The Rapidly Changing Landscape of Traveler Behavior and Values
Emerging Technologies and an Unexpected Pandemic

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School of Sustainable Engineering and the Built Environment

TOMNET – USDOT Sponsored Tier 1 University Transportation Center

MARG

TOMNET Transportation Center
Teaching Old Models New Tricks

http://tomnet-utc.org | http://mobilityanalytics.org

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Acknowledgements

- ASU Scholars
  - Deborah Salon, Associate Professor
  - Sara Khoeini, Assistant Research Professor
  - Denise Capasso da Silva
  - Shivam Sharda
  - Irfan Batur
  - Tassio Magassy
  - Taehooie Kim

Question:
What is going on with travel demand?

COVID-19 has required most of us to make **large changes** to our daily lives.

commuting

working from home

flying to
meet people

video
conferencing

Will some of these new behaviors **"stick"**?

Some thought leaders say yes, while others think not.

Survey Sections

I. Employment

II. Working and Studying

III. Shopping and Dining

IV. Social Interaction

V. Transport

VI. Attitudes

VII. Demographics

VIII. Social Network

Our recruitment thus far has been almost entirely via **direct email contact** and **social media**.

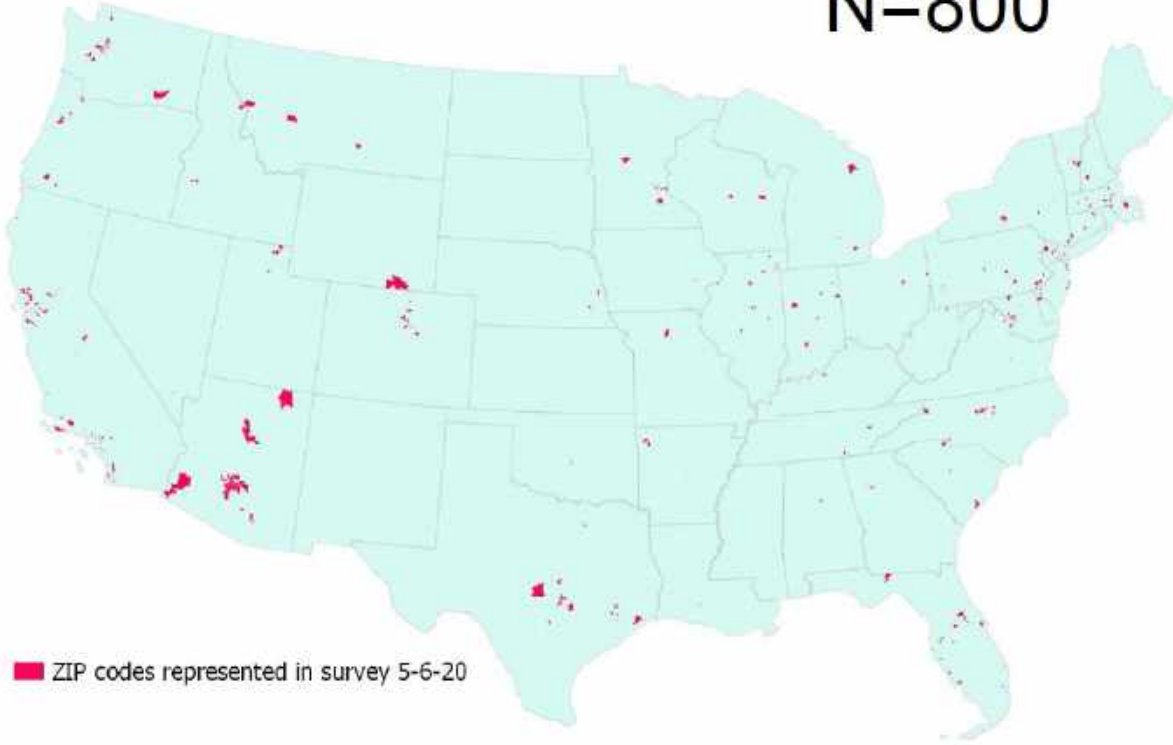National Science Foundation
WHERE DISCOVERIES BEGIN

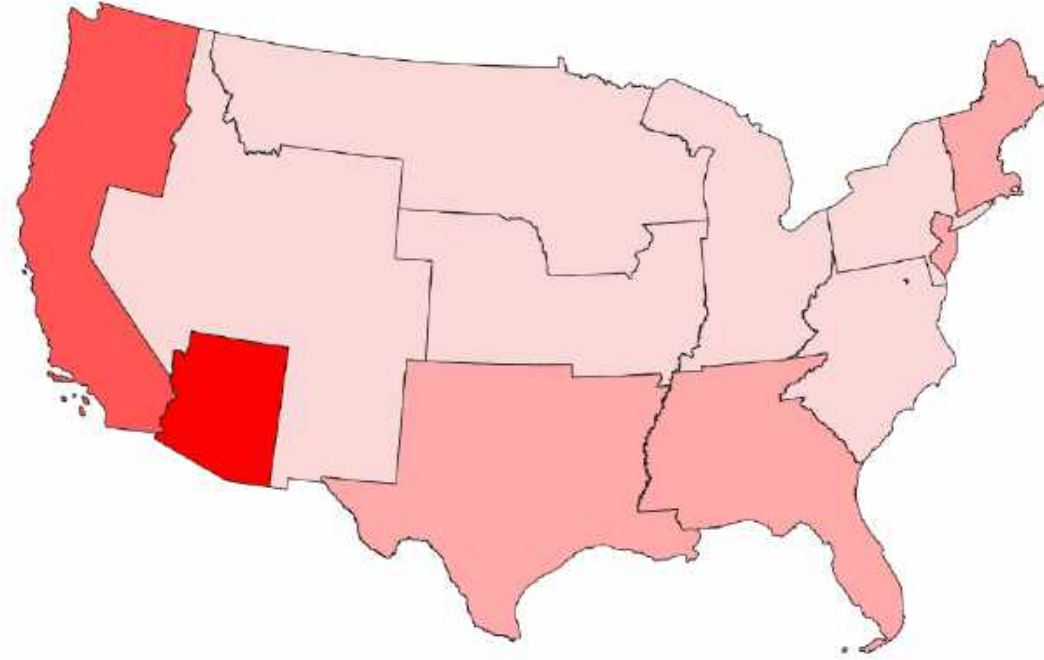We are partnering with researchers at the University of Illinois Chicago for the next stage of this project.

UIC

N=800

ZIP codes represented in survey 5-6-20

Respondents
23 - 40
40 - 75
164
268

Income

Legend: Census, Survey

Income categories: Less than $10,000; $10,000 to $14,999; $15,000 to $24,999; $25,000 to $34,999; $35,000 to $49,999; $50,000 to $74,999; $75,000 to $99,999; $100,000 to $124,999; $125,000 to $149,999; $150,000 to $199,999; $200,000 or more

Age

Legend: Census, Survey

Age categories: 18-19; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49; 50-54; 55-59; 60-64; 65-69; 70-74; 75-79; 80-84; 85 and over; 85-121

Education (age 25 or over)

Census / Survey

- Some grade/high school
- Completed high school or GED
- Some college or technical school
- Bachelor's degree(s) or some graduate school
- Completed graduate degree(s)

Metropolitan area size

Census / Survey

- 100k or less
- 100k–500k
- 500k–1m
- 1m–3m
- 3m–5m
- More than 5m
- Non-metropolitan

Household income change?

Gone up a lot	
Gone up somewhat	
Stayed the same	
Gone down somewhat	
Gone down a lot	

24% Approx. evenly split across income groups in our sample

0   100   200   300   400   500   600

Working From Home

Legend:
- No (yellow)
- Yes (maroon)

Pre-COVID | Now | Post-COVID

Able to WFH | Actual WFH | Able to WFH | Actual WFH | Able to WFH | Actual WFH

Why decreased productivity?

Why increased productivity?
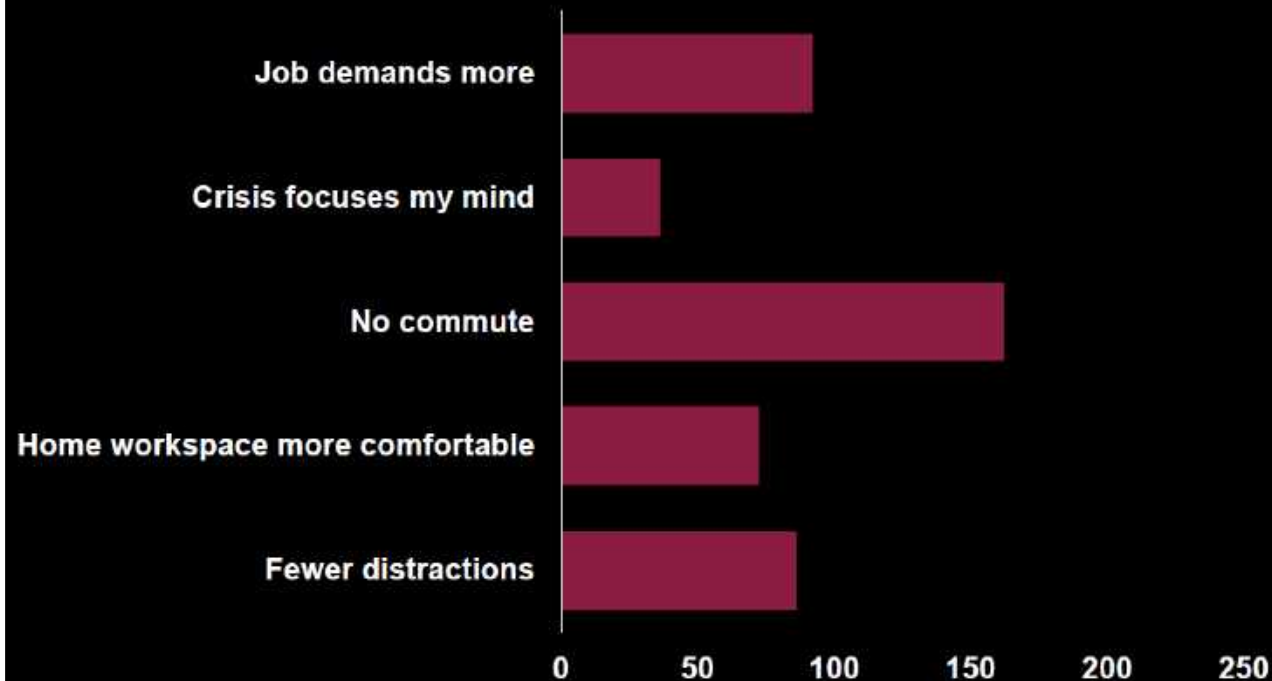
Online Meetings Once/Week or More
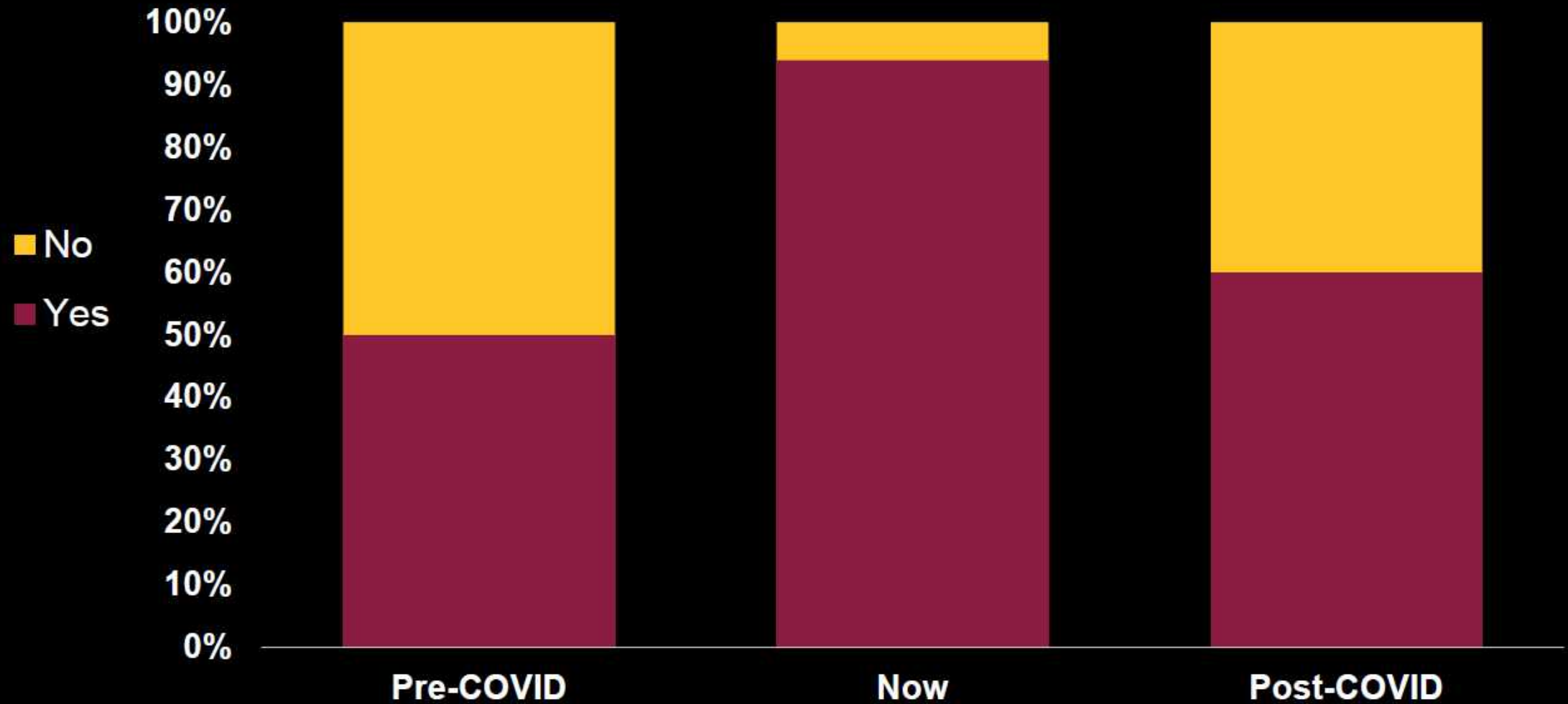
Expected Change in Air Travel
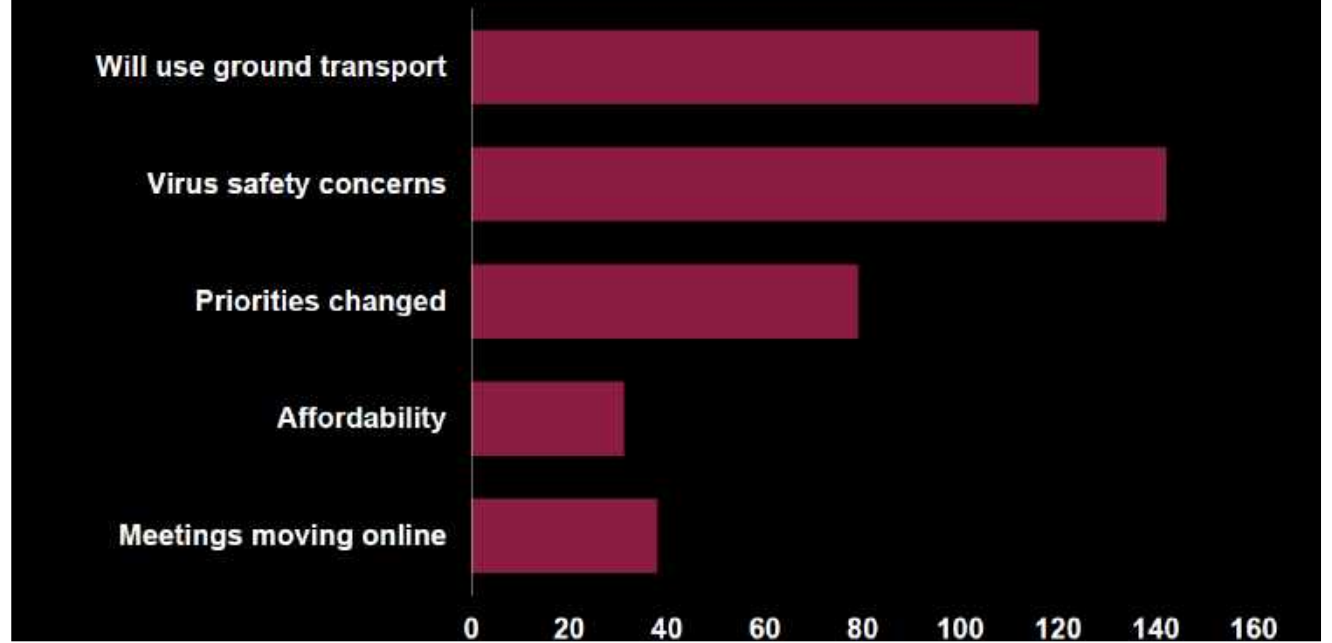
Expected Change in Daily Travel
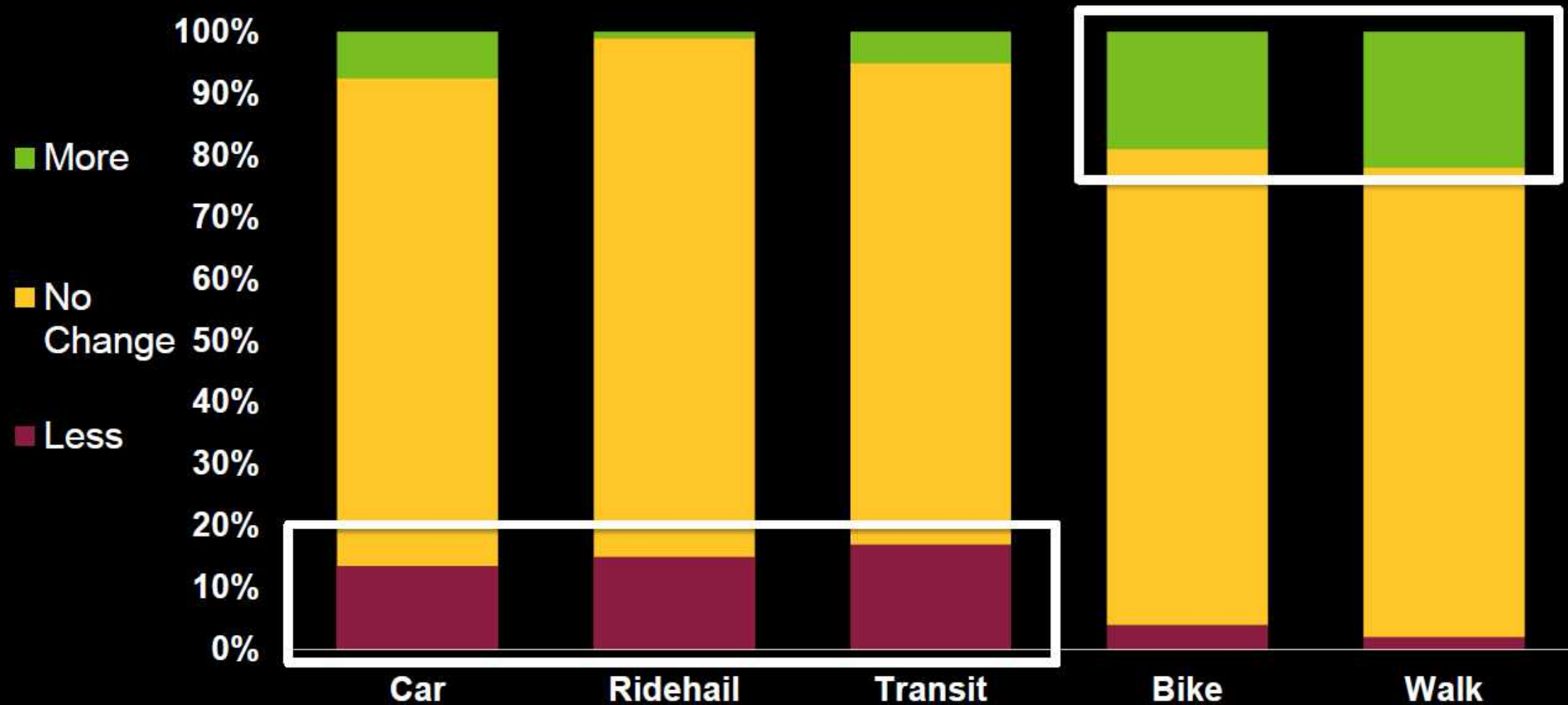
Expected change when COVID-19 is no longer a threat

■ Seen but not answered ■ Much less ■ Somewhat less ■ About the same ■ Somewhat more ■ Much more
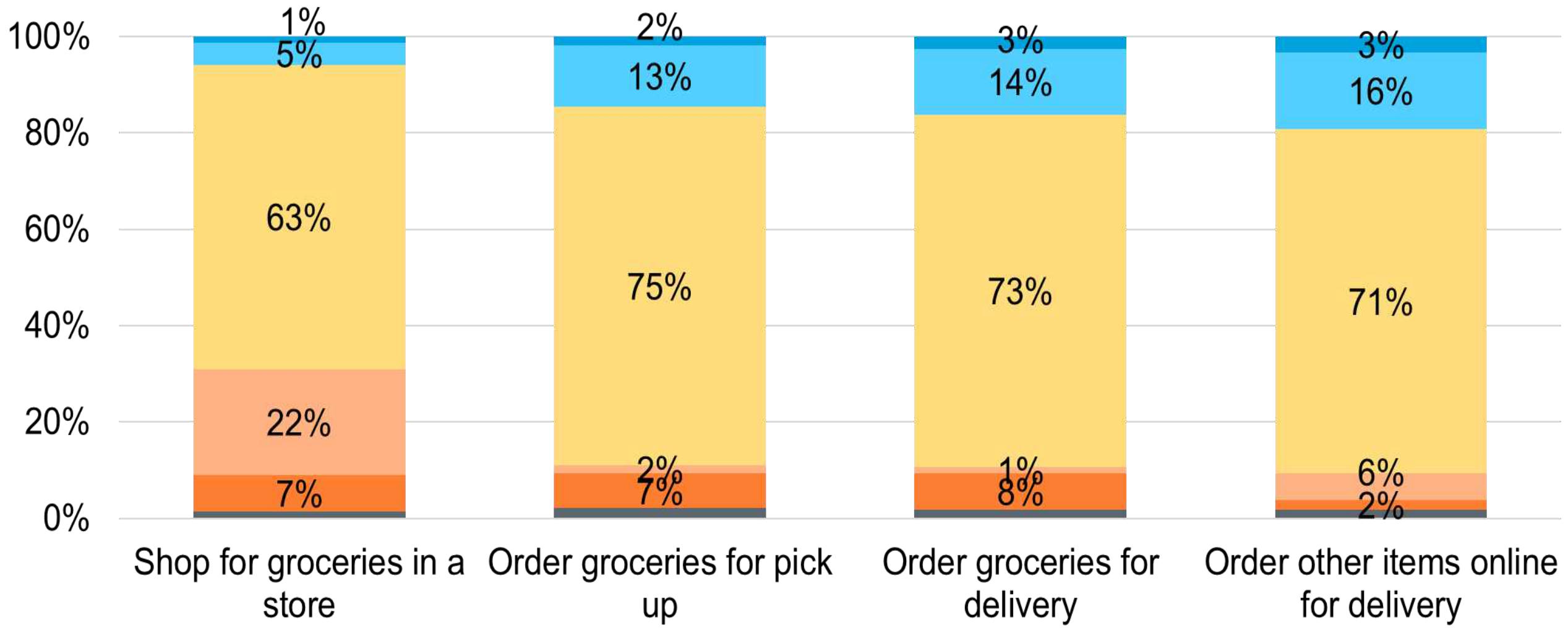
Will these expectations of change become actual change?

Time will tell, but in the meantime, more representative data will help.

- ◉ Connected vehicles
  - V2V and V2I configurations
- ◉ Automated vehicles
  - Various degrees of automation
- ◉ Autonomous vehicles
  - Truly driverless
- ◉ (Shared/Hailed) Mobility Services (TNCs)
  - On-demand
- ◉ Electrification
- ◉ No Travel – Virtual and Delivered!

Sharing and Hailing

Service type	Service model	Business model
Carsharing	• Round-trip / One-way • Free floating / Station-based	• Fleet-based (Public / Private) • Community-based • Peer-to-peer
Bikesharing / Scooter sharing	• Round-trip / One-way • Docked-based / GPS-based	• Fleet-based (Public / Private) • Peer-to-peer
Dynamic carpooling	• Vanpooling / Carpooling • Short-distance / Long-distance • On-demand / Pre-arranged	• Public-private partnership • Peer-to-peer
Ride-hailing	• Single-user / Pooling • On-demand / Pre-arranged	• Private (For Hire-services) • (In some case) Subsidized by public
Microtransit	• Fixed / Flexible route • On-demand / Flexible scheduling	• Public-private partnership

Source: Alemi, F. (2018). What Makes Travelers Use Ridehailing ? Exploring the Latent Constructs behind the Adoption and Frequency of Use of Ridehailing Services, and Their Impacts on the Use of Other Travel Modes. University of California Davis.

Not a Lot of Sharing, But a Lot of Hailing

Basic Ride-hailing Concept

Navigation
Fare/time estimation

Ride Request

Request Notification

Acceptance Notification

Request Acceptance

APP

Payment and Feedback
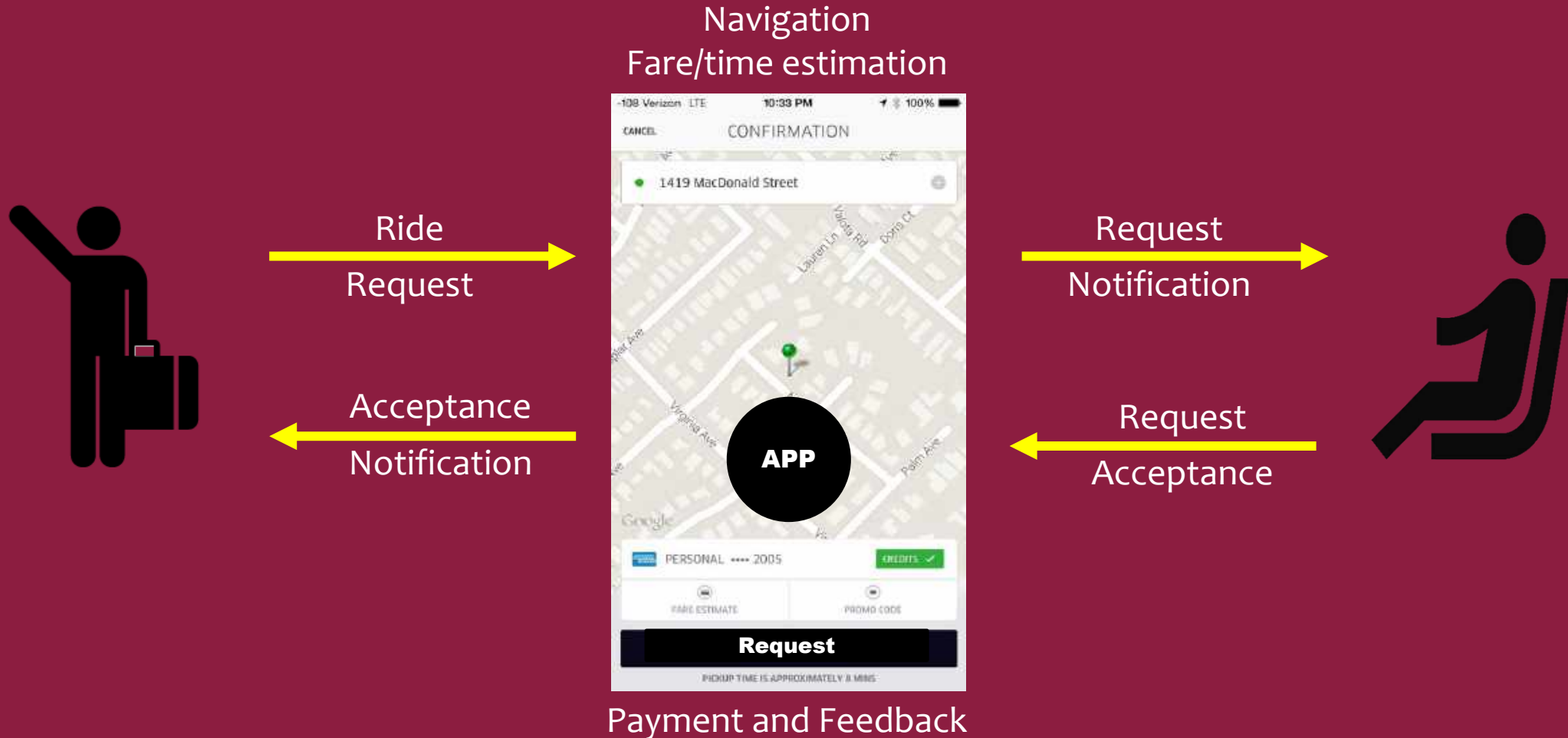
Dramatic Growth
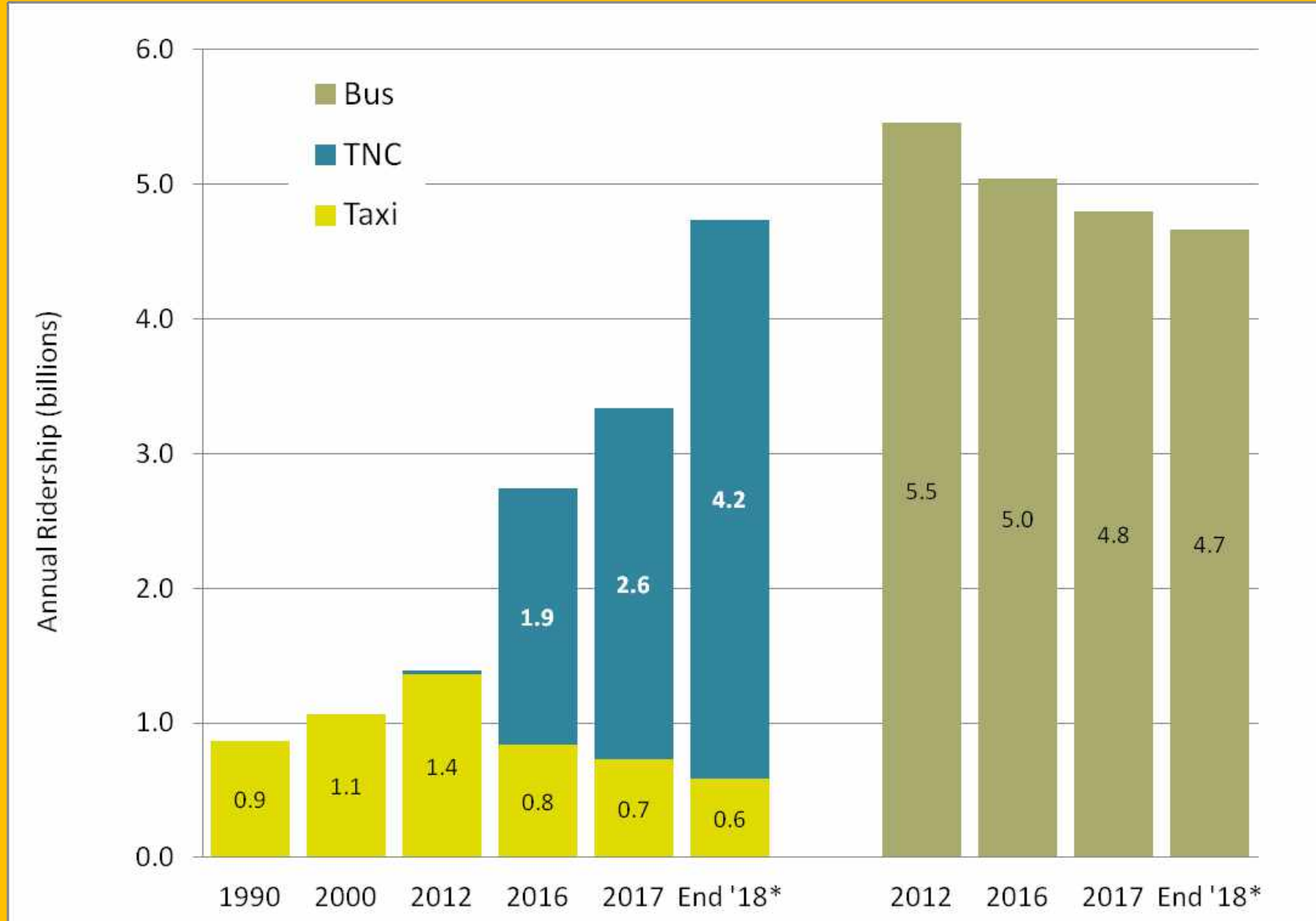
Ride hailing ↑

Taxi ↓

Bus ↓

Ride hailing plus **taxi ridership exceeded** total bus ridership by 2018

Micromobility Choices

- **Shared micromobility** – leverage the technology while minimizing unintended consequences

First Mile – Last Mile – Every Mile!

What is Shared Micromobility?

Shared Micromoblity encompasses all shared-use fleets of small, fully or partially human-powered vehicles such as bikes, e-bikes, and e-scooters.

Station-based bike share
(including e-bikes)

Dockless bike share
(including e-bikes)

Scooter share

Source: NACTO

Micromobility Choices

- Shared micromobility could prove incredibly popular

84 Million Trips on Shared Micromobility in 2018

Legend:
- Scooter share
- Dockless bike share
- Station-based bike share

Total Trips Taken in Millions (y-axis: 10, 20, 30, 40, 50, 60, 70, 80, 90)

- 2010: 321 K
- 2011: 2.4 M
- 2012: 4.5 M
- 2013: 13 M
- 2014: 18 M
- 2015: 22 M
- 2016: 28 M
- 2017: 35 M
- 2018: 84 M
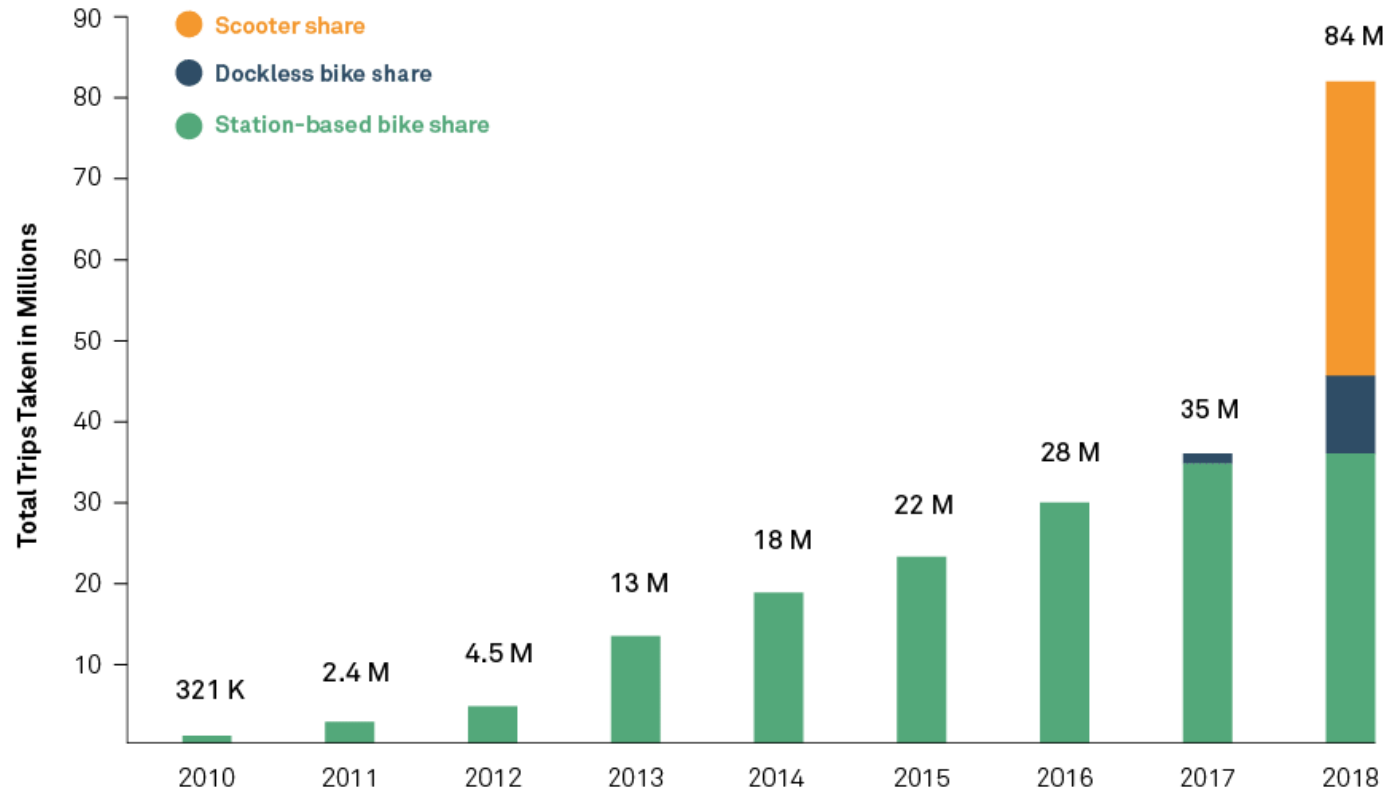
Source: NACTO

Breakdown of 2018 trips

84 million trips

- Scooter share trips: 38.5 M
- Dockless bike share trips: 9 M
- E-bike trips (station-based & dockless): 6.5 M
- Station-based bike share trips: 36.5 M
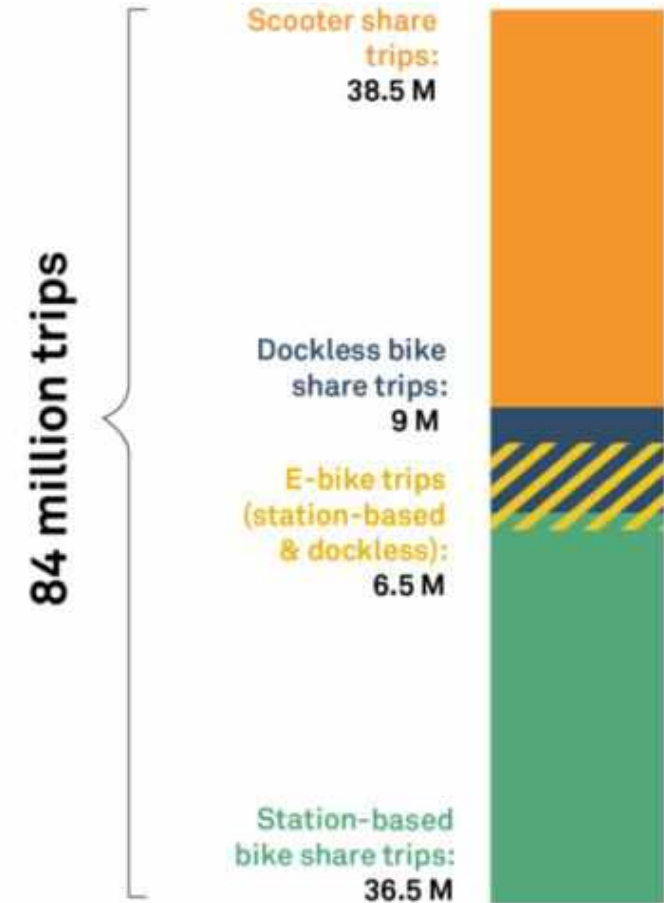
Source: NACTO

Autonomous Vehicle

"An autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in "autopilot" mode using various in-vehicle technologies and sensors, including adaptive cruise control, active steering (steer by wire), anti-lock braking systems (brake by wire), GPS navigation technology, lasers and radar."

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It's happening!
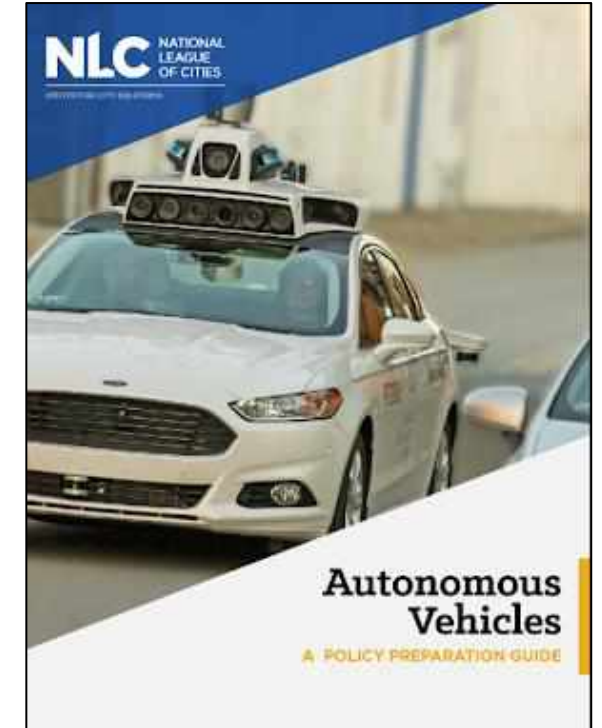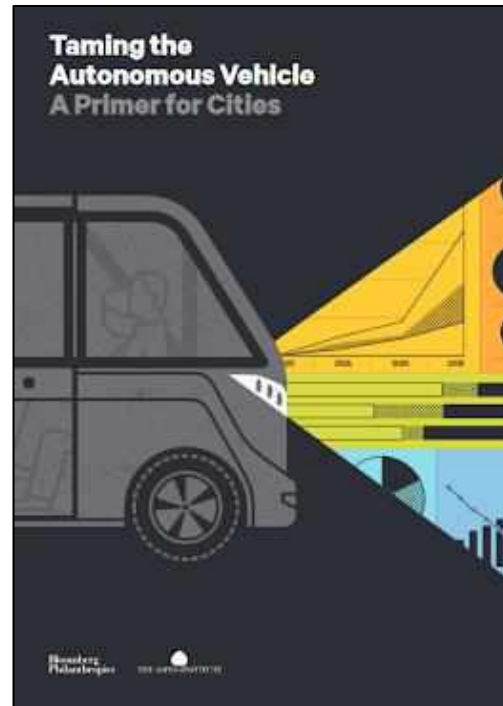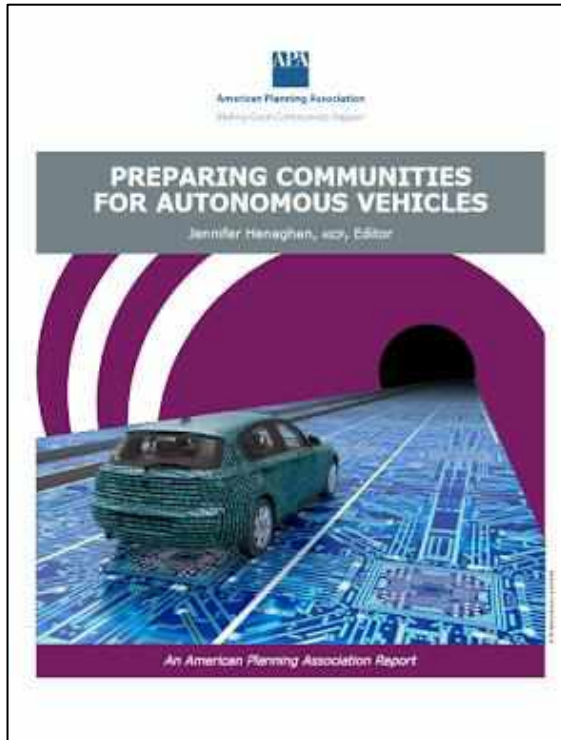
Waymo Now Giving Self-Driving Car Rides to the Public in Phoenix
Average Joes are about to get a crack at riding in the company's autonomous minivans.

AV adoption

Slight majority of Americans would not want to ride in a driverless vehicle if given the chance; safety concerns, lack of trust lead their list of concerns

% of U.S. adults who say they would/would not want to ride in a driverless vehicle

44% Yes, would want to ride in a driverless vehicle
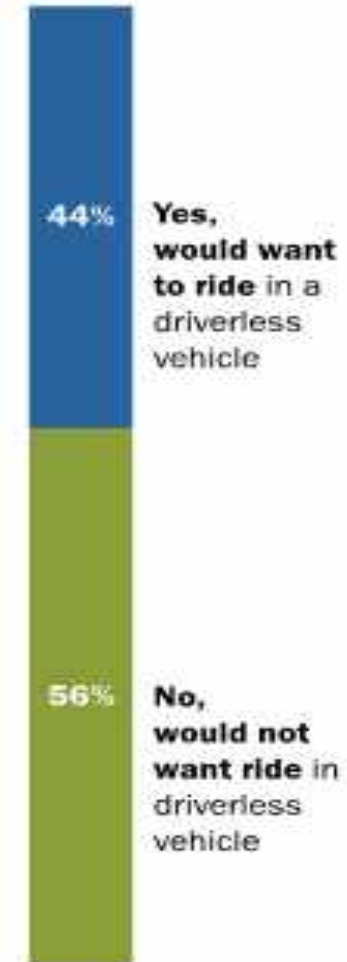
Among those who say yes, % who give these as the main reasons

Just for the experience/think it would be cool	37%
Would be safer	17
Can do other things while driving	15
Less stressful than driving	13
Greater independence	4
Convenience	4
Good for long trips	2
Other	9

56% No, would not want ride in a driverless vehicle

Among those who say no, % who give these as the main reasons

Don't trust it/worried about giving up control	42%
Safety concerns	30
Enjoy driving	9
Feel technology is not ready	3
Potential for hacking	2
Other	8
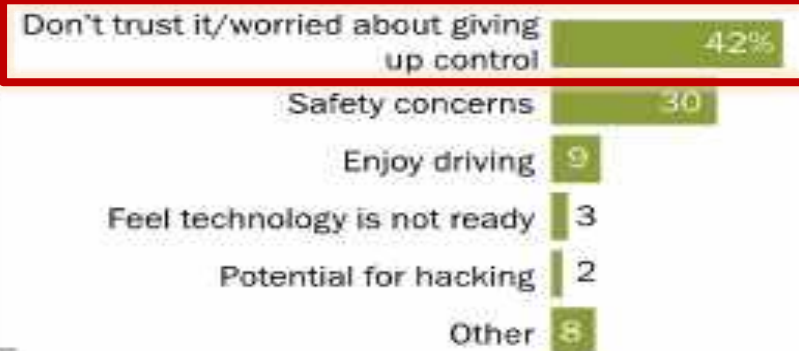
Source:
http://www.pewinternet.org/2017/10/04/automation-in-everyday-life/pi_2017-10-04_automation_3-05/

How a Self-Driving Uber Killed a Pedestrian in Arizona

By TROY GRIGGS and DAISUKE WAKABAYASHI UPDATED MARCH 21, 2018

A woman was struck and killed on Sunday night by an autonomous car operated by Uber in Tempe, Ariz. It was believed to be the first pedestrian death associated with self-driving technology.

What We Know About the Accident

MOEUR PARK

N. MILL AVENUE

fear about riding in a fully autonomous vehicle

78% ➤ **63%** ➤ **73%**

early 2017   early 2018   may 2018

survey taken few weeks after the Uber
fatal accident in Tempe, AZ

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Mobility

There are 49 million Americans over age 65; 53 million people have some form of disability.

AVs would enable new employment opportunities for approximately 2 million individuals with disabilities.

Sources:
https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety
http://secureenergy.org/wp-content/uploads/2017/01/Self-Driving-Cars-The-Impact-on-People-with-Disabilities_FINAL.pdf

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Public opinion evolving

Considerable uncertainty on public acceptance and interest

Long way to go to full automation

Will take time for this Revolution to play out

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TOMNET D-STOP

Transformative Transportation Technologies Survey (T⁴ Survey)

TOMNET Transportation Center
Teaching Old Models New Tricks

The ABCs (Attitudes – Behaviors – Choices) of Future Mobility

TOMNET and D-STOP
USDOT-Sponsored Tier 1 University Transportation Centers
Present

Highlights from an In-Depth Behavioral Survey on Transformative Technologies in Transportation

Friday, June 12, 2020
8:00 AM to 1:00 PM (Pacific time)
Webcast Live on Zoom
Webcast Details
Register for the Webcast

TOMNET Transportation Center
Teaching Old Models New Tricks

CTR D-STOP

About the Webinar
In 2019, four universities comprising the TOMNET and D-STOP Tier 1 University Transportation Centers, namely, Arizona State University, Georgia Tech, The University of Texas at Austin, and University of South Florida, conducted a survey to understand traveler attitudes, behaviors, and mobility and lifestyle choices in the context of new mobility services and rapidly evolving transportation technologies. An identical survey was administered to a random sample of individuals in the four metro regions of Phoenix, Atlanta, Tampa, and Austin, yielding an overall sample of more than 3,500 respondents. This event presents key findings from the survey, and sheds light on the rapidly evolving transportation landscape. Join us at this virtual seminar to participate in an exciting data-driven conversation on the future of mobility!

This webinar will be webcast live to a worldwide audience using Zoom.

To register for the live webcast please click HERE.

After registering, you will receive a confirmation email containing information about how to join the webcast.

Arizona State University | Georgia Tech | University of South Florida | THE UNIVERSITY OF TEXAS AT AUSTIN | UNIVERSITY of WASHINGTON

SCHEDULE OF PRESENTATIONS

Note: All times are Pacific Daylight Time, PDT.

| Time	Presentation
8:00 AM	*Opening Remarks and Welcome* Patricia L. Mokhtarian, Georgia Institute of Technology
8:10 AM	*Project Overview and Results from the Initial Phoenix Pilot Survey* Ram M. Pendyala, Denise Capasso da Silva, and Sara Khoeini, Arizona State University
8:30 AM	*Comparison of Alternative Survey Recruitment/Deployment Methods* Giovanni Circella, Georgia Institute of Technology
8:50 AM	*Q&A and Break*
9:10 AM	*People's Lifestyle Preferences, Attitudes, and Travel Patterns* Nikhil Menon and Michael Maness, University of South Florida
9:30 AM	*Residential Choice Preferences in Relation to New Mobility Options* Deborah Salon, Arizona State University
9:50 AM	*Q&A and Break*
10:10 AM	*Micro-mobility and Ridehailing Services: Current Use and Perceptions* Yongsung Lee, Giovanni Circella, and Patricia Mokhtarian, Georgia Institute of Technology
10:30 AM	*Willingness to Share Ridehailing Trips: Revealed and Stated Preferences* Shuqing Kang and Chandra Bhat, University of Texas Austin
10:50 AM	*Q&A and Break*
11:10 AM	*Autonomous Vehicles: Familiarity, Awareness, and Perceptions* Sara Khoeini, Arizona State University
11:30 AM	*Autonomous Vehicles: Potential Travel Behavior Implications* Michael Maness, University of South Florida
11:50 AM	*Q&A and Break*
12:10 PM	*Future Vehicle Ownership Patterns in an Era of Autonomous Vehicles* Katherine Asmussen and Chandra Bhat, University of Texas Austin
12:30 PM	*Exploring Willingness to Pay for Autonomous Vehicles* Denise Capasso da Silva and Sara Khoeini, Arizona State University
12:50 PM	*Q&A*
1:00 PM	*Closing Remarks* Ram M. Pendyala, Arizona State University

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Study Purpose

Collect a rich set of data across multiple jurisdictions that includes information about people's travel behavior, socioeconomics, and attitudes towards and perceptions of **advanced transportation technologies and mobility options**

Survey Locations
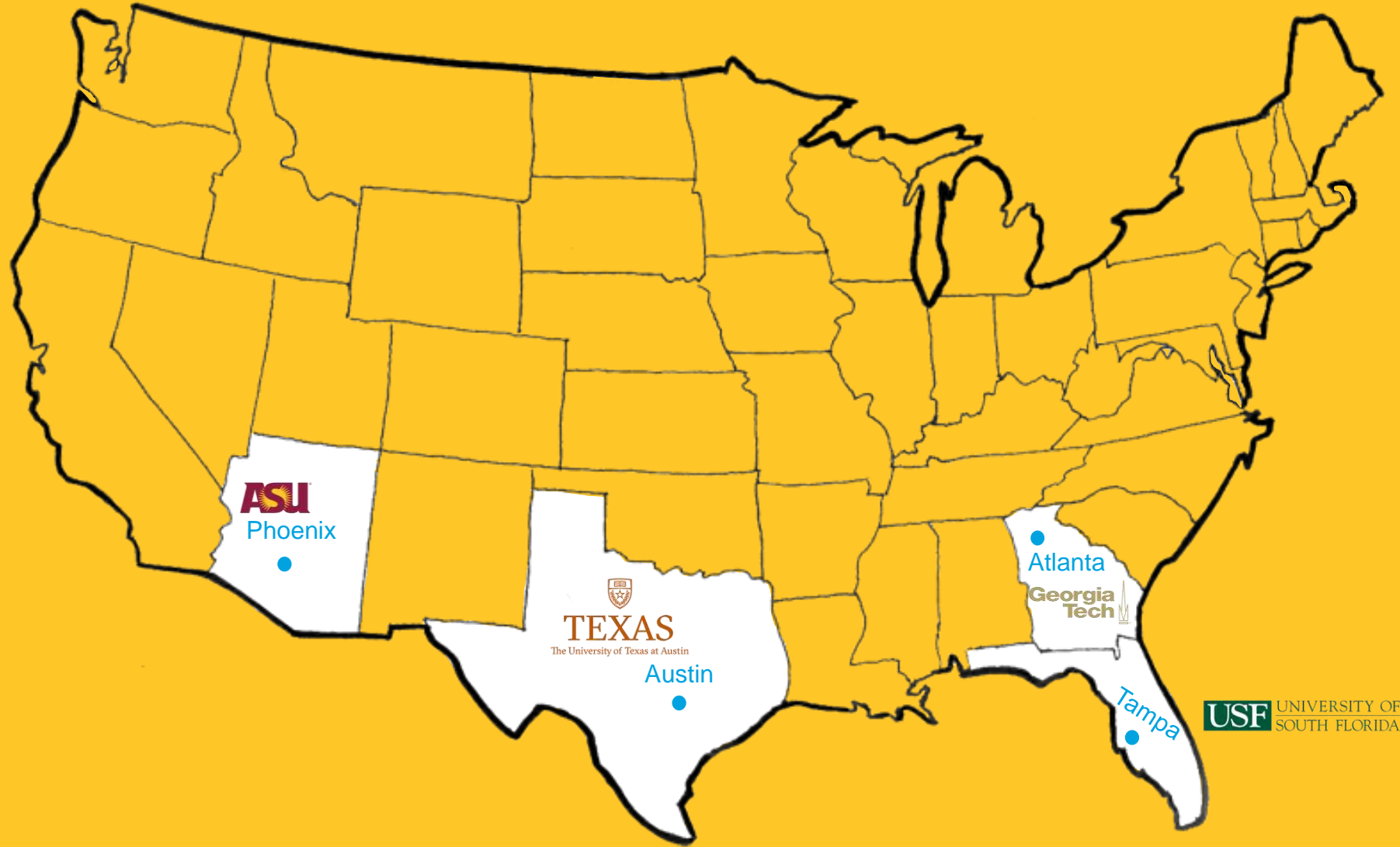
Full Deployment

- Summer/Fall 2019

- Target sample size: 1,000 respondents per Metro Area

- Random address-based sample, purchased from marketing company:

    - 50,000 e-mail invitations
    - 10,000 postal invitations (no electronic address available)

Full Deployment

- Online instrument only, powered by Qualtrics
  - Mail invitees were required to access the online survey to complete their response

- Rewards strategy
  - $10 for each of the first 250 respondents
  - All other respondents: entered into draw for one hundred $10 gift cards

Full Deployment Sample Size:

1,071 Respondents

Survey Instrument

Attitudes and Preferences → **Vehicles You Have and Where You Live** → **Current Travel Patterns** → **Mobility on Demand and Shared Mobility Services** → **Autonomous Vehicles** → **Background Information**

Sample Characteristics - Age

Legend: Male (N=517) — Female (N=513) — Maricopa County 18 years and above (N=3.3 million)

Age group	Male	Female	Maricopa County
18-29 years	3%	9%	22%
30-39 years	7%	10%	18%
40-49 years	9%	18%	17%
50-59 years	17%	25%	16%
60-69 years	29%	21%	14%
70+ years	34%	17%	13%
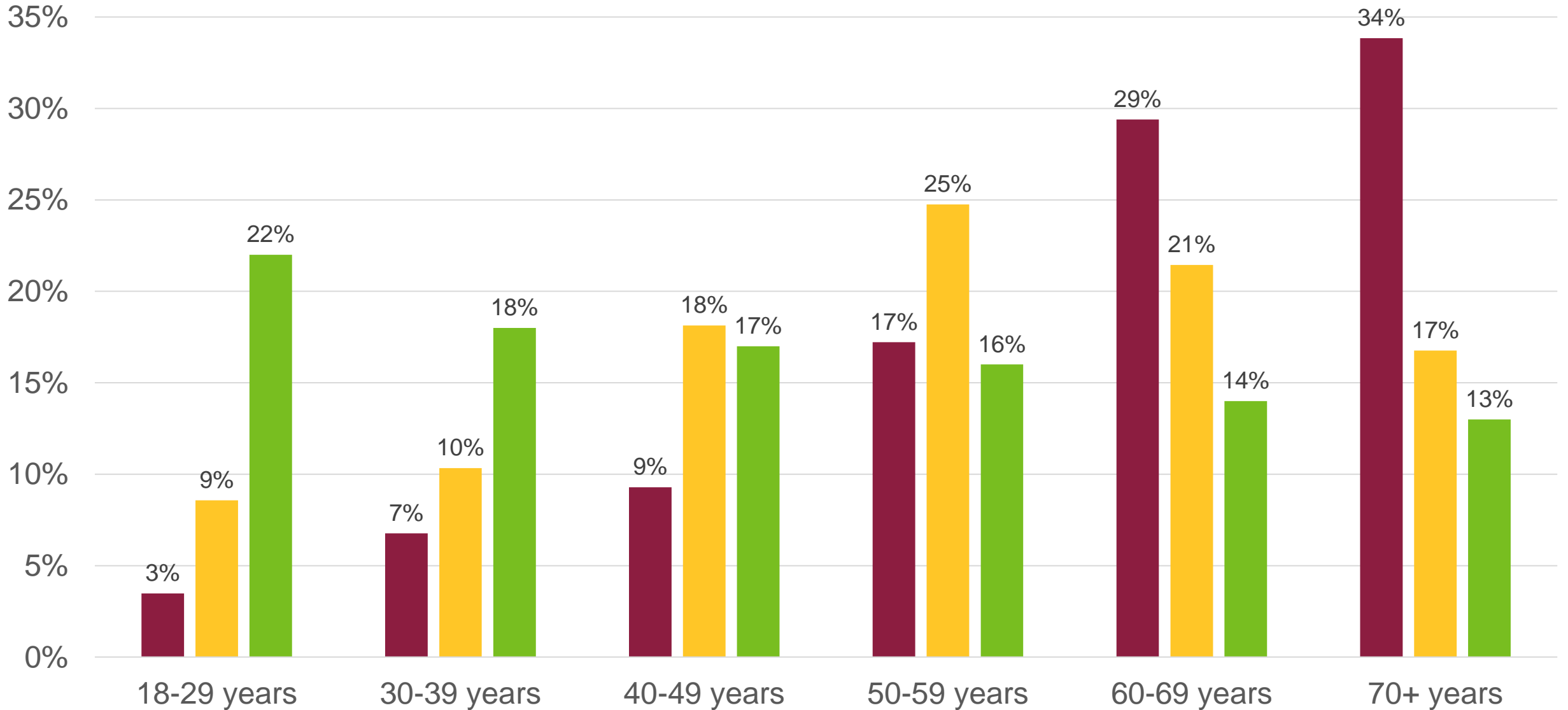
Sample Characteristics - Income

T4 Survey (N=1,005) ■ Maricopa County households (N=1.5 million) ■
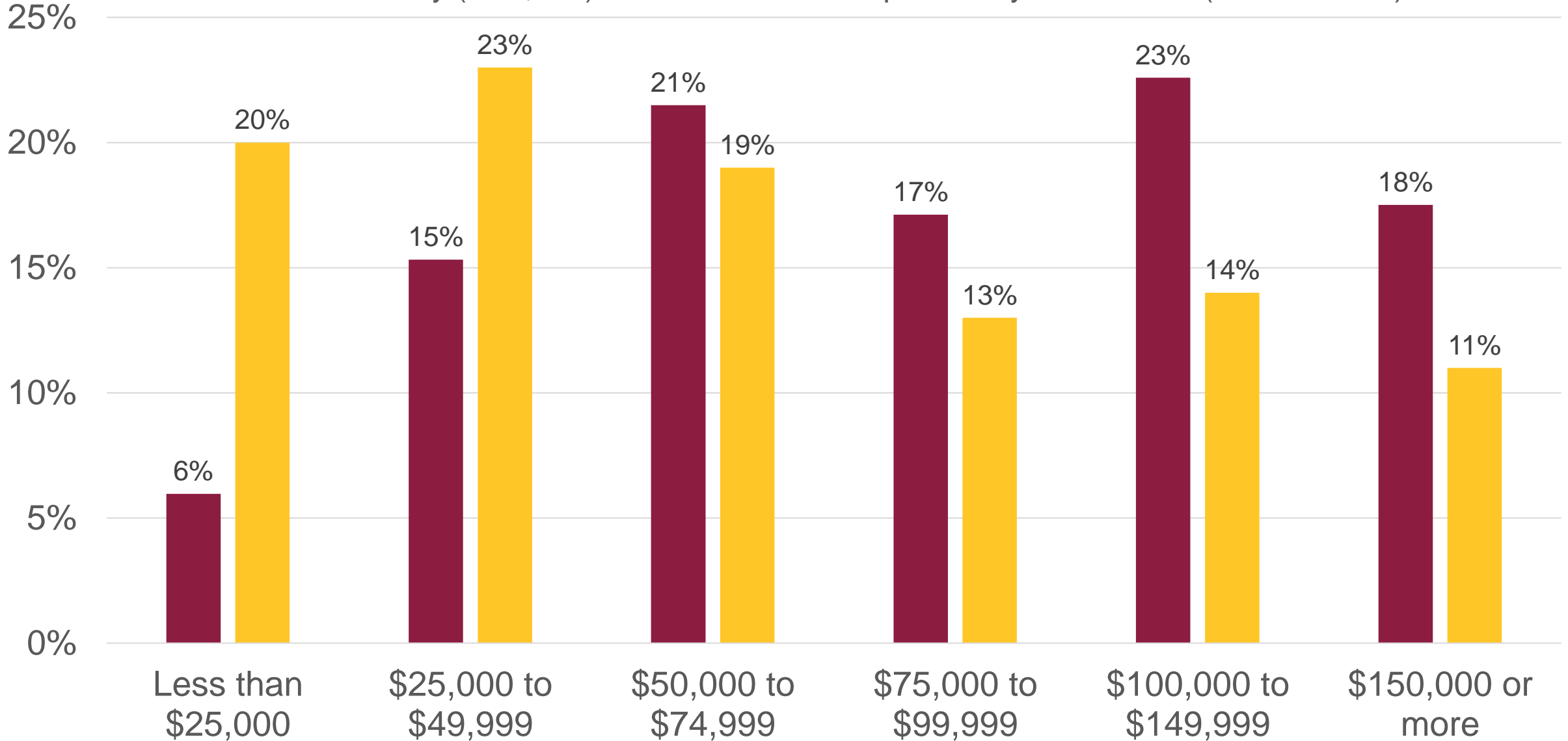
Income	T4 Survey	Maricopa County households
Less than $25,000	6%	20%
$25,000 to $49,999	15%	23%
$50,000 to $74,999	21%	19%
$75,000 to $99,999	17%	13%
$100,000 to $149,999	23%	14%
$150,000 or more	18%	11%

Commute Mode

Legend:
- Not available
- Available but I never use it
- Less than one day a month
- 1-3 days a month
- 1-2 days a week
- 3 or more days a week

Drive private vehicle, alone (N=554): 2%, 2%, 2%, 5%, 7%, 81%

Drive private vehicle, with passengers (N=538): 51%, 17%, 5%, 7%, 8%, 13%

Ride in private vehicle, with others (N=542): 60%, 16%, 7%, 5%, 5%, 6%

Public transit: bus (N=543): 37%, 55%, 3%, 1%, 1%, 3%

Public transit: light rail (N=540): 65%, 27%, 3%, 2%, 1%, 2%
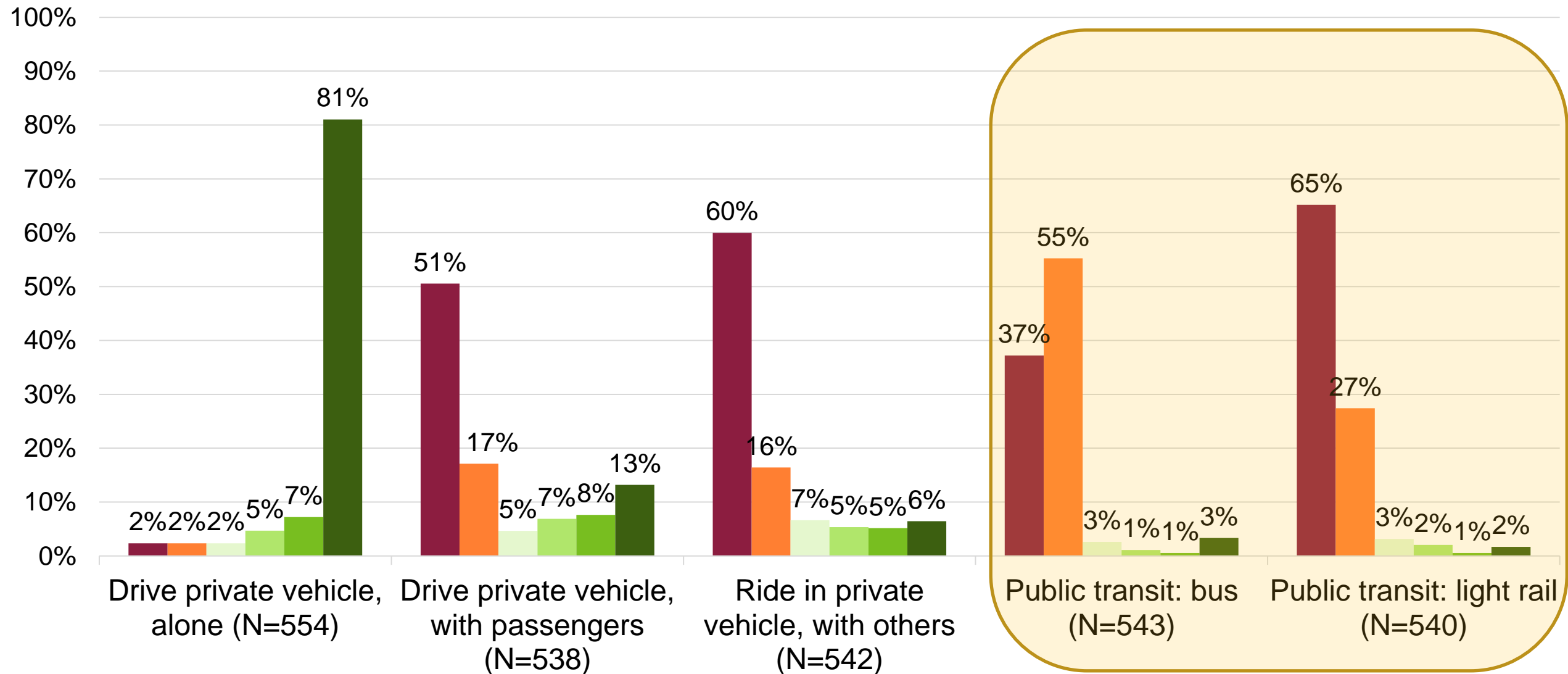
Mode Use for Non-Commute Trips

Legend:
- Not available
- Available but I never use it
- Less than one day a month
- 1-3 days a month
- 1-2 days a week
- 3 or more days a week

Drive private vehicle, alone (N=1,061): 2%, 2%, 1%, 5%, 22%, 68%

Drive private vehicle, with passengers (N=1,052): 10%, 8%, 8%, 15%, 28%, 32%

Ride in private vehicle, with others (N=1,051): 20%, 14%, 15%, 21%, 18%, 12%

Public transit: bus (N=1,048): 32%, 63%, 3%, 1%, 1%, 0%

Public transit: light rail (N=1,041): 52%, 36%, 8%, 3%, 1%, 1%
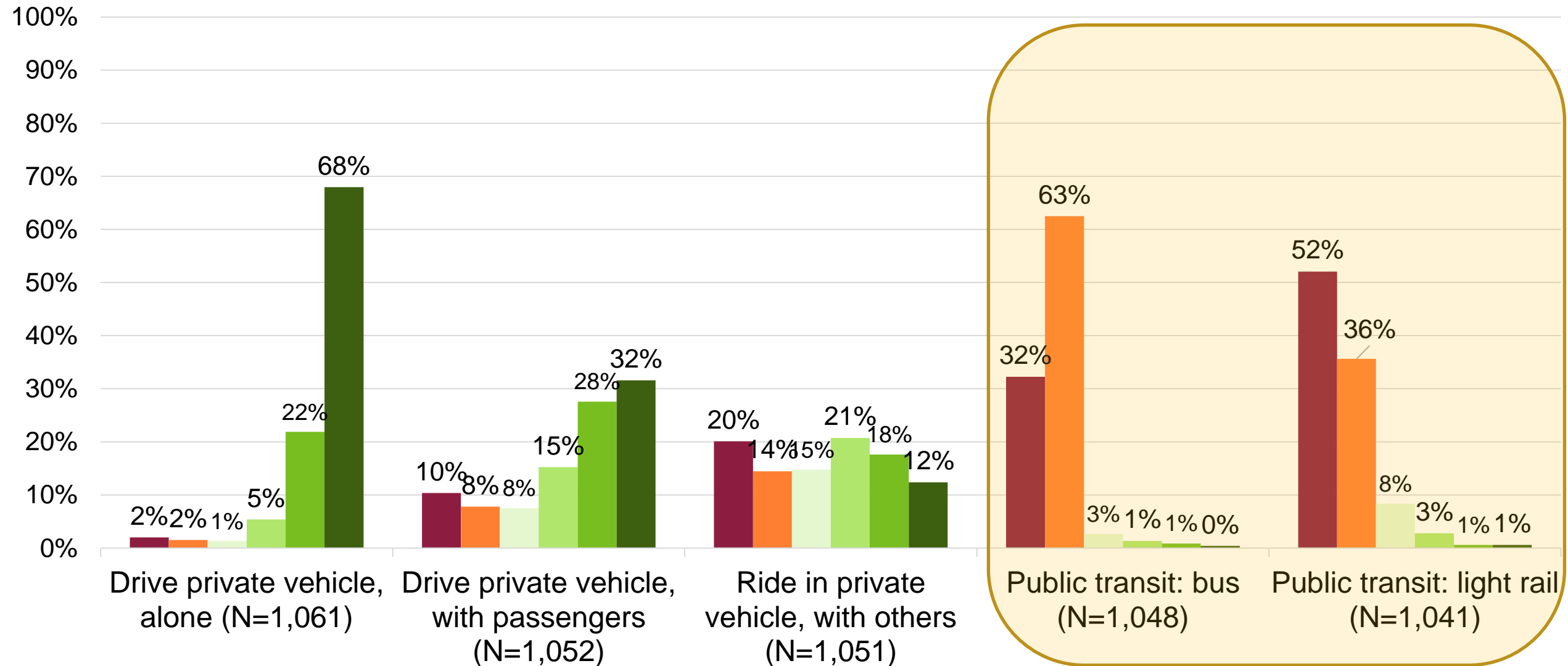
Attitudes Towards Transit and Vehicle Ownership

- ■ Strongly disagree
- ■ Somewhat disagree
- ■ Neutral
- ■ Somewhat agree
- ■ Strongly agree

	0%	20%	40%	60%	80%	100%

I am committed to using a less polluting means of transportation (e.g., walking, biking, and public transit) as much as possible. (N=1,070)
9% | 22% | 32% | 28% | 9%
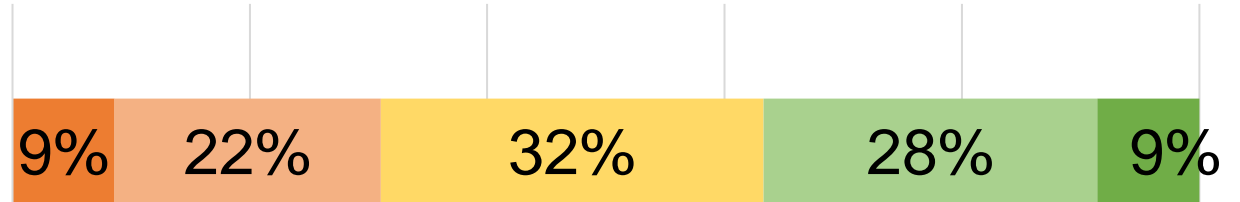
Most of the time, I have no reasonable alternatives to driving. (N=1,068)
8% | 12% | 9% | 33% | 38%
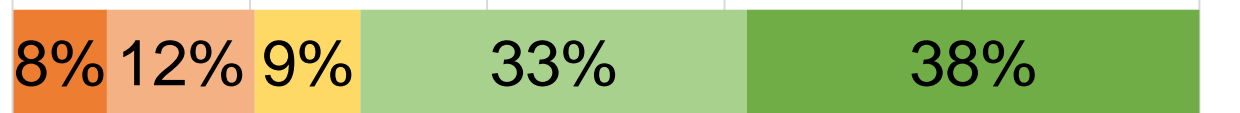
I definitely like the idea of owning my own car. (N=1,069)
6% | 16% | 77%

52

Attitudes Towards Transit and Residential Location

■ Strongly disagree ■ Somewhat disagree ■ Neutral
■ Somewhat agree ■ Strongly agree

	0%	20%	40%	60%	80%	100%

Public transit is a reliable means of transportation for my daily travel needs. (N=1,068)
50% | 26% | 14% | 6% | 3%

I prefer to live close to transit, even if it means I'll have a smaller home and live in a more densely populated area. (N=1,071)
29% | 31% | 20% | 14% | 6%

I prefer to live in a spacious home, even if it is farther from public transportation or many places I go. (N=1,070)
9% | 24% | 24% | 29% | 16%
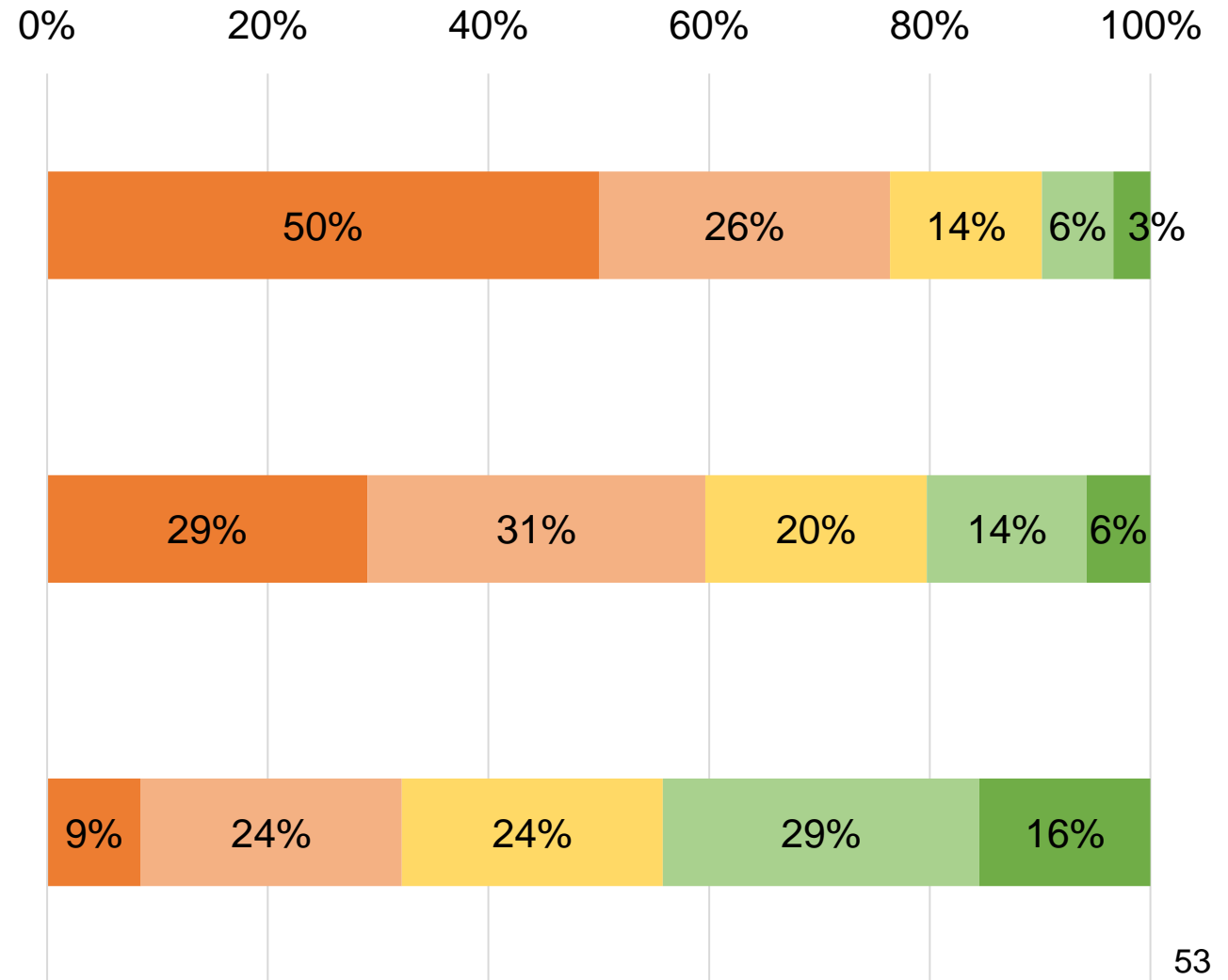
For Those Who Use Ridehailing Services...

Primary Purpose of Last Ridehailing Trip (N=514)

Purpose	Percentage
Commute Location	9%
Shopping/ errands	3%
Eating/ drinking	15%
Social/ recreational	23%
To access airport	24%
To access public transit	0%
Medical/ dental	3%
Going/ returning home from another location	14%
Other	8%

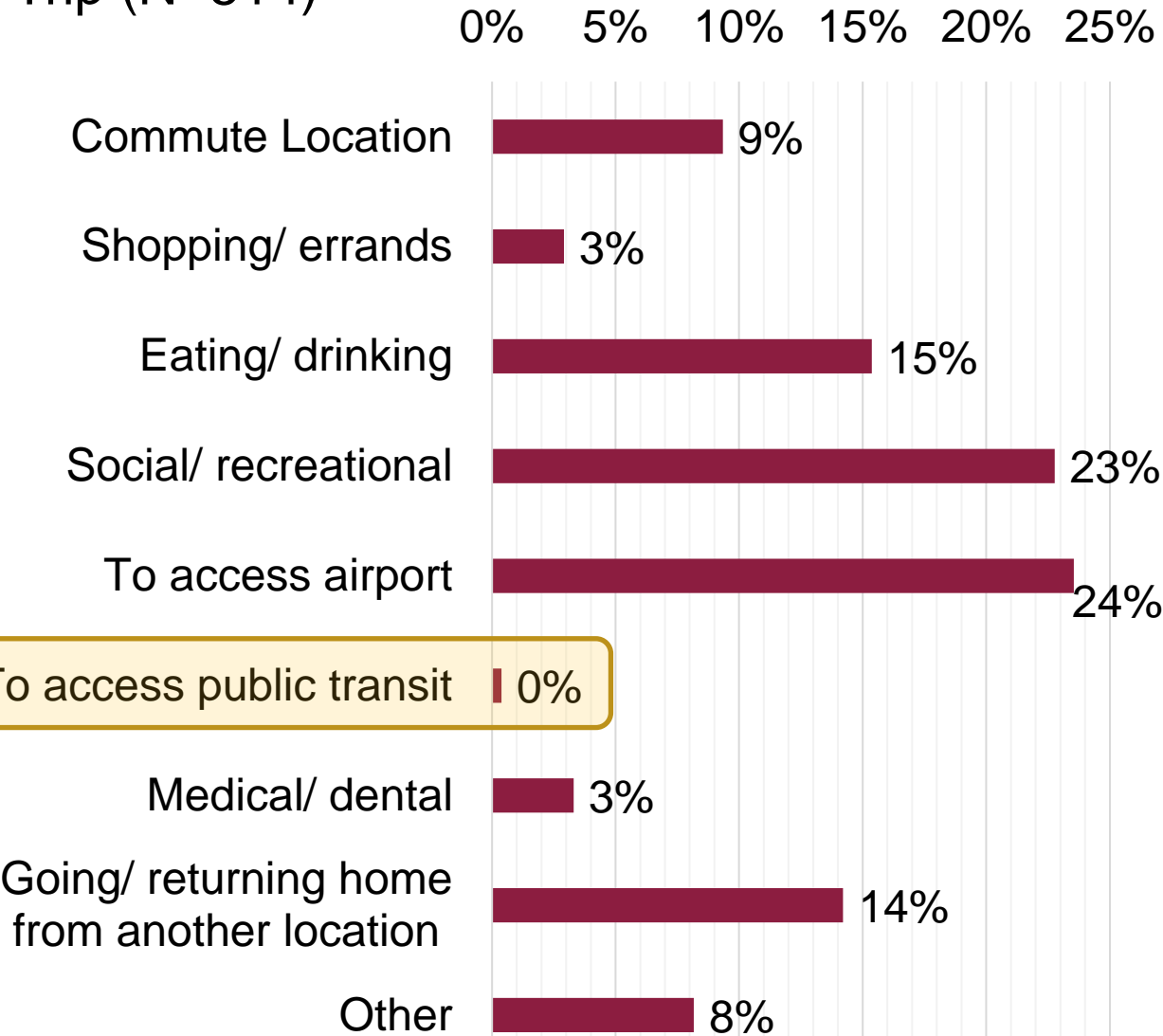## Alternative Mode, Had Ridehailing Not Been Available (N=516)

Mode	Percentage
Drive private vehicle, alone	16%
Drive private vehicle, with…	19%
Ride private vehicle, with others	12%
Ride the bus	4%
Ride the light rail	2%
Use taxi	30%
Use a bikesharing or e-…	0%
Walk	3%
Ride my personal bicycle or…	1%
I would not have made this trip	6%
Other	8%
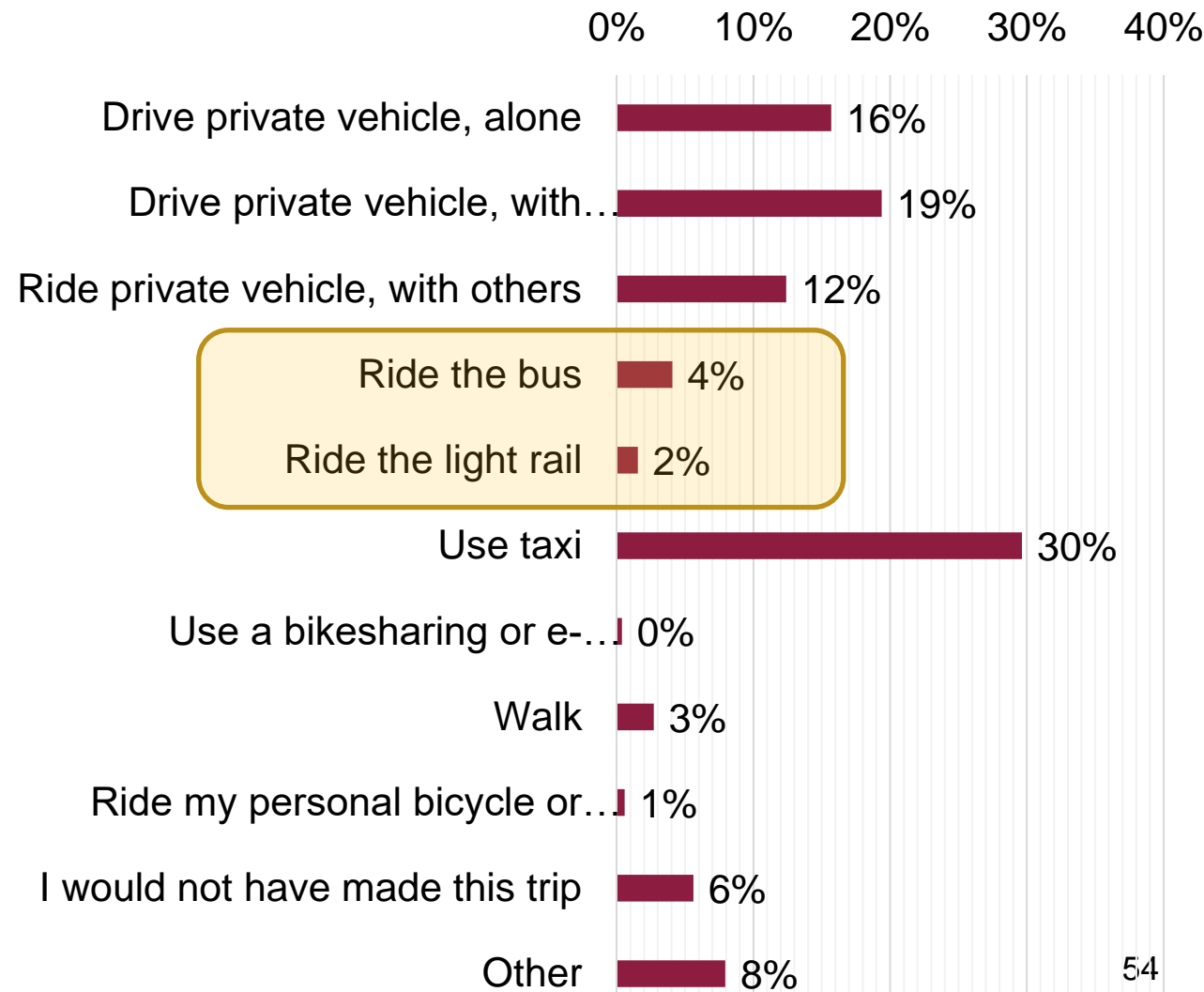
Impact of Ridehailing Usage on Transit

Legend:
- Changed usage, but not because of ridehailing
- Use it less often
- Use it about the same
- Use it more often

Public transit: bus (N=307)
- Changed usage: 26%
- Use it less often: 10%
- Use it about the same: 63%
- Use it more often: 1%

Public transit: light rail (N=309)
- Changed usage: 25%
- Use it less often: 12%
- Use it about the same: 62%
- Use it more often: 2%
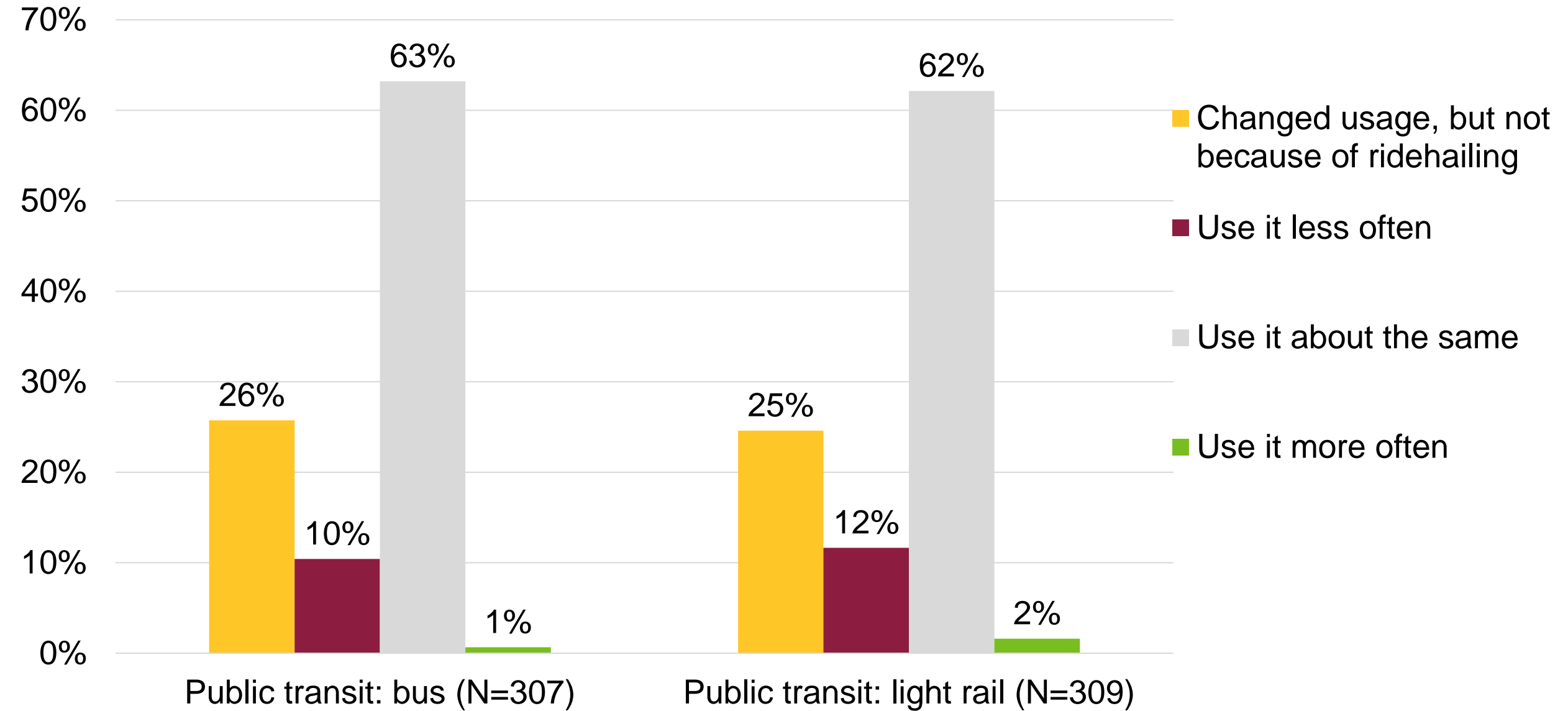
For Those Who Used bikesharing and/or e-scooter sharing services…

WHY did you use the service (N=56)

Reason	Percentage
No need to park/parking was expensive or scarce	16%
For more physical exercise	9%
To save time	20%
To save money	5%
Public transit was not available	9%
Public transit was not convenient	2%
Private vehicle was not available	4%
Just to enjoy the ride/try the new service	73%
Other	2%
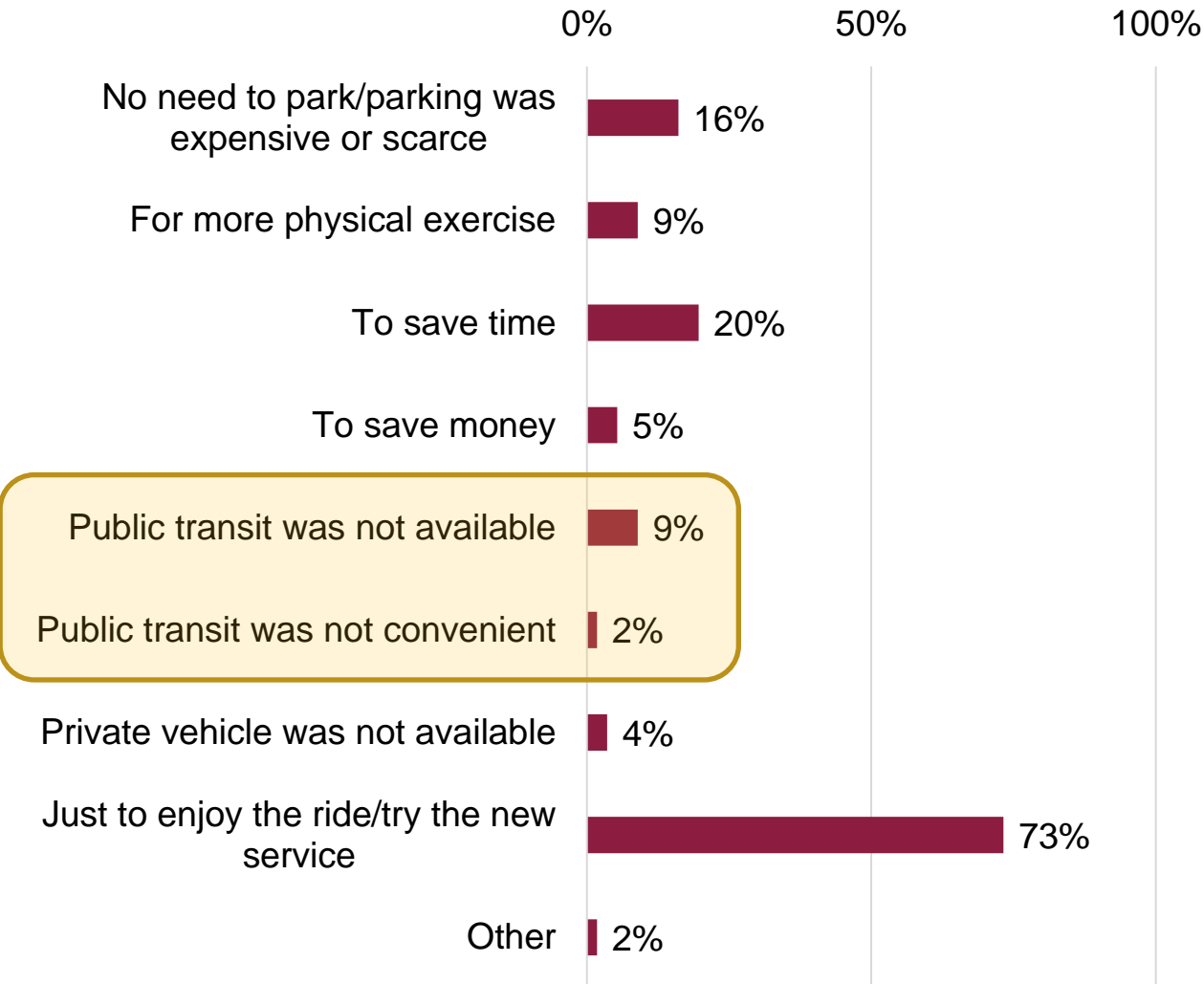
Alternative Mode, if NO Bike/E-Scooter Sharing Service (N=56)

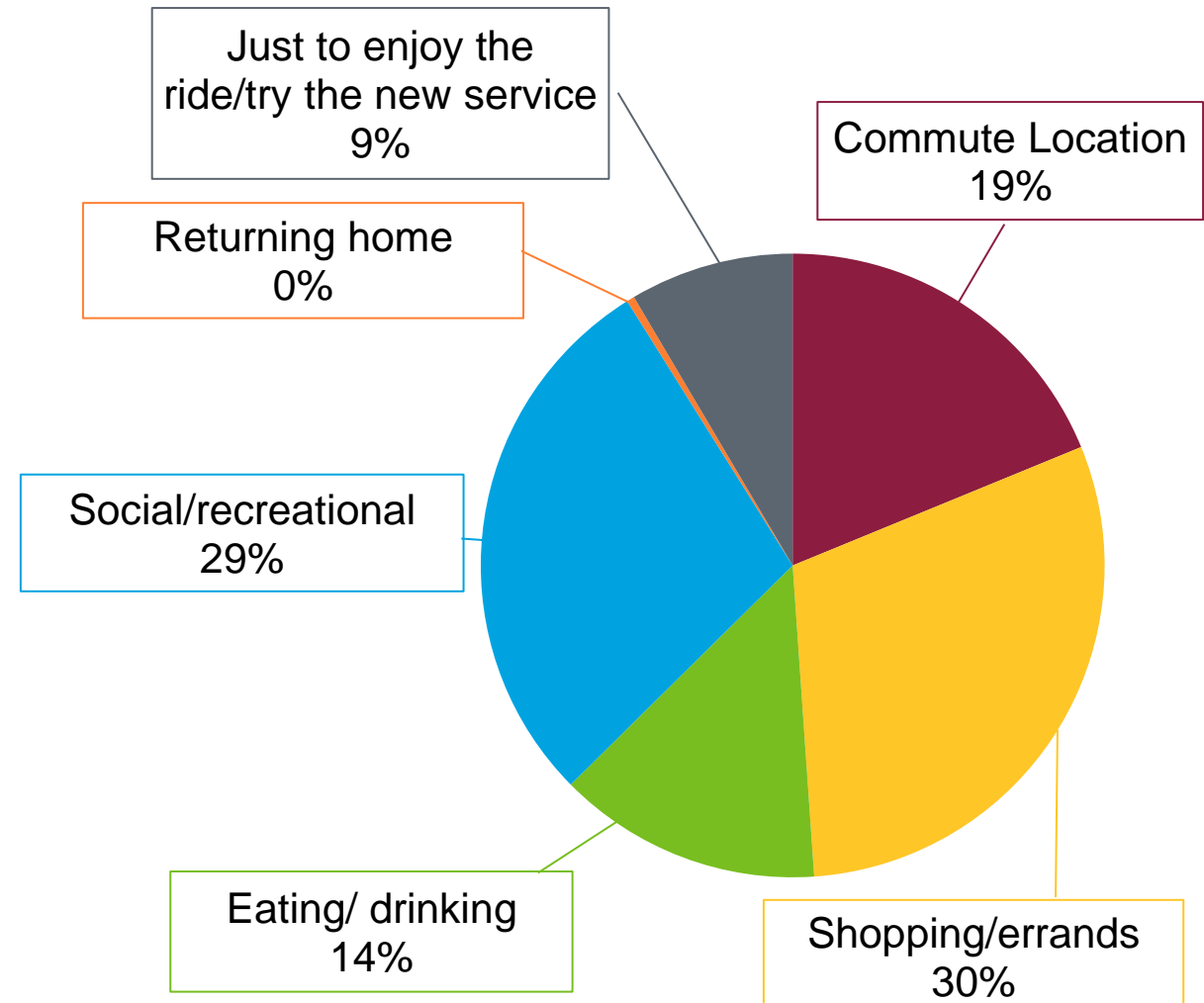| Mode	Percentage
Drive private vehicle, alone	13%
Drive private vehicle, with others	5%
Ride in private vehicle, with others	5%
Ride the light rail	2%
Use Uber/Lyft	7%
Use my own bike or scooter	5%
Walk	45%
I would not have made this trip	18%
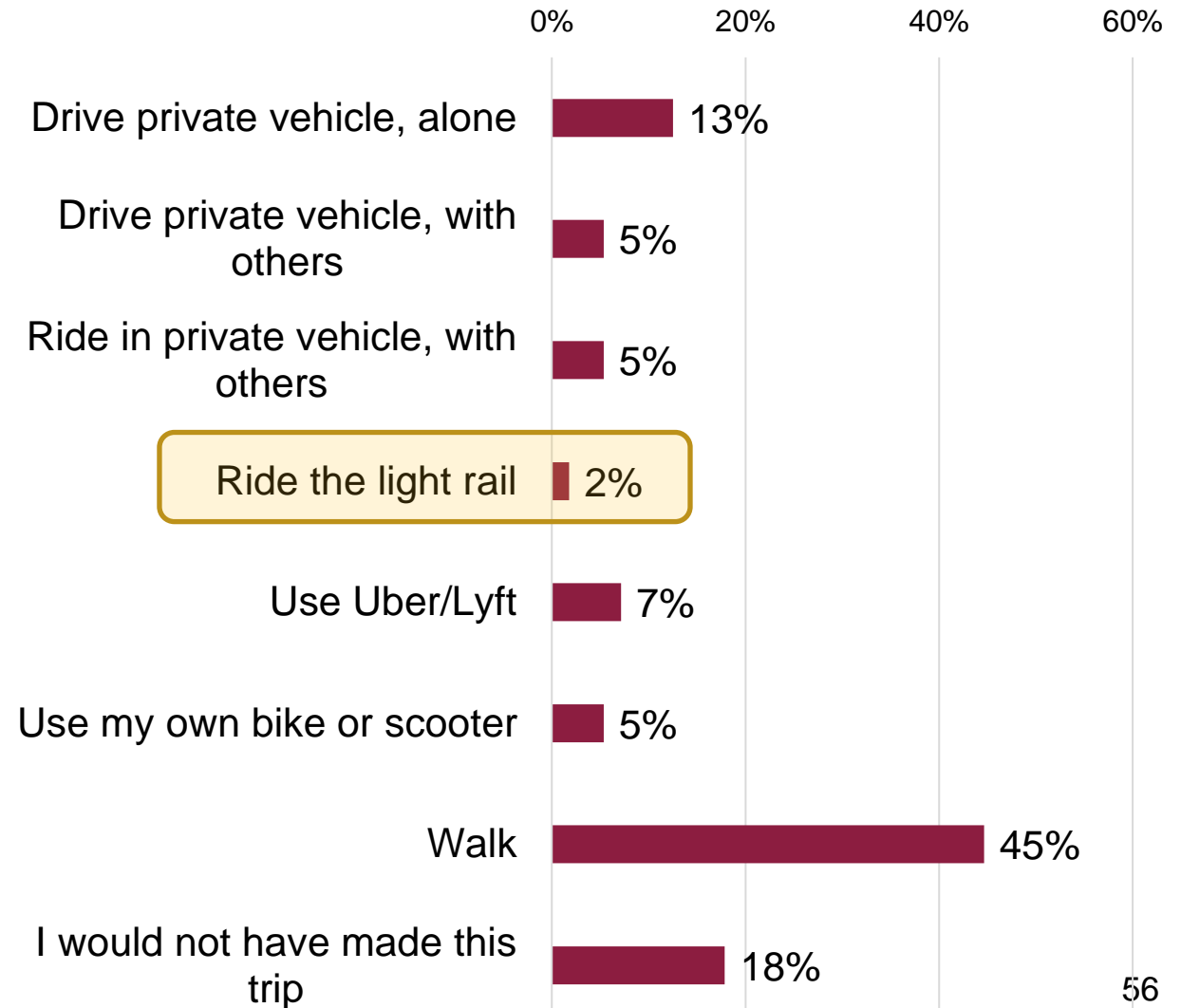
Note: More than one choice could be selected.

Characteristics of last bike/e-scooter trip (N=70)

Trip length

- Less than a mile: 22%
- 1-2 miles: 56%
- 3-4 miles: 18%
- 5 miles or more: 4%

Trip purpose

- Just to enjoy the ride/try the new service: 9%
- Returning home: 0%
- Social/recreational: 29%
- Eating/ drinking: 14%
- Commute Location: 19%
- Shopping/errands: 30%
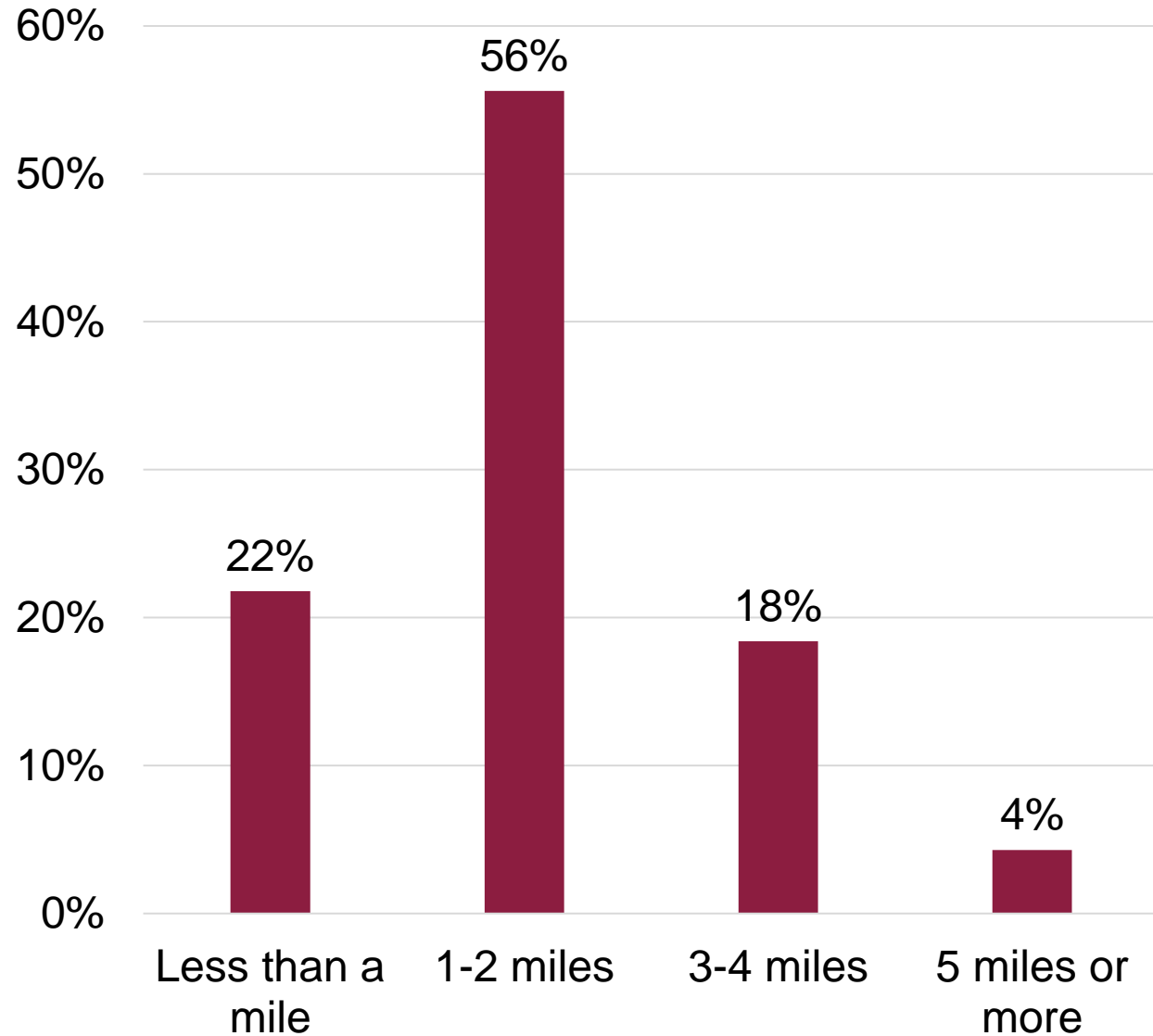
Familiarity with Autonomous Vehicles (N=1051)

- Very familiar 12%
- Actually riden an AV 1%
- Never heard of AVs 11%
- Heard about them, but not familiar 35%
- Somewhat familiar 41%
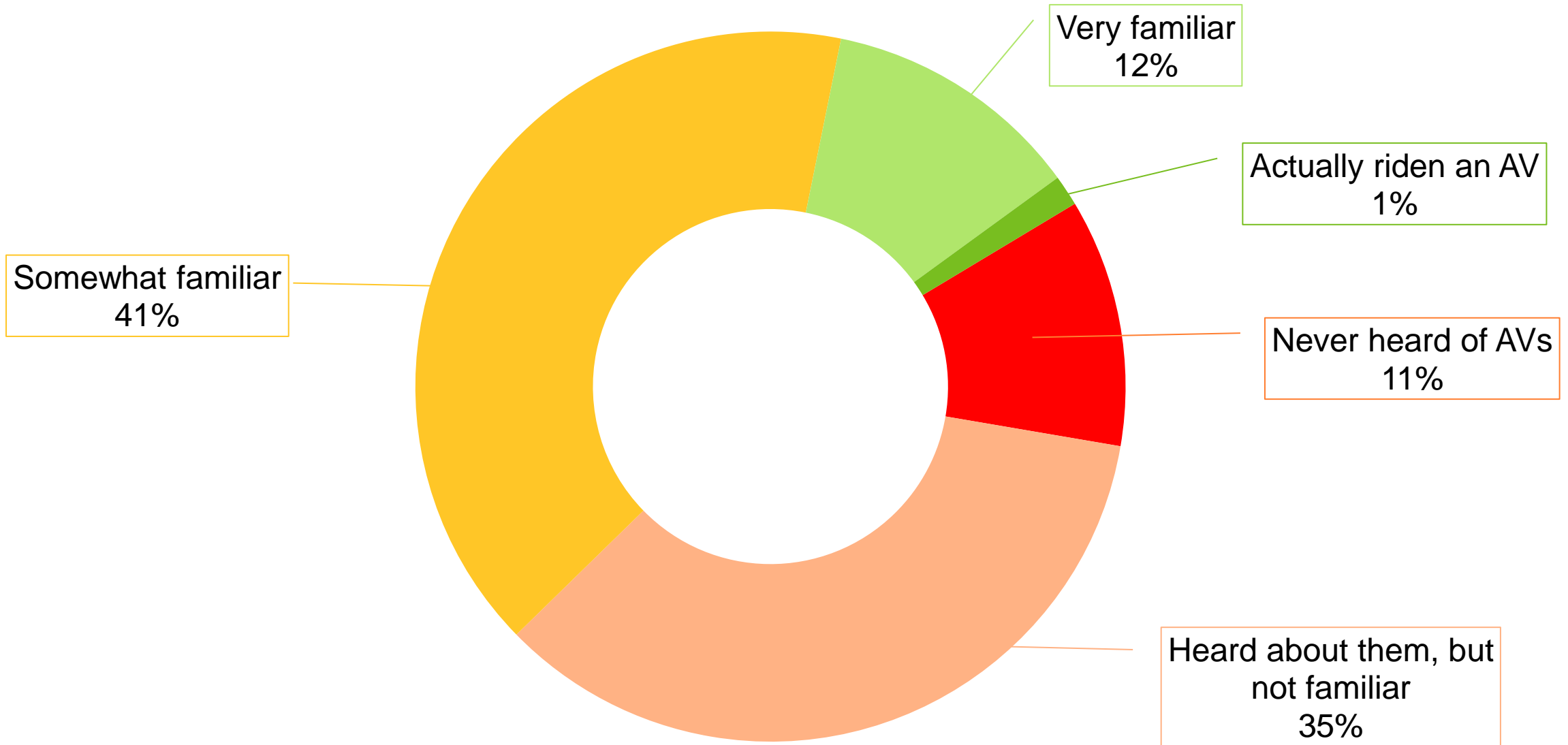
How much longer would you be willing to commute in an AV, compared to your current commute? (N=631)
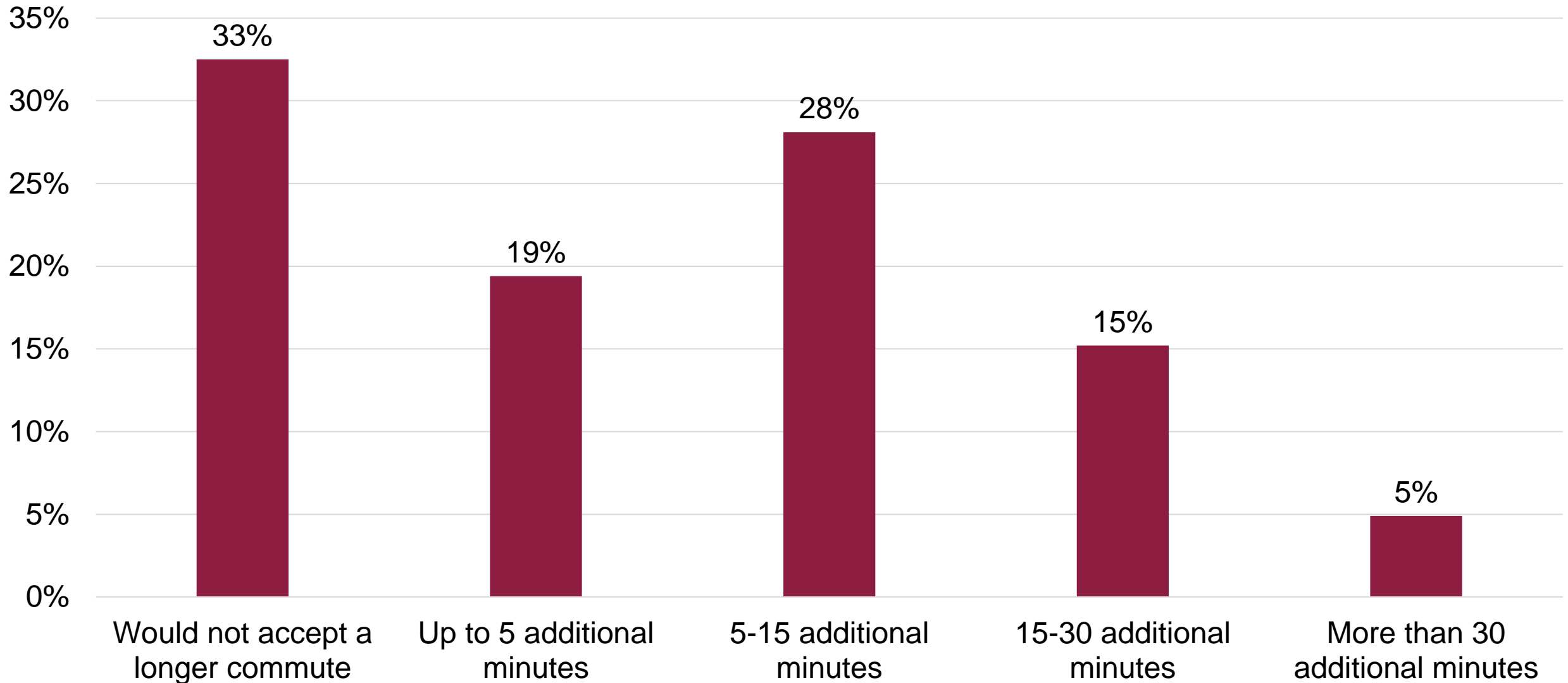
How might the number of cars your household currently own change, once AVs become available? (N=1051)

Likely own more cars than today
8%

Likely own fewer cars than today
16%

Likely own the same number of cars as today
76%
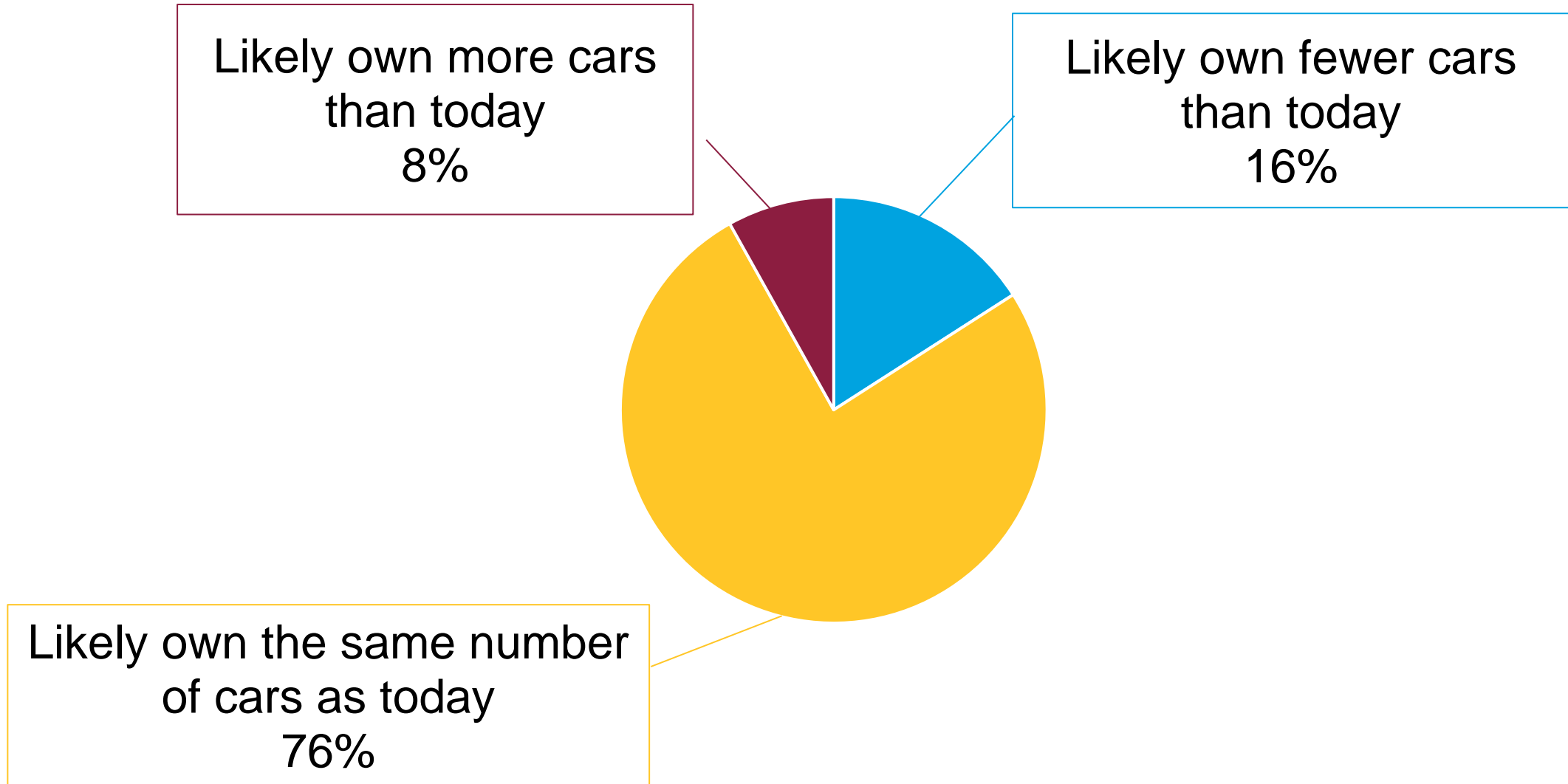
When Do You Expect to Buy an AV? (N=1039)

One of the first people to buy an AV, 5%

Never buy an AV, 43%

Eventually buy an AV, 52%
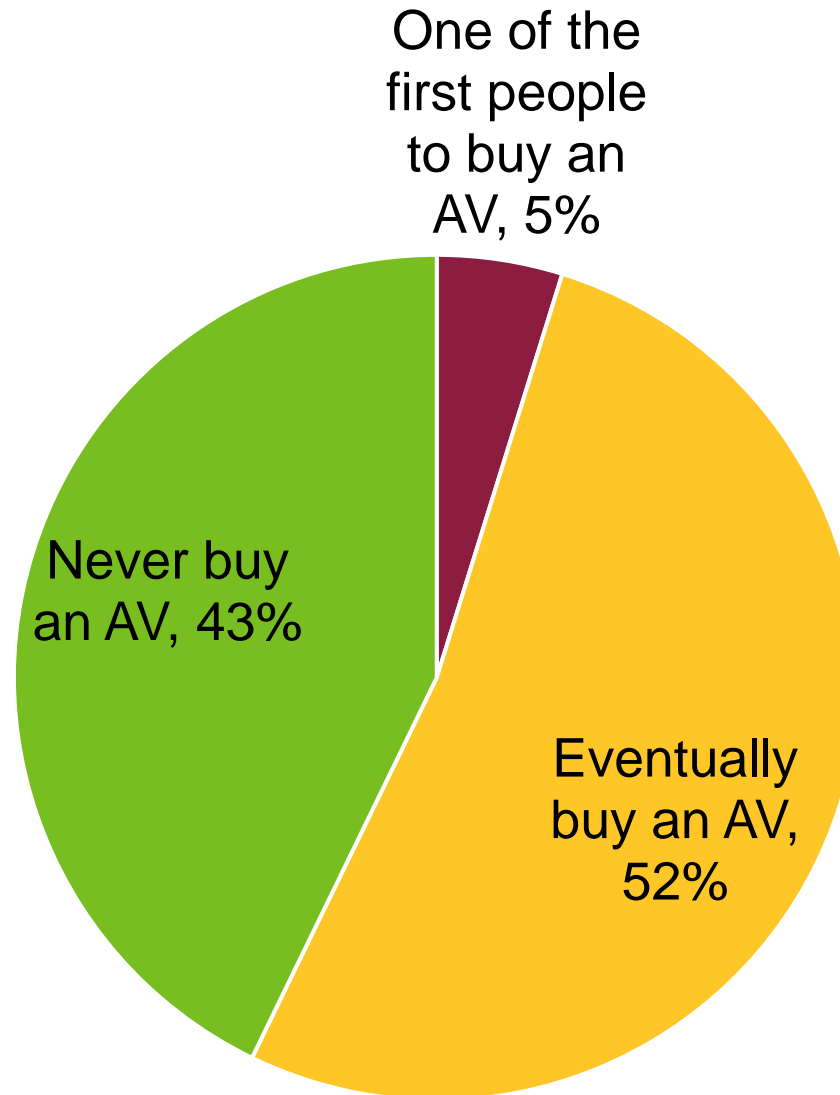
Engage in Activities During an AV Trip

ALL SCENARIOS (N=1052)

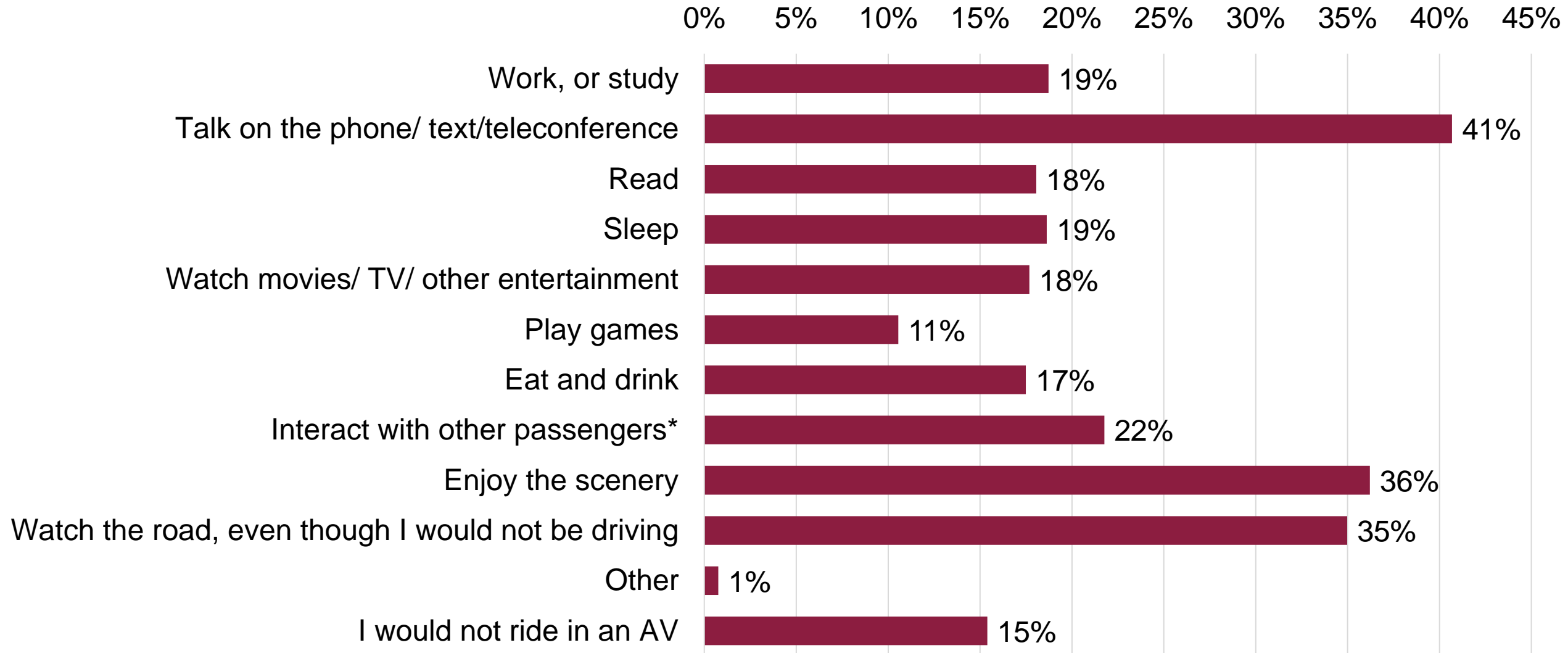| Activity	Percentage
Work, or study	19%
Talk on the phone/ text/teleconference	41%
Read	18%
Sleep	19%
Watch movies/ TV/ other entertainment	18%
Play games	11%
Eat and drink	17%
Interact with other passengers*	22%
Enjoy the scenery	36%
Watch the road, even though I would not be driving	35%
Other	1%
I would not ride in an AV	15%

Note: More than one choice could be selected. The option "Interact with other passengers" was shown only when the scenario was applicable.

How Will AV-based Mobility-on-Demand Services Affect Usage of Modes?

Legend: ■ Use Less ■ Use the Same ■ Use More

Mode	Use Less	Use the Same	Use More
Human-driven personal vehicle (N=1059)	39%	58%	4%
Human-driven ridehailing services (N=1046)	37%	58%	5%
Public transit: bus (N=1045)	37%	61%	2%
Public transit: light rail (N=1047)	32%	64%	4%
Walk (N=1047)	15%	80%	4%
Bicycle or scooter (N=1045)	25%	72%	3%
Airplane (N=1049)	10%	87%	3%
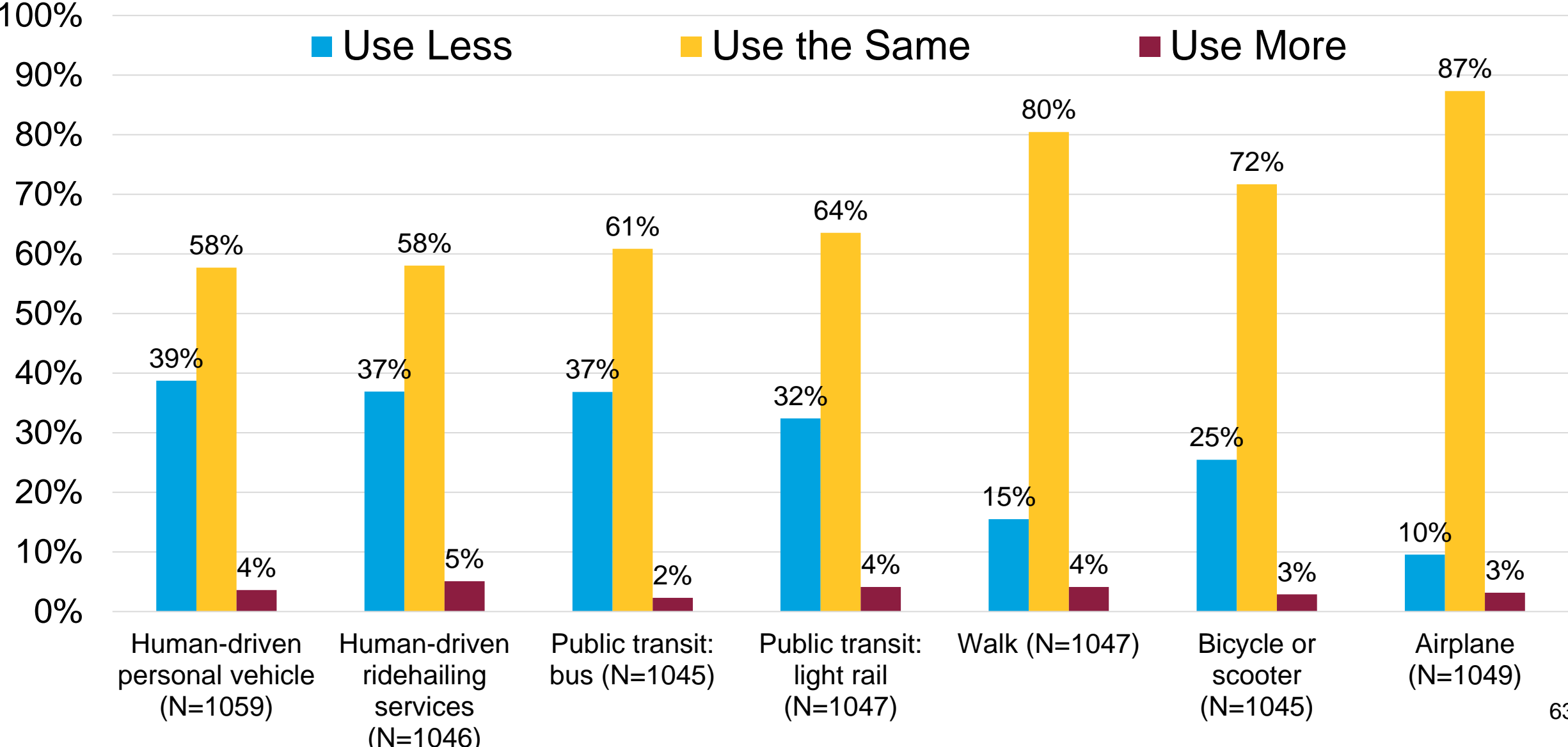
Leverage and Promote Alternatives

- Reduce vehicular travel demand
  - Telecommuting and IoT connectivity

Share of Americans Working from Home
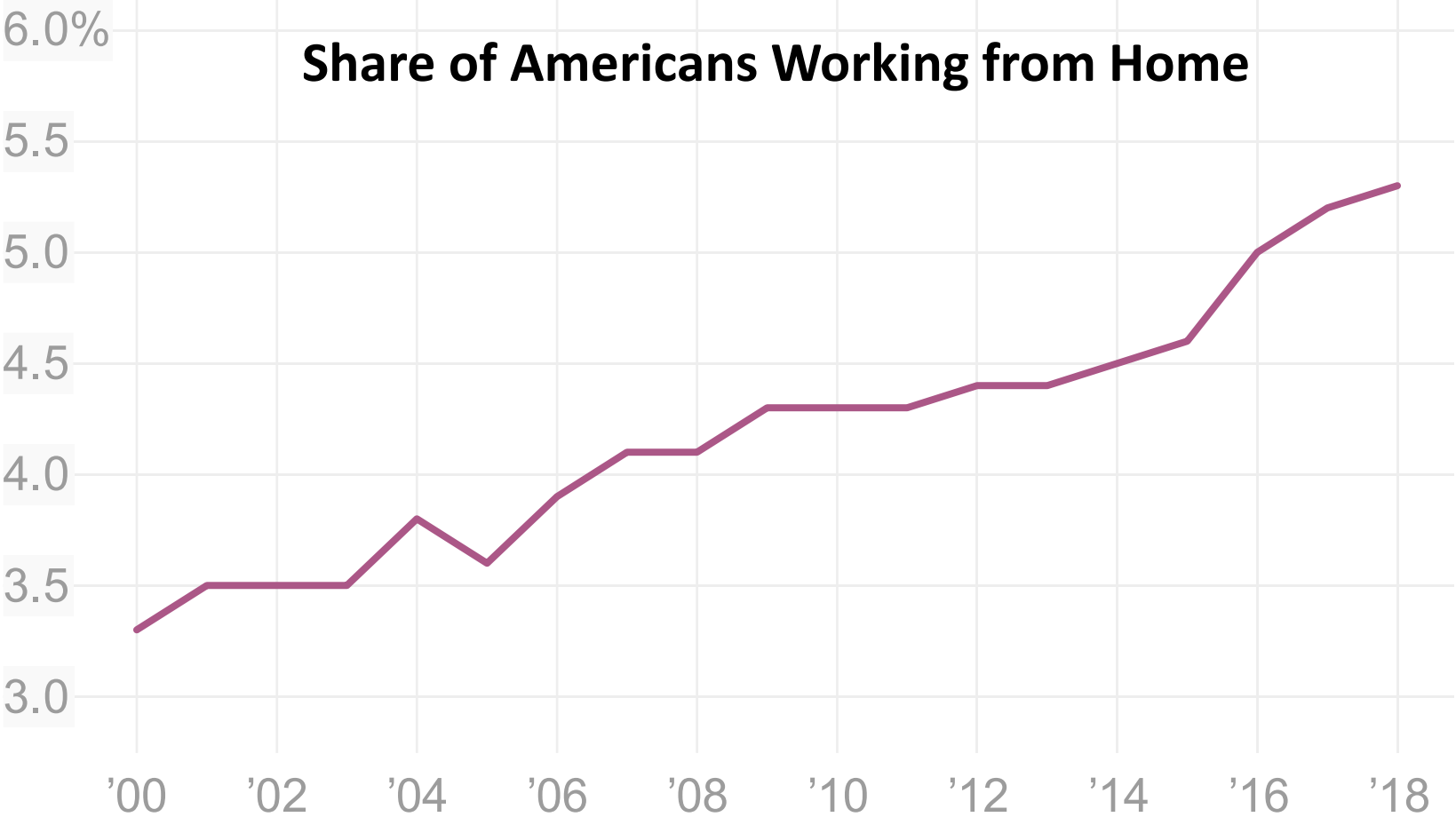
Land Use and Parking:
Car-Free Communities and Lifestyles

Culdesac™

Welcome to the first car-free neighborhood built from scratch in the U.S.

We start from a simple insight: the way we move defines the way we live. And the way we move is changing fast. The first Culdesac car-free neighborhood launches in 2020 in Tempe, Arizona.

Explore Culdesac

1,000 Residents, 0 Private Cars

Culdesac Tempe — the first car-free neighborhood built from scratch in the U.S. — will be home to over 1,000 people.

We've pulled out the parking lots to make room for acres of greenspace, friendly courtyards, and shops right at your doorstep. We're bringing together services like ridesharing, bikes and scooters, and same-day grocery delivery, so zero private cars means zero hassle. Plus, an on-site light rail stop makes it a breeze to get downtown for work.

Reward, Empower, and Incentivize

- Gamified apps that offer incentives and rewards

- Users also get CO2 and Time Savings and Driving Scores

Automation → Nimble and Flexible

Removes the need to operate large vehicles to amortize driver labor over

- Enables higher frequency, smaller units of capacity
- Enables lower cost (smaller scale) infrastructure
- Enables greater flexibility in fitting infrastructure in constrained built environments
- **Enables first-last mile connectivity**

Advocate for Transit's Goals/Strengths

Some markets will still need high capacity vehicles – transit's space efficiency is key

Space Efficiency

space required to transport **60 people**

car — uber — autonomous car

Space Efficiency

Tear Down Modal Silos

- Let's focus on the **future of mobility** **(not the future of a specific mode of transportation)**

- In an aging society, increasing numbers will need door-to-door mobility service

The Goals Remain the Same, The Strategies Have to Evolve

Key goals ⟶ May be best addressed with...
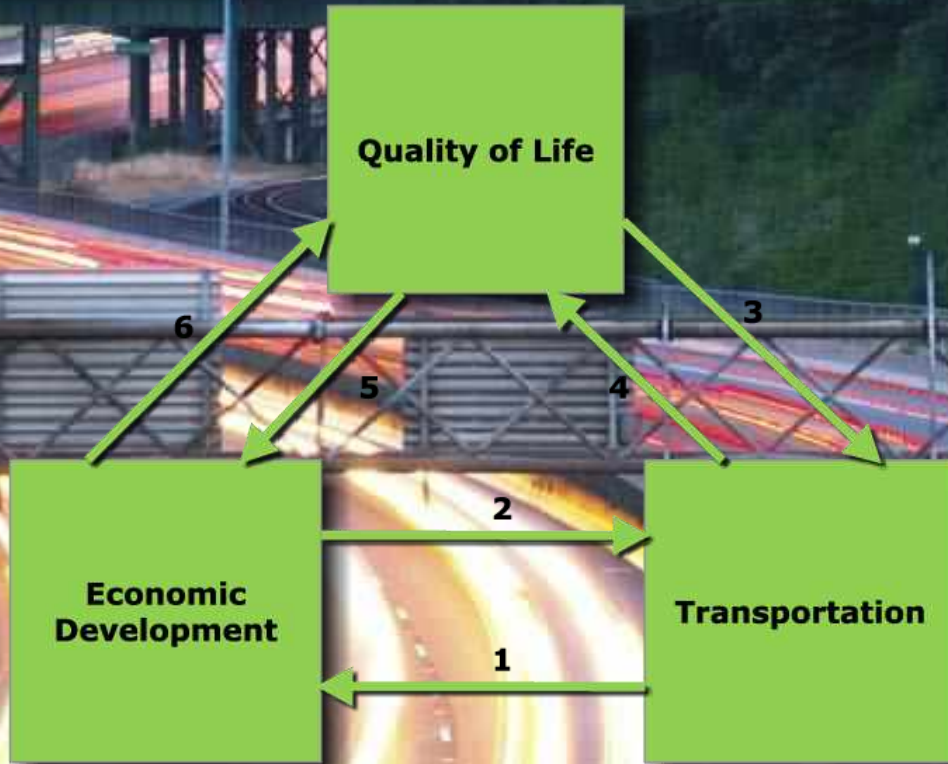
1. Mobility

2. Resource efficiency

3. Economic competitiveness

1. **Multiple Technologies and services**

2. Mixes of public and private providers (embrace partnerships)

3. Different pricing and funding strategies

Ram Pendyala, PhD
pendyala@asu.edu

Quality of Life

Economic Development

Transportation

The Future ↑

Thank you!