues to evolve and be extremely popular. While the favorite social media platforms continue to change and evolve, as do the popular titles and technology features for online gaming and gambling, the engagement of these capabilities continues to expand. New capabilities and strategies such as the online participation in competitive/participatory exercise programs are continuing to incrementally expand the range of activities with remote participation options. The average American spends around 2 hours and 21 minutes per day on social media.[9] While research has not fully disentangled the net impact on travel, the hypothesis is consistent with the downward trend in trips rates show in Figures 13 and 14.

Many other personal and business transactions will gravitate to online conduct. Bank teller transactions have dramatically diminished as online deposits, autopay arrangements, smartphone check depositing, and myriad other payment and fund-transfer arrangements have minimized the need for personal interactions and associated travel. Online secure signature protocols, web camera face- and ID-scanning capabilities, and secure document transfers enable a multitude of business activities to be carried out via the web.

Online secure signature protocols, web camera face- and ID-scanning capabilities, and secure document transfers enable a multitude of business activities to be carried out via the web.

According to a Pew Research Center 2020-2021 survey, 97% of American adults had a mobile phone, and 85% have a smartphone. In addition, 77% of Americans own a desktop or laptop computer, and 53% have tablets. There are about 274 million smartphones in use in the United States.[10] In comparison, there were 282 million personal and commercial vehicles registered in the U.S. in 2021, and 92% of households have one or more vehicles.[11, 12] Communication devices increasingly enable people to take advantage of online or over-the-

9 "Global Social Media Statistics," Datareportal, https://datareportal.com/social-media-users (accessed 10 Feb. 2025).

10 Mobile Fact Sheet, Pew Research Center, April 7, 2021, https://www.pewresearch.org/internet/fact-sheet/mobile/ (Accessed 10 Feb. 2025).

11 U.S. Department of Transportation, "State Motor Vehicle Registrations--2021," Highway Statistics Series Table Mv-1, October 2023, https://www.fhwa.dot.gov/policyinformation/statistics/2021/mv1.cfm

12 Analysis of 2022 American Community Survey data from U.S. Census Bureau, "Selected Housing Characteristics," Table DPO4, https://data.census.gov/table/ACSDP1Y2022.DP04, (accessed 10 Feb. 2025).

phone communications in lieu of travel. In 2022, 94 percent of adults had a bank account facilitating online business transactions.[13]

This means a lot of foregone travel. As shown in Figure 13, per capita trip-making reduced from 4.3 trips per day in 1995 to 3.4 trips per day in 2017. The share of commuters reporting usually working at home increased from 4.4% in 2013 to 5.7% in 2019 and 17.9% in 2021.[14] Work-at-home has been the fastest changing commute mode and commuting comprises a huge share of public transit ridership.[15] E-commerce, distance learning, and other communication substitutions no doubt played some role in declining overall travel and public transit use.

E-commerce, distance learning, and other communication substitutions no doubt played some role in declining overall travel and public transit use.

The penetration of high-quality communications and internet connectivity will only increase over time. Commitments to internet expansion in infrastructure legislation, aging out of the generation more technology reluctant, and ever-improving software capabilities are destined to improve communications capabilities. Technology and communications companies are exploring myriad new devices, tools and capabilities to enhance communications capabilities and functionality. Artificial intelligence, virtual reality, three-dimensional holograms, enhanced software platforms, and other innovations may play a future role in improving communications and interaction capabilities. Increases in travel cost or increasing concerns about environmental impacts of travel may enhance the pace of adoption of ICT alternatives to travel.

13 Board of Governors of the Federal Reserve system, "Report on the Economic Well-Being of U.S. Households in 2022 - May 2023," https://www.federalreserve.gov/publications/2023-economic-well-being-of-us-households-in-2022-executive-summary.htm. Accessed May 2024.

14 Steven Polzin, Irfan Batur, Ram Pendyala, "Changing Travel Behavior Insights from the 2021 ACS, ATUS, and CE Surveys," TOMNET Transportation Center Policy Brief, Arizona State University, March 2023, https://tomnet-utc.engineering.asu.edu/wp-content/uploads/sites/5/2023/03/Changing-Travel-Behavior-Insights-From-the-2021-ACS-ATUS-and-CE-Surveys.pdf.

15 CJI Research Corporation, "Who Rides Public transportation," American Public Transportation Association, 2017, https://www.apta.com/wp-content/uploads/Resources/resources/reportsandpublications/Documents/APTA-Who-Rides-Public-Transportation-2017.pdf (Accessed 11 Feb. 2025).

PART 7

LAND USE AND DEMOGRAPHIC CHANGES

Development density, urban design, land use mix, network connectivity, and intermodal connections are all topics urban planners discuss as they consider the future of cities. The relationship between transportation and land use is well-established as a key factor influencing the amount of travel and the competitiveness and viability of alternative modes of travel. Stakeholders who strive to minimize the negative externalities of travel often rely heavily on influencing land use and activity patterns as a critical factor in the viability of their scenarios for the future of cities. The underlying motivation in these scenarios is to minimize personal vehicle travel to reduce its externalities of disruption to the natural and man-made environment, resource consumption, emissions, and travel safety risk.[16] The most critical element in in this goal is to increase densities and then balance land uses to increase accessibility and alter designs to further facilitate access to alternative modes.

[16] Jean-Paul Rodrigue, *The Geography of Transport Systems*, Fifth Edition, (New York: Routledge, 2020, https://transportgeography.org/.

Emerging and continuing land use and development trends present challenges to these aspirations. The motivation for the concentration of activities has been to minimize travel time/cost to enable economic and social interactions. Dense central business districts (CBDs) grew because they offered proximity to markets, employees, customers, and often intercity transportation connections that offered value to people and businesses. Densities of central business districts and surrounding areas reflected the value of the accessibility inherent in their central location, which enabled not only economy of scale but also agglomeration economies to be captured.

The growth in knowledge businesses and the ability to substitute virtual connections are hypothesized to have weakened the criticality of in-person proximity and may undermine the benefits of agglomeration economics that justify the investments in higher-cost, dense location choices typical of CBDs.[17] While select urban locations, such as the District of Columbia, Wall Street, Chicago's Loop, and others, may maintain a distinct set of conditions that continue to motivate dense activity concentrations, these conditions are not present in all metropolitan areas. While land constraints may result in densification in growing geographically constrained locations like Miami, a weakened economic argument for concentration to capture agglomeration benefits may undermine further densification of activity nodes to the levels that support competitive alternative modes. Highly concentrated activities serve as the foundation for investment in and travelers' decisions to use alternative modes, and these densities can enable shorter trips. Urban crime, housing affordability, school quality, and other factors similarly challenge the future of some urban core areas.

> *Meaningful changes in land-use patterns require multiple decades to materialize in a way that would be significant at the national level.*

As pointed out in "Public Transit and Climate Change," the pace of land-use change is modest, limited by the fact that a very small share, 1-2% of the residential dwelling unit inventory, is added or replaced annually. Meaningful changes in land-use patterns require

[17] Giuliano, G., Kang, S. & Yuan, Q., "Agglomeration economies and evolving urban form," *Annals of Regional Science*, 63, 2019, 377–398, https://doi.org/10.1007/s00168-019-00957-4.

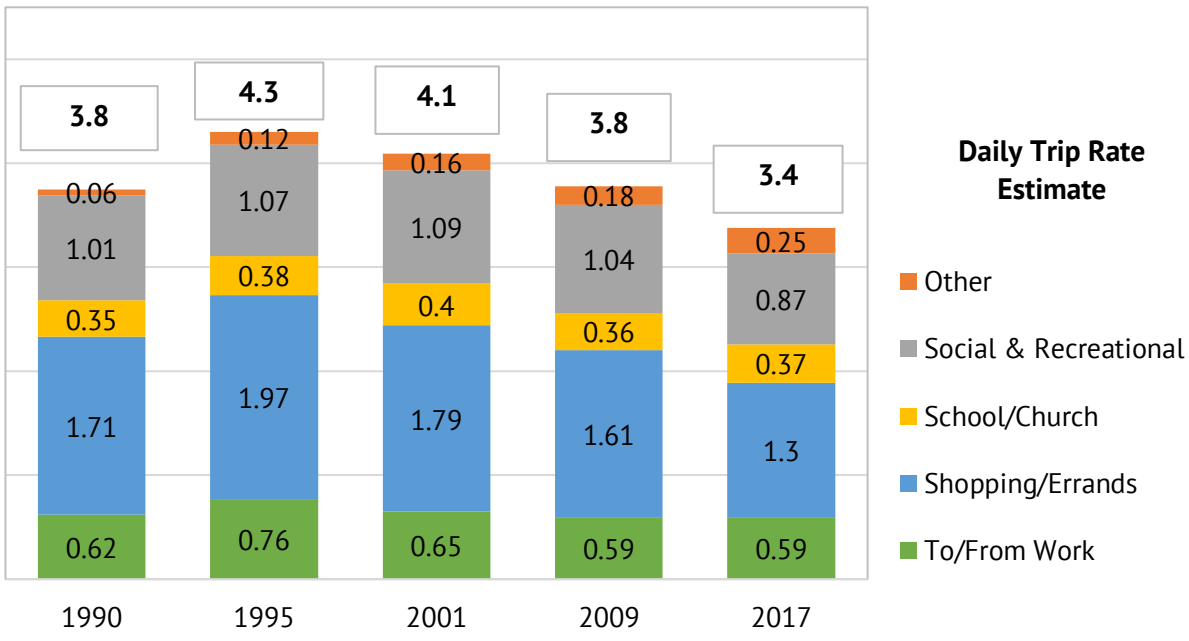
multiple decades to materialize in a way that would be significant at the national level. While aggressive initiatives may reshape land-use patterns in select corridors in rapidly growing areas, there is no credible case for meaningful changes in residential densities, household size, or trip attraction volumes at non-residential land-use locations. Redevelopment of aged structures and infill development may increase densities in some locations, but resultant densities may still not reach threshold levels where alternative modes become meaningfully more competitive.

Changes in land-use mixes, urban configuration, and urban/site design can also affect travel. Planners aspire to provide environments accommodative to active modes, walking, biking, and transit, and land-use mixes and development scale to enable convenient and short trips to meet most of the daily travel needs. Incremental changes in design characteristics may support alternatives to personal vehicle travel, but both the scale and pace of change will be modest by virtue of the cost and magnitude of the challenge of modifying the substantial urban infrastructure.

Evidence from the National Household Travel Survey, shown in Figure 13, indicates declines in trip rates since 1995.[18] This trend is reinforced by trends from the American Time Use Survey (ATUS). Figure 14 presents the average number of daily trips per person from the ATUS data between 2003 and 2022. The figure shows the declining household travel trip rates over the past two decades. These declines in trip rates also hamper reaching the threshold levels of use necessary to make investment in alternative modes highly productive. As additional data is gathered to understand post-COVID travel behaviors, it will be important to understand what are trending to be destined to be still lower trip-generation levels for future transportation planning.

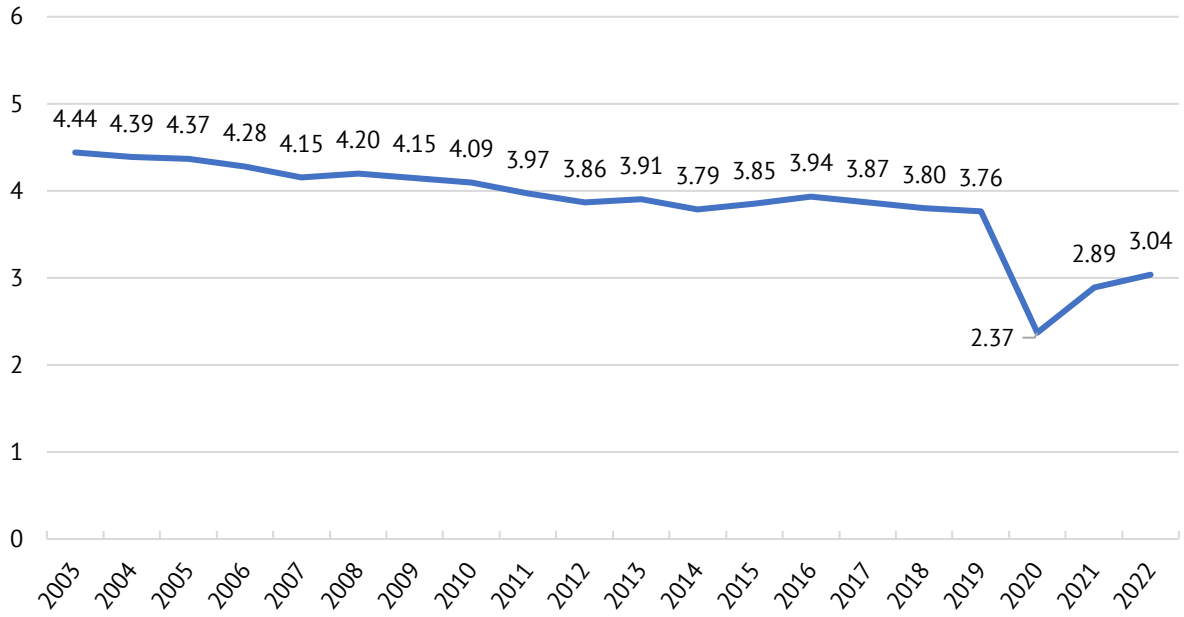
[18] The 2022 NHTS data released in early 2024 (Office of Policy and Governmental Affairs, "Summary of Travel Trends: 2022 National Household Travel Survey," United States Department of Transportation. Federal Highway Administration., January 1, 2024, https://rosap.ntl.bts.gov/view/dot/73764) showed a far lower trip rate, 2.28 vs. 3.4 in 2017. The sample, size, changes in methodology and impacts of CIVID-19 lead to caution in the interpretation of the magnitude of the downward trend.

FIGURE 13: DAILY PERSON TRIP RATE



Source: U.S. Department of Transportation, Federal Highway Administration, *Summary of Travel Trends: 2017 National Household Travel Survey,* July 2018. 2017_nhts_summary_travel_trends.pdf (ornl.gov)

FIGURE 14: NUMBER OF DAILY PERSON TRIPS



Source: ASU analysis of American Time Use Survey data. https://www.bls.gov/tus/

Numerous other factors influencing future travel demand levels are also at play. COVID-stimulated telework levels and housing affordability spur shifts in settlement patterns away from core urban communities in many cases, but constrained housing supply dampens the magnitude of that effect.[19] Regional relocation trends are also influencing urban travel conditions with several metropolitan areas seeing outflows of the population while others see growth. Shrinking areas may see less travel demand, making it more challenging to justify greater public transit service levels or roadway expansion expenditures while other growing areas will require additional investment. In general, outflows tend to be from older established denser urban areas (Philadelphia, Cleveland, Chicago, Baltimore, etc.) often with more robust public transit infrastructure and bike/walk friendliness to more sprawling post-auto-era urban areas with less mature public transportation and less bike- and walk-conducive environments (e.g., Phoenix, Dallas, Houston, Orlando, Atlanta, Miami). The subsequent section on public transportation enumerates some of these shifts.

Housing affordability generally favors suburban and exurban development trends; however, affordability may also favor multifamily developments, which are denser and tend to be more urban-centric. In the absence of strong economic motivations for the densification of activities, future activity concentration will depend on geographic constraints or an ability to garner public support and a willingness to use policy and regulatory actions to drive land development. This may include actions to remove zoning constraints to densification in desirable locations, where regulatory requirements and vested interests of current residents often push to preserve the status quo.

> *A more recent urban planning proposal seeks to coordinate development patterns such that the basic daily needs of individuals can be accommodated via short trips. This idea is often referred to as the 15- or 20-minute city.*

[19] Adam Ozimek, "How Remote Work is Shifting Population Growth Across the U.S.," Economic Innovation Group, April 13, 2022, https://eig.org/how-remote-work-is-shifting-population-growth-across-the-u-s/.

A more recent urban planning proposal seeks to coordinate development patterns such that the basic daily needs of individuals can be accommodated via short trips. This idea is often referred to as the 15- or 20-minute city. The challenge remains sustaining service and retail activities at a scale consistent with the geography of short trips. America's retail and service sectors are strongly influenced by economy of scale considerations leading to consolidation to relatively large facilities whose market areas requires a substantial geography often resulting in trip lengths beyond the convenient bike and walk trip range. For example, nearly one-quarter of grocery sales in the U.S. are captured by Walmart, whose store size is not conducive to neighborhood scale.[20, 21]

While there are numerous opportunities to influence land use and urban design in support of alternative modes and to favor minimizing travel distances and supporting trip chaining/consolidation, each of these activities has a host of confounding considerations that impede the pace and extent to which they can have a significant national impact. For example, some of the suburban development configurations that lack dense grid network of many older urban core areas are precluded from that development pattern by rules protecting wetlands and habitats. With each change, there are consequences and impacts, economic and otherwise, that must be considered.

[20] Danny Sheriden, "Grocery Market Share, Q1 2022," Fact of the Day, https://www.factoftheday1.com/p/august-16-grocery-market-share-q1 (Accessed October 2024).

[21] As of Jan. 31, 2023, Walmart had a total of 3,572 supercenter stores throughout the United States and 781 neighborhood markets. "Number of Walmart U.S. stores in the United States from fiscal year 2021 to 2024, by type," Statista, https://www.statista.com/statistics/269425/total-number-of-walmart-stores-in-the-united-states-by-type/# (Accessed 10 Feb. 2025).

PART 8

THE ROLE OF PUBLIC TRANSPORTATION MOVING FORWARD

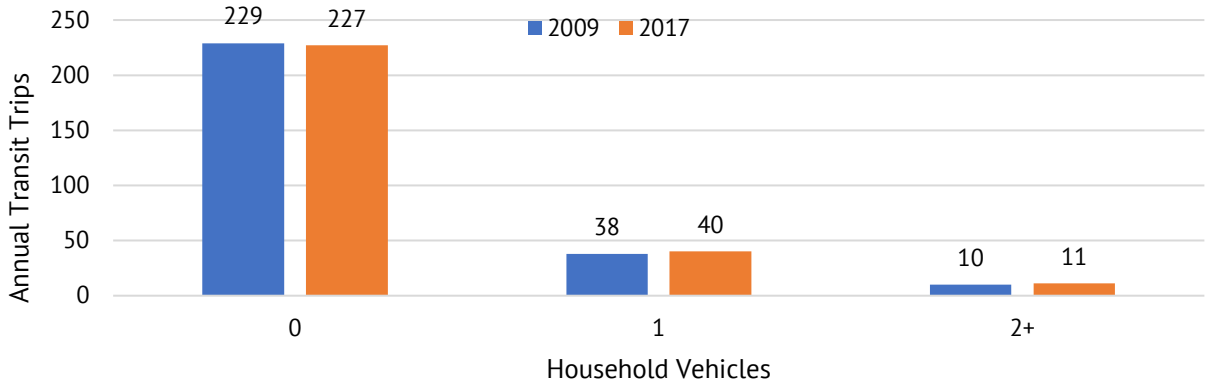
Traditional public transit is at a unique point in its history with perhaps the greatest gap between empirical reality and the aspirations and expectations of industry stakeholders. Public transit is frequently cited as a critical element in a more equitable and sustainable future with broad advocacy support from stakeholders envisioning public transportation playing a far more substantial role in future urban mobility.

Most certainly public transit will continue playing an important role in providing mobility for individuals who do not have access to cars, as well as providing efficient travel in chronically congested, high-demand corridors. The big disconnect exists in the expectations that most public transportation is or will be able to attract sufficient demand to deliver on the resource efficiency expectations to help address GHG concerns.

Public transportation has had a challenging decade. Persistent ridership declines from 2013 to 2019 despite growth in service and a strong economy signaled travelers' willingness to forgo prior levels of travel on public transportation. Researchers have enumerated these

trends and investigated the contributing factors.[22, 23] While complex multi-factor behaviors preclude definitive quantitative attribution of causes, several things were clear. Record levels of auto availability–in terms of both auto ownership and auto trips via services like Lyft and Uber–spurred shifts away from public transportation. Low interest rates, affordable vehicle prices, accommodating licensing practices where several states enabled undocumented immigrants' driving privileges, fluctuating but generally affordable fuel prices, and lax enforcement of auto insurance requirements, were among the contributing factors. Figure 15 reveals the significance of auto availability on household travel.

FIGURE 15: PER CAPITA ANNUAL TRANSIT TRIPS BY HOUSEHOLD VEHICLE AVAILABILITY



Source: Analysis of 2009 and 2017 National Household Travel Surveys. National Household Travel Survey (ornl.gov).

Additional travel choices and the choice to conduct activities virtually or procure services through contract providers are other critical factors. Ride-hailing was anticipated by some transportation analysts to be a complementary mode by providing access to public transit and supporting reduced reliance on auto ownership, yet to date empirical data indicates that the net effect is ride-hailing captures more previous transit trips than it induces additional transit use.[24]

22 "Recent Decline in Public Transportation Ridership: Analysis, Causes, and Responses," Transit Cooperative Research Program Report 231, The National Academies Press, 2022, https://doi.org/10.17226/26320, M. Manville, E. Blumenberg and B. Taylor, "Falling Transit Ridership: California and Southern California," UCLA Institute of Transportation Studies, December 2017.

23 Gregory D. Erhardt, Jawad Mahmud Hoque, Vedant Goyal, Simon Berrebi, Candace Brakewood, Kari E. Watkins, "Why has public transit ridership declined in the United States?," *Transportation Research Part A: Policy and Practice*, Volume 161, 2022, Pages 68-87, ISSN 0965-8564, https://doi.org/10.1016/j.tra.2022.04.006.

24 M. Graehler, R. Mucci, and G. Erhardt, "Understanding the Recent Transit Ridership Decline in Major US Cities: Service Cuts or Emerging Modes?," presented at the TRB 2019 Annual Meeting, Washington, D.C., 2018.

Bike-sharing and scooter use and more recently e-bikes are similarly enabling some previous transit trips to be carried out on these travel choices; for example, a scooter ride may replace a short urban trip or even replace a feeder-distributor transit trip to a linehaul transit service.

Service quality, fares, fears of accident and/or crime safety, and service reliability are some of the other factors in select metropolitan areas influencing transit use. In some communities, service levels remain below pre-COVID levels; and in others, media sources report anecdotal concerns about cleanliness, crime, and homeless loitering.[25] Conditions are still dynamic and data to quantify the national impact has not been assembled. Declines in overall commuting result in driving and parking being more competitive than in pre-COVID conditions, encouraging some travelers to now favor driving options. The growth in telework for information job holders has resulted in a more polarized profile of transit riders which itself can result in some travelers then being more anxious about using transit.[26]

Declines in overall commuting result in driving and parking being more competitive than in pre-COVID conditions, encouraging some travelers to now favor driving options.

Demographic and land-use changes are also playing a role. Changes in the age distribution of the population also undermine transit use. Younger people, 15 to 29, are a stronger transit market, and their share of the population declined from 21% in 2010 to 20% in 2020. Simultaneously, the share of the population over 65, a group that historically travels less, increased from 12.7% to 16.8% of the population during that decade.[27] The dispersion

[25] Julene Paul, "Temporary versus Permanent Pandemic Transit Leavers: Findings from the 2022 US National Household Travel Survey," *Findings*, Jan 16 2024, https://doi.org/10.32866/001c.92046. House Committee on Transportation & Infrastructure, "Hearing on Revenue, Ridership and Post-Pandemic Lessons in Public Transit," https://transportation.house.gov/calendar/eventsingle.aspx?EventID=407523.

[26] Schouten, A., Taylor, B. D., & Blumenberg, E. (2021). "Who's on Board? Examining the Changing Characteristics of Transit Riders using Latent Profile Analysis." *Transportation Research Record*, 2675(7), 1-10. https://doi.org/10.1177/0361198120987225.

[27] U.S. Census, "Age Distribution for U.S. Population: 2000, 2010, and 2020 Censuses," https://www.census.gov/library/visualizations/interactive/age-distribution-for-united-states-population.html (Accessed February 11, 2025).

of historically concentrated public housing populations in some metropolitan areas also impacts access to and use of public transportation.[28]

Several of the historically strong public transit markets in major metropolitan areas have seen declines in population, whereas cities that were/are growing rapidly have less mature public transit services and less transit-supportive land use and density profiles. Table 3 lists the nine largest metropolitan areas in the country, showing their population change between 2015 and 2022. Collectively, these metro areas grew slower than the total national population, and three of the top nine had absolute declines in population. Table 3 also shows the pre-COVID public transit mode share for usual commuters as reported by the American Community Survey. The nation's single largest metropolitan transit market, New York, showed the largest absolute decline in population. In 2019, New York commuters comprised over 38% of the nation's transit commuters. As tens of thousands of New Yorkers migrate to other locations in the country, they are inevitably moving to locations where commuting by public transportation is dramatically lower. The metropolitan areas with the most significant growth, Houston, Atlanta, and Dallas, have transit mode shares well below the national average. The second report, "Public Transit and Climate Change," has additional discussion of public transportation trends.

To compound the historic trends shown in Table 3, COVID-influenced trends on commuting mode choice are having a dramatic and disproportionate impact on public transportation. Public transportation works best when serving large dense concentrations of workers, frequently office workers in central business districts (CBDs). Information workers are best able to work from home, which has resulted in the dramatic decline in overall transit use. While some recovery is underway and various prognosticators envision a range of estimates of the ultimate work-from-home population as post-COVID commuting behaviors stabilize, there is a growing consensus that work-from-home will remain a substantial share of all work arrangements.[29] Many rail services have been significantly impacted as they often serve commute markets. The telework phenomenon has also resulted in longer and higher-fare trips being more likely to be impacted. Work trip commuters are less likely to have discount fare eligibility and more likely to have longer trip lengths. In addition, the loss of

[28] Haughey, Richard M, "Higher-Density Development: Myth and Fact," Washington, D.C.: ULI–the Urban Land Institute, 2005, https://americas.uli.org/wp-content/uploads/ULI-Documents/HigherDensity_MythFact.ashx_.pdf.

[29] "Remote Work Statistics and Trends in 2024," and Bureau of Labor Statistics, "Over one-third of private-sector establishments increased telework during the COVID-19 pandemic" U.S. Department of Labor, https://www.bls.gov/opub/ted/2022/over-one-third-of-private-sector-establishments-increased-telework-during-the-covid-19-pandemic.htm (Accessed 17 Oct. 2024).

these commuters changes the profile of transit travelers which may influence overall attitudes toward using and supporting public transportation.

TABLE 3: IMPACTS OF GROWTH TRENDS ON TRANSIT MARKETS

Largest 9 Metro Areas	Population				ACS Public Transit Commuting "Usual" Mode Share in		
	7/1/2015	7/1/2022	Change	% Change	2019	2022	% Change
New York-Newark-Jersey City, NY-NJ-PA	20,182,305	19,617,869	-564,436	-2.8%	31.6%	23.8%	-24.7%
Los Angeles-Long Beach-Anaheim, CA	13,340,068	12,872,322	-467,746	-3.5%	4.8%	3.1%	-35.4%
Chicago-Naperville-Elgin, IL-IN-WI	9,551,031	9,441,957	-109,074	-1.1%	12.4%	7.0%	-43.5%
Dallas-Fort Worth-Arlington, TX	7,102,796	7,943,685	840,889	11.8%	1.3%	0.6%	-53.8%
Houston-The Woodlands-Sugar Land, TX	6,656,947	7,340,118	683,171	10.3%	2.0%	1.4%	-30.0%
Washington-Arlington-Alexandria, DC-VA-MD-WV	6,097,684	6,373,756	276,072	4.5%	13.1%	6.0%	-54.2%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	6,069,875	6,241,164	171,289	2.8%	9.4%	5.7%	-39.4%
Atlanta-Sandy Springs-Alpharetta, GA	5,710,795	6,222,106	511,311	9.0%	2.8%	1.4%	-.50.0%
Miami-Fort Lauderdale-Pompano Beach, FL	6,012,331	6,139,340	127,009	2.1%	2.9%	2.4%	-17.2%
Subtotal for 9 Metro Areas	***80,723,832***	***82,192,317***	***1,468,485***	***1.8%***	**---**		
National Total	**324,607,776**	**333,287,557**	**8,679,781**	**2.7%**	**5.0%**	**3.1%**	**-38.0%**

Source: Census (Index of /programs-surveys/popest/datasets (census.gov) and ACS data (Census Bureau Data)

The work trip market is critical to public transportation, as it constitutes approximately 49% of transit trips.[30] Work trips are the strongest transit market for numerous reasons, including their tendency to be concentrated in destinations like CBDs, their predominant occurrence during peak periods when roadway congestion is most severe, their regular and repeat nature, their tendency to be single-person trips without luggage and supplies requiring vehicle storage, their tendency to occur during periods when transit has its best-peak period service levels while roadway driving is most congested, their tendency to occur during busy times of days providing a sense of safety in numbers, the willingness of some employers to subsidize their use, the ability for some to avoid work place parking costs for

[30] CJI Research Corporation, "Who Rides Public Transportation," American Public Transportation Association, January 2017.

lengthy stays, etc. Thus, replacing these trips by attracting travelers from other trips poses a significant challenge.

The loss of public transit riders during COVID goes beyond the loss of commuters switching to telework. The total workforce declined over 25 million workers from February 2020 and didn't return to the pre-COVID-19 levels until spring 2022.[31] Some travelers secured additional vehicles during the pandemic with the share of zero-vehicle households as reported in the American Community Survey reaching a record low of 8.0 percent in 2021.[32] Other travelers appeared more likely to choose autos for travel post-pandemic, perhaps leveraging less onerous commuting and parking conditions, greater work schedule flexibility enabled by accommodating workplaces, impacts of residential relocations during COVID, or residual sensitivities about personal health or crime safety perceptions of returning to public transit.

> *Changing perceptions and attitudes regarding the importance of public transportation use in impacting climate change may also influence future ridership trends.*

Changing perceptions and attitudes regarding the importance of public transportation use in impacting climate change may also influence future ridership trends. The perception that public transportation is a solution to transportation emissions may increase the influence of this factor in mode-choice decisions. However, as electrification of personal vehicles becomes more common, it may diminish the public's motivation to weigh climate impacts in their mode-choice decisions. Similarly, empirical evidence of the actual emissions efficiency of transit services in poor or moderate markets may undermine motivations for using transit unless transit productivity improves markedly.[33]

31 U.S. Bureau of labor statistics, "Civilian labor force participation rate," https://www.bls.gov/charts/employment-situation/civilian-labor-force-participation-rate.htm, (accessed February 2025).

32 "COVID Recovery? Changing Travel Behaviors? Insights From the 2022 ACS, ATUS, and CE Data Sets" Policy Brief, Arizona State University. Dec 2023. COVID-Recovery-TOMNET-TBD-Brief.pdf (asu.edu).

33 Steven E. Polzin, "Transportation and Climate Change: Public Transit and Climate Change," Reason Foundation, 2025.

While every metropolitan context is unique, the national historic empirical data indicate that the rate of growth in public transportation ridership is below the rate of growth in service. This means that service expansion will diminish the productivity and efficiency of public transportation on average.[34] This is a logical expectation as one would presume that the current service is allocated to the most productive geographies and the most logical time periods. Thus, additional service is likely to be deployed in less promising markets and be less productive. In addition, those who are dependent on public transit are most probably already using it for much of their travel demand, thus, most new ridership would be dependent upon attracting those who have alternative means of travel. This is a more challenging market to capture. Research has not identified a tipping point where transit service expansion provides proportionately larger increases in ridership.

Electrification of multiple modes of vehicles offers environmental benefits and could influence travel decisions and mode choices by virtue of changing the relative GHG impact of travel options. A consequence might be a diminished preference for electrified transit travel relative to personal vehicle travel if that personal vehicle becomes electrically propelled. To the extent that environmental considerations dampen overall urban travel demand, electrification coupled with sustainable generation may diminish those sensitivities.

> *“Americans generally recognize the importance of mobility and will likely continue to support options for those reliant on traditional public transportation services and evolving variants or strategies.”*

Americans generally recognize the importance of mobility and will likely continue to support options for those reliant on traditional public transportation services and evolving variants or strategies. These evolving plans may require leveraging technology and collaborating among various levels of government, the private sector, and institutional stakeholders. What remains less clear is the role that public transportation can play as the provider of mass transportation where it can deliver efficiencies in resource utilization.

[34] Transit Cooperative Research Program, *Traveler Response to Transportation System Changes, Chapter 9 – Transit Scheduling and Frequency*, TCRP Report 95, Transportation Research Board, Washington DC, 2004.

Resource constraints, the difficulty of scaling transit costs and capacity to market demand without penalizing levels of service for remaining passengers, and the public's tolerance for funding less productive and more expensive services, provide emerging challenges as Federal COVID supplemental resources run out. Even if those challenges are overcome, use of transit will depend on it being a safe, comfortable mode. Actual and perceived urban crime levels and the comfort and security of travelers accessing, using, and egressing public transit are critical considerations. Safety and civility are critical to transit's ability to attract and retain travelers, and it is a factor that is beyond the immediate control of the transit operator.[35] Infrastructure and service investments will fail to produce desired results if the lack of civility in some of the largest transit market cities is not improved and sustained.

Existing high-volume public transportation markets in communities highly dependent on public transportation and those services necessary to support critical workers are likely to continue to garner support. The extent to which new geographies develop or mature to the corridor level travel volumes necessary to support high levels of public transit services and operate with resource efficiency remains to be seen. Certainly, some communities and some corridors have sufficiently unique characteristics that dense development may materialize. Other communities may choose to support one or more corridors to offer a transit-intensive lifestyle choice. However, expectations that public transportation can be ubiquitously viable at attractive levels of service over broad swaths of urban America are not supported by empirical data or by evidence of a public willingness or financial capacity to redesign and reconfigure urban areas to optimize transit use.

[35] J. Li, Q. He, and Q. Pan, "Crime, environments, service characteristics, and transit ridership: a multilevel analysis," *Transportation*, 2024, https://doi.org/10.1007/s11116-023-10459-0.

PART 9

MICROMOBILITY OPTIONS

New technologies are enabling new travel options. These include vehicle options such as electric scooters, electric bikes, and a wide variety of other electric vehicles, including mini cars, unicycles, and various trike configurations. While the Segway failed to revolutionize urban transportation as some had envisioned, and e-scooters have met with mixed success, many of these vehicle concepts are still evolving with improving hardware characteristics, business models for delivery, and government regulatory strategies. Low-cost electric minicars are selling well in Asian countries. E-bikes and e-scooters, both provided through shared-use businesses and individual ownership, are gaining footholds. Electric golf carts, the closest U.S. equivalent to mini cars, have found popularity in niche markets in locations like barrier islands and senior communities. Automated robots are similarly establishing niche markets for delivery services in some urban areas and campuses.

The internet is filled with articles about emerging new mobility vehicle configurations and business models. These include visions of drones serving as delivery vehicles and ultralight electrically powered aircraft serving niche passenger shuttle markets. Many of these technologies have assorted hurdles to overcome regarding safety, regulation, sustainable business models, and market acceptance. Evolving toward mixed vehicle types with greater personal exposure and lighter vehicle weights sharing travel ways with existing vehicles will exacerbate safety problems if not accompanied by disciplined governance and operating behaviors.

> *These emerging travel options will be both competitive with existing means of travel and potentially complementary to some travel options.*

These emerging travel options will be both competitive with existing means of travel and potentially complementary to some travel options. By focusing primarily on individual travel, they offer convenience, direct door-to-door routing, a climate-friendlier impact, and a significant amount of self-determination and flexibility for travelers. They provide an opportunity to scale the vehicle size to more closely match the size of the payload or passenger count and hence be more resource efficient. While their ultimate role remains to be seen, their virtues suggest they are potentially competitive options to existing travel modes.

In addition to new vehicle concepts, technologies are enabling numerous other traits of vehicles to change. These include obvious things like navigation systems, improved safety features, driver assist systems, and comfort, convenience, and entertainment features. These features can change the relative appeal of different travel choices in ways that may influence mode choice. In addition, the communications and connectivity capabilities of new vehicles have significantly changed the nature of ownership options and the pricing structure of travel choices. They enable short-term vehicle use or rental options which significantly change the nature of travel pricing. Historically, personal vehicle use has relied upon a cost structure that includes high initial capital costs or high monthly lease costs that are fixed with marginal use costs being quite modest on a per-vehicle mile basis. The shared use structure capitalizes the vehicle asset cost into a trip or mileage charge, a feature that makes access to the modes much easier but simultaneously makes the user more cognizant of the actual fully amortized per-mile travel cost. Sharing a vehicle amongst sequential travelers can also minimize or eliminate the owners' costs, if any, of providing parking at both the origin and destination end of trips. These same communications and logistics technologies can also enable simultaneous sharing of travel vehicles, and shared rides, offering cost savings to travelers and resource efficiencies in the overall provision of mobility.

Diminished environmental impacts are likely due both to the transition toward electrification and its ability to be sustainably sourced and opportunities to scale vehicle sizes more proportional to payloads.

The collective consequence of this set of changes in mobility technologies has a yet-to-be-determined impact on the quantity, mode, and subsequent impacts of urban travel going forward. Improved choices and features are desirable and offer an opportunity to improve overall mobility. Diminished environmental impacts are likely due both to the transition toward electrification and its ability to be sustainably sourced and opportunities to scale vehicle sizes more proportional to payloads. Enhanced features and new ownership models should make mobility available to more groups including low-income travelers and persons with disabilities who may take advantage of new features, new services, and new cost structures. New technologies are likely to continue to mitigate the probability of accidents and the injuriousness of those accidents to passengers for every vehicle category. However, the mix of vehicle types and sizes on existing infrastructure risks exacerbating safety challenges if the use of vulnerable modes (bike, walk, scooter, e-bike, trikes, tiny cars) increases. Other factors such as in vehicle driver distractions and misbehaviors, and larger vehicle sizes and weights may have offsetting safety impacts.

PART 10

AUTOMATION

Early advocates of automation of transportation guessed wrong on the timing. Very bright people and very significant investors placed large bets that automation was "just a few years away" several years ago.[36] However, now automation is here, at least to some extent, but is years away from being more ubiquitous. Significant challenges, both technological and institutional, remain to be resolved before broader application is anticipated. Perhaps even more important, the economic viability of a self-sustaining business deployment, either in ride-hail operation or as a vehicle for private ownership, remains to be seen. Market acceptance will be critical to the pace of deployment. Travelers' tolerance for the price and service levels that can be provided autonomously while being financially viable, remain to be seen as the market scales and matures. Additional legal, liability, safety, and other issues will emerge as the number and diversity of contexts for deployment increases.

"Travelers' tolerance for the price and service levels that can be provided autonomously while being financially viable, remain to be seen as the market scales and matures."

[36] "Reality check: $160 billion can't get autonomous vehicles on road", *Automotive News*, Nov. 4, 2022. https://www.autonews.com/mobility-report/autonomous-vehicle-reality-check-after-160-billion-spent.

A significant share of the public may well continue to favor having the autonomy of personal vehicle ownership and be reluctant to rely on a company or government for their mobility. The high cost of developing and deploying automation at scale may diminish market competition and risk noncompetitive pricing and the lack of a competitive market for mobility providers.

Yet, automation does have an opportunity to be a significant factor in future urban travel for both passengers and products. As an additional choice for travelers and shippers, automated services will inevitably compete with existing transportation options and influence their market shares. If attractive economics materialize, they have an opportunity to improve safety, provide more affordable choices for persons with limited personal mobility, accelerate the movement from internal combustion vehicles, reduce parking needs, complement opportunities to move to more efficient multimodal travel behaviors and support mobility for individuals not in a position to incur the upfront costs of vehicle ownership or be in a position to provide their own mobility.

Automation of vehicles offers the opportunity to deploy a variety of sizes of shared-use vehicles to correspond to travel densities.

Automation of vehicles offers the opportunity to deploy a variety of sizes of shared-use vehicles to correspond to travel densities. The public transit industry, significantly burdened by the labor cost of operators, has favored larger vehicles to both accommodate peak loads and provide sufficient capacity to amortize the significant cost of labor. To the extent that technology can replace the vehicle driver/operator functions, both driving the vehicle and handling customer interactions, automation could make sustaining and expanding public transit services more viable. Automated vehicle services, when available in a meaningful way, are likely to compete with traditional public transportation as low level of service markets with thin trip densities might be better served by ride-hailing services or variants of microtransit that can be provided by autonomous vehicle services. Customers may choose these services if they compete with transit or transit may collaborate and coordinate or subsidize these services in a broader coordinated mobility-as-a-service strategy.

PART 11

THE FUTURE OF URBAN MOBILITY

ADDRESSING NON-HOUSEHOLD BASED TRAVEL

Most of the preceding discussion focused on personal travel. Urban travel has additional components, including travel by individuals as part of their jobs, commercial and freight transportation, travel by government and business fleet vehicles ranging from school buses, police cars, and military vehicles to housing inspectors, travel by service providers like lawn, cleaning, and repair professionals, travel by visitors to the area, and vehicles passing through the area on their way to and from other locations. The share of roadway travel by these travelers is going to vary across communities depending upon their location on the transportation network, the nature of their economy, and other factors. The total of this additional travel is significant and, in many ways, distinctly different in terms of the infrastructure and investment needs and its ability to be influenced by various policy actions. The data defining this travel, the planning profession's understanding of the behavior of this travel segment, and knowledge about the magnitude and nature of this travel is far more limited than for household-based travel.

Significant shares of non-home-based travel are captive to specific modes by the nature of the activity and the availability of alternative modes to meet the respective need. The vehicles can be specialized, like police and fire vehicles, or require unique capabilities, like hauling trash. Other travelers are captive to their arriving mode because segments of their

trip extend beyond the range of alternative modes. For example, a family on a cross-country camping trip is not able to abandon their vehicle and traverse the urban area on a bike, bus, or foot before continuing their journey beyond the opposite boundary of the urban area. Travel to deliver goods and services often have specialized vehicles for storage or special functions and frequently involve trip chains to diverse locations that preclude or dramatically complicate using alternative modes.

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Using vehicle miles of travel (VMT) estimates from the 2017 National Household Travel Survey (NHTS) and Federal Highway Administration (FHWA) data indicate that at the national level, household travel comprises approximately 70 percent of total vehicle miles of travel, heavy freight travel is approximately 10 percent, and the remaining 20 percent is a combination of commercial and service vehicle travel. The 2022 NHTS data suggests that this non-household-based travel has been growing substantially.[37]

If there is a continuing shift by households to outsourcing activities to service vendors and continued growth in e-commerce activities with ever shorter delivery windows (which require more travel per customer delivery) then this market segment will continue to grow and merits greater understanding and attention in transportation policy and investment decisions. Non-household travel levels are likely to vary substantially across urban areas depending upon the nature of their economy and population as well as their geography.

[37] These estimates are based on debiting household VMT as measured by the 2017 NHTS from the Total VMT for 2017 as measured by the Federal Highway Administration and debiting the Heavy Vehicle VMT calculated by FHWA.

DYNAMICS AND UNCERTAINTIES

The factors that influence transportation demand and supply are changing at a pace that is unprecedented in the lifetime of most transportation professionals. The prospect of being able to anticipate or prescribe conditions 25 to 50 years in the future is exceptionally daunting. This pace of change suggests favoring investments that do not require decades to implement and whose value can be amortized in relatively short time frames. It argues caution in making investments premised on returns multiple decades in the future: for example, investments in a fixed guideway system whose benefits are dependent on realizing strong growth in demand forecast 25 years hence. It favors adaptive policies and investments and/or incremental investments such that subsequent modifications are possible, and the cost consequences of modifications are manageable. It suggests careful monitoring of emerging conditions so that necessary changes can be implemented quickly. It favors open processes and broad input with limited preconceived notions. While it makes predictive planning challenging, it also risks prescriptive strategies being ill-advised or unlikely to accomplish the intended goals.

“This pace of change suggests favoring investments that do not require decades to implement and whose value can be amortized in relatively short time frames.”

AN ERA OF MORE LIMITED TRAVEL GROWTH

In general, the total U.S. population is growing far slower than in previous decades, and its growth is highly dependent on policy-driven immigration levels.[38] As noted earlier, per capita travel demand has been stable or declining for most of the 21st century. While redistribution of population can create the need for additional capacity even in the absence of overall national demand growth, several urban areas should be considering scenarios where there is no travel demand growth and even potential declines in demand. Building

[38] William H. Frey, “U.S. population growth has nearly flatlined, new census data shows,” Brookings Institution, December 23, 2021, https://www.brookings.edu/articles/u-s-population-growth-has-nearly-flatlined-new-census-data-shows/.

for growth in the absence of sound evidence that an area is destined to grow risks misdirected and wasted resources. Slowing or the absence of growth in travel enables resources to be directed toward restoring and upgrading transportation system elements to improve resiliency, safety, technology integration, impact mitigation, emissions efficiency, and other attributes.

> *Building for growth in the absence of sound evidence that an area is destined to grow risks misdirected and wasted resources.*

In many larger communities, the foundational transportation infrastructure–such as streets and highways, rail lines, and air- and sea-ports–is mostly established, and by virtue of scale, subsequent changes will be only incremental. Some communities have substantial capital needs backlogs for aging infrastructure that requires maintenance and rehabilitation, leaving limited resources to invest in new capacities.

OPPORTUNITIES TO LEVERAGE TECHNOLOGY

The evolution and deployment of technology plays a pivotal role in shaping the future of urban transportation. Virtually every facet of transportation is currently undergoing transformation due to technological advancements. These changes include enhanced vehicle and infrastructure safety, bolstered resilience, minimized environmental footprints, improved accessibility for marginalized travelers, and the adaptation of diverse pricing and third-party payment capabilities. Technology is also facilitating new governance, regulatory, and ownership frameworks, optimizing logistics for vehicle sharing and package delivery, effectively managing congestion and parking issues, and implementing versatile transportation funding strategies—ranging from inventive fare payment systems to mileage-based vehicle fees.

Furthermore, the automation of vehicle operations holds the promise of reducing labor costs while increasing accessibility and service levels. Electrification efforts are set to curb carbon emissions, aligning with environmental sustainability goals. Improved digital and virtual communication platforms have the potential to replace arduous travel with digital

interactions, thereby reducing travel and freeing up transportation capacity for more valuable interactions.

In essence, technology's pervasive influence is reshaping urban transportation by revolutionizing multiple aspects, paving the way for a more efficient, accessible, and potentially sustainable future.

> *...the automation of vehicle operations holds the promise of reducing labor costs while increasing accessibility and service levels.*

INTEGRATION OF MOBILITY-AS-A-SERVICE

Technology has enabled both new vehicle concepts and new business models for providing mobility. The capabilities of convenient payment, logistics, and scheduling enable sharing vehicle assets and sharing rides for multi-occupant vehicles. While these concepts have yet to fully mature, they will inevitably play a role in the future of urban mobility. Issues relating to regulation, safety, cyber security, market acceptance, and other attributes remain to be fully resolved and different urban areas may have very different degrees of penetration. How these service concepts are integrated with publicly provided services such as public transportation will be an important determinant of their ultimate role. The mix between individual versus business ownership of scooters, e-bikes, trikes, and urban cars will sort out over time as the relative economics stabilize. These services offer opportunities for improved mobility for some segments of the traveling public and provide both competition and complementarity to both private and public transportation. These services provide an opportunity for resource efficiency and provide an opportunity to facilitate the electrification of transportation. As with other characteristics of urban transportation, different metropolitan areas may have meaningfully different strategies and levels of the implementation of these mobility options.

THE ROLE OF AUTOMATION

We have reached a point where it is safe to say that automation is here, yet the pace and markets for deployment remain highly uncertain, as are the issues of ownership and governance. Automation will play a role in both person and freight transportation, and both surface and aerial automation may have a role in the future of urban transportation. Automation is potentially complementary and competitive for both auto and traditional public transit services. Automation may provide an attractive means of providing some paratransit services and low-volume fixed-route transit services. It also could provide a cost-effective strategy for operating high-capacity public transit services in exclusive or semi-exclusive guideway operations if the industry embraces the technology and uses it to reduce labor costs and scale vehicle size to offer competitive frequencies while efficiently serving the levels of demand.

“Automation is potentially complementary and competitive for both auto and traditional public transit services.”

But automation, depending on the price points at which it can be provided, may also provide strong competition for traditional public transportation. To the extent that user-side subsidies for transportation or guaranteed income strategies provide access to safety net services for economically disadvantaged people, automated services may allow underperforming fixed-route services to be discontinued, enabling better economic and environmental performance for that public transit that remains to serve high-volume markets. If traditional public transit services try to sustain or improve current service levels in current markets while other travel options challenge their markets, the industry will further struggle to justify environmental or resource efficiency arguments.

PUBLIC TRANSIT'S FUTURE

The foundational goals that underlie public transportation, mobility opportunities for those without alternatives, and resource-efficient mobility for large numbers of people, remain intact with strong public support[39]. However, the ability of public transportation as it currently exists to accomplish those goals is challenged by the changes in conditions in urban areas. New travel choices and new travel behaviors are not conducive to a return to pre-COVID normal, to say nothing of justifying an expanded role for public transportation in urban areas. The impact of telework on transit's traditional core market of commuters is transformative. Communication substitutions for travel for other activities, a trend that is destined to continue increasing, further challenge transit. Other travel options from e-bikes and scooters to ride-hailing services and various mobility-as-a-service options will expand choices for individuals that might have historically used public transportation.

> *"Communication substitutions for travel for other activities, a trend that is destined to continue increasing, further challenge transit."*

Auto availability is at record levels as travelers favor the autonomy, speed, and flexibility of personalized travel options. Through no fault of the transit industry, several traditionally strong transit markets have gained perceptions of being unsafe for accessing and using transit which further deters riders. Institutional challenges in the industry such as controlling project costs and schedules, fiscal sustainability, workforce availability, service reliability, and others have undermined confidence in the industry, undermining both ridership and public confidence.

Aspirations that more funding for public transportation or more aggressive transportation and land-use coordination will meaningfully impact future transit utilization lacks empirical evidence that such initiatives can produce in a time frame or at a scale that is meaningful in the aggregate. Transportation and land-use coordination are supportive and can influence mode choice and trip lengths, but moderate population growth and a huge base

[39] Asha Weinstein Agrawal, *What Do Americans Think about Public Transit? A Review of U.S. Public Opinion Polling Survey Questions*, Mineta Transportation Institute, July 2015, https://transweb.sjsu.edu/sites/default/files/1132-US-public-opinion-on-transit-a-survey-review.pdf.

of a fixed building and transportation infrastructure dampens the influence of incremental changes. The cost of living in urban centers, potentially diminished agglomeration economies of core urban areas, urban crime concerns, and migration away from transit-friendly areas, are among the other factors that would need to be overcome for a renaissance in densification of urban areas necessary to support high quality productive public transportation.

PART 12

NEXT STEPS

Providing mobility for all segments of the population and mitigating the disruptive and environmental consequences associated with transportation is a daunting task, one tough to find a constructive path forward. That said, the first step is to recognize that it is an extraordinarily challenging task. Avoid presumptions of simplistic solutions, relying on out-of-date behaviors, trends, or data, or presuming an ability to prescribe and implement planners' vision of the future that may not be consistent with the public's behaviors in a democratic, resource-constrained society. There is not one answer; there is extensive uncertainty, and there is risk. It is premature to outline a total plan for moving forward but it is possible to define some steps and directions. Strategies include the following:

- *Leverage communication as a substitute for travel*–The change in travel associated with the dramatic adoption of telework and hybrid telework dwarfs the impact of decades of travel demand management efforts and exceeds the roles of urban bike, walk, and transit use in terms of its impact on VMT. Many activities will continue to require face-to-face interaction, but every effort should be made by individuals, businesses and institutions to make available as many activities as possible through communication or digital interactions to reduce burdensome or unnecessary travel and enable transportation resources to be directed to valued travel.

- *Recognize the mobility challenge goes well beyond urban household travel*–Total urban travel includes that travel generated by resident households but also through intercity traffic, freight traffic, visitor and tourist travel, and commercial and service vehicle travel. While household-based travel is well researched, less is known about the

behaviors of the other market segments and their needs and behavioral responses to various investments and policies. Commercial and service vehicle travel is a growing travel segment as households embrace ecommerce and frequently procure services that require the service providers to travel. Trip chaining, transportation of supplies and materials, dispersed market areas, and other factors tend to make these services dependent on roadway vehicles and less conducive to alternative travel options. Transportation planning should develop a better understanding of these markets and leverage logistics and electrification and other options that may be identified to minimize travel extent and emissions.

- *Leverage emerging technologies and associated new mobility options*–In many ways, emerging technologies create tremendous opportunities to improve urban mobility for all populations while mitigating the negative consequences. Electrification, automation, app-based vehicle and ridesharing businesses, newly emerging vehicles like scooters and e-bikes, as well as other smaller electric vehicles or robots and potentially other technology innovations that enable travel choices in vehicle types, their features or the business models for mobility provision enabled by the technology, offer the prospect of greater choices and minimized impacts. These options are still evolving and maturing but merit continued exploration and experimentation by transportation stakeholders with close monitoring and quick adjustments as more is learned about how best to integrate these resources into the urban mobility portfolio.

- *Be pragmatic about the role that traditional public transit can play*–Honor the goals of public transit while acknowledging that strategies might now or in the future be best attained by a broader menu of investments and policies. Traditional transit works where traditional transit works. To base future plans on urban development patterns, densities and foundational travel behavior motivations changing enough to enable public transit to perform in an environmentally sound and financially sustainable way is, at best, aspirational. Depending on environments that do not have or are unlikely to attain the demand levels required to support the quality of service that travelers will find competitive is not a viable path forward. Traditional transit should continue to serve markets where it makes sense, but integration with automation, mobility-as-a-service, vehicle sharing, user-side subsidies, and other strategies should be pursued to provide equitable and resource-efficient services.

- *Use data driven and behaviorally sound strategies for minimizing urban travel GHG impacts*–Table 2 referenced key strategies to address minimizing GHG impacts of

transportation. The first option, minimizing travel by finding alternative ways to carry out the activity remains an underappreciated strategy for reducing GHG. The second strategy, minimizing travel that consumes fuel, encourages the reduction of vehicle travel by shortening trip lengths and or chaining trips. A spectrum of policies, including land use and activity pattern changes, are the most referred to strategies toward that end. Leveraging this strategy is confounded by the mass of fixed infrastructure, slow rate of population growth enabling densification, cost and time frames for having an impact and trade-offs required to meaningfully change U.S. activity and settlement patterns.

The remaining category includes shifting to modes with lower GHG emissions and minimizing the GHG emissions of travel modes. Shifting to lower GHG modes offers some promise via shifts to bike, walk and emerging electric micromobility options, generally for shorter trips. The second report, *Public Transit and Climate Change*, focused on the conditions under which public transportation could support GHG goals.

Ultimately the goal of zero GHG emissions requires eliminating the GHG emissions produced by vehicles. This involves the electrification of transportation vehicles and the transition to green electricity generation or other green-fueled options. This is the only way to reach zero emissions and is potentially less impactful on the settlement choices and travel freedoms of Americans. It puts tremendous pressure on technology development and deployment but offers the spinoff benefit of maturing green technologies for broader global deployment. Only when zero-emissions transportation options are available and affordable will other countries with far more limited resources or political will make progress towards GHG emissions reductions.

Urban areas are entering a new era for transportation. The breadth of issues, evaluation criteria, and set of stakeholders is far larger.

Urban areas are entering a new era for transportation. The breadth of issues, evaluation criteria, and set of stakeholders is far larger. The pace of change has accelerated, and the range of policy, service, and investment options is much expanded. Planning and consensus building may be far more difficult. Common sense is less common, and compromise is more

challenging in a polarized environment with diminished trust in government, businesses, and institutions. Financial resources are likely to be dearer as accumulating deficits and competing needs stress public resources, but the data, tools, and technologies are better.

The path forward is also challenged by something of a conundrum of conflicting goals that impact GHG reduction initiatives. Transportation stakeholders are extremely interested in expanding accessibility and ensuring equitable access to transportation by travelers who are disadvantaged while at the same time, actions to support emissions reductions may impede mobility if pricing or capacity constraints undermine the quality or cost of travel for other segments of the population.

There is a strong desire to reduce or eliminate GHG emissions from the transportation sector and there will be a strong consensus if, over time, this can be accomplished without compromising cost or other considerations. The need for informed transportation decisions, innovative strategies, and disciplined planning and execution remains high.

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