The Rapidly Changing Landscape of Traveler Behavior and Values

Emerging Technologies and an Unexpected Pandemic

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TOMNET – USDOT Sponsored Tier 1 University Transportation Center

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
shopping in stores

online shopping and delivery
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.
We are partnering with researchers at the University of Illinois Chicago for the next stage of this project.
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
Would you like to continue any of these new ways of living after COVID-19 is no longer a threat?
Working From Home

Pre-COVID Actual: 50%  
Post-COVID Expected: 68%
<table>
<thead>
<tr>
<th>Reason</th>
<th>Decreased Productivity</th>
<th>Increased Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too many concerns to focus</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>Home workspace less comfortable</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>Equipment not available</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Difficult to communicate</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>More distractions</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>Care for others</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Job demands more</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Crisis focuses my mind</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>No commute</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Home workspace more comfortable</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Fewer distractions</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Online Meetings Once/Week or More

<table>
<thead>
<tr>
<th></th>
<th>Pre-COVID</th>
<th>Now</th>
<th>Post-COVID</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Expected change when COVID-19 is no longer a threat

- Shop for groceries in a store:
  - 7% Much less
  - 22% Somewhat less
  - 63% About the same
  - 7% Somewhat more
  - 1% Much more

- Order groceries for pick up:
  - 2% Much less
  - 7% Somewhat less
  - 75% About the same
  - 2% Somewhat more
  - 1% Much more

- Order groceries for delivery:
  - 8% Much less
  - 1% Somewhat less
  - 73% About the same
  - 1% Somewhat more
  - 3% Much more

- Order other items online for delivery:
  - 2% Much less
  - 6% Somewhat less
  - 71% About the same
  - 2% Somewhat more
  - 3% Much more
Will these expectations of change become actual change?

Time will tell, but in the meantime, more representative data will help.
The Future of Mobility

- 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

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

Not a Lot of Sharing, But a Lot of Hailing

Basic Ride-hailing Concept

- Ride Request
- Acceptance Notification
- Request Notification
- Request Acceptance
- Navigation
- Fare/time estimation
- Payment and Feedback

APP
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

**What is Shared Micromobility?**

Shared Micromobility 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

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.”

Source:
https://www.gartner.com/it-glossary/autonomous-vehicles/
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

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
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

Sources:
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:
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

TOMNET D-STOP
Transformative Transportation Technologies Survey (T^4 Survey)
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

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.

SCHEDULE OF PRESENTATIONS
Note: All times are Pacific Daylight Time, PDT.

8:00 AM Opening Remarks and Welcome
Patrick L. McKibben, 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 Kheirandish, Arizona State University
8:30 AM Comparison of Alternative Survey Recruitment/Deployment Methods
Giovanni Cirriola, Georgia Institute of Technology
9:00 AM Q&A and Break
9:10 AM People’s Lifestyle Preferences, Attitudes, and Travel Patterns
Nikil Mehrotra and Michael Marois, University of South Florida
9:30 AM Residential Choice Preferences in Relation to New Mobility Options
Deborah Saltik, Arizona State University
9:50 AM Q&A and Break
10:10 AM Micro-mobility and Ride-sharing Services: Current Use and Perceptions
Yangseung Lee, Giovanni Cirriola, and Patrick McKibben, Georgia Institute of Technology
10:30 AM Willingness to Share Ride-sharing Trips: Revealed and Stated Preferences
Shuang Kang and Chandira Bhat, University of Texas Austin
10:50 AM Q&A and Break
11:10 AM Autonomous Vehicles: Familiarity, Awareness, and Perceptions
Sana Noori, Arizona State University
11:30 AM Autonomous Vehicles: Potential Travel Behavior Implications
Michael Marois, 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 Ammens and Chandira Bhat, University of Texas Austin
12:30 PM Exploring Willingness to Pay for Autonomous Vehicles
Denise Capasso da Silva and Sara Kheirandish, Arizona State University
12:50 PM Q&A
1:00 PM Closing Remarks
Ram M. Pendyala, Arizona State University
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.
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

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

18-29 years:
- Male: 3%
- Female: 9%
- County: 18%

30-39 years:
- Male: 7%
- Female: 10%
- County: 18%

40-49 years:
- Male: 9%
- Female: 17%
- County: 17%

50-59 years:
- Male: 17%
- Female: 16%
- County: 25%

60-69 years:
- Male: 29%
- Female: 21%
- County: 21%

70+ years:
- Male: 34%
- Female: 14%
- County: 17%

Note: The percentages for each age group are calculated based on the respective sample sizes and the population of Maricopa County 18 years and above.
Sample Characteristics - Income

- **T4 Survey (N=1,005)**
- **Maricopa County households (N=1.5 million)**

<table>
<thead>
<tr>
<th>Income Category</th>
<th>T4 Survey (%)</th>
<th>Maricopa County (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $25,000</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>$25,000 to $49,999</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>$50,000 to $74,999</td>
<td>23%</td>
<td>15%</td>
</tr>
<tr>
<td>$75,000 to $99,999</td>
<td>21%</td>
<td>19%</td>
</tr>
<tr>
<td>$100,000 to $149,999</td>
<td>17%</td>
<td>13%</td>
</tr>
<tr>
<td>$150,000 or more</td>
<td>23%</td>
<td>14%</td>
</tr>
<tr>
<td>More than $150,000</td>
<td>18%</td>
<td>11%</td>
</tr>
</tbody>
</table>

T4 Survey (N=1,005) Maricopa County households (N=1.5 million)
Mode Use for Non-Commute Trips

- **Drive private vehicle, alone (N=1,061)**:
  - Not available: 2%
  - Available but I never use it: 2%
  - Less than one day a month: 1%
  - 1-3 days a month: 5%
  - 1-2 days a week: 15%
  - 3 or more days a week: 32%

- **Drive private vehicle, with passengers (N=1,052)**:
  - Not available: 2%
  - Available but I never use it: 8%
  - Less than one day a month: 2%
  - 1-3 days a month: 15%
  - 1-2 days a week: 28%
  - 3 or more days a week: 68%

- **Ride in private vehicle, with others (N=1,051)**:
  - Not available: 1%
  - Available but I never use it: 8%
  - Less than one day a month: 1%
  - 1-3 days a month: 18%
  - 1-2 days a week: 21%
  - 3 or more days a week: 32%

- **Public transit: bus (N=1,048)**:
  - Not available: 3%
  - Available but I never use it: 1%
  - Less than one day a month: 1%
  - 1-3 days a month: 1%
  - 1-2 days a week: 0%
  - 3 or more days a week: 63%

- **Public transit: light rail (N=1,041)**:
  - Not available: 8%
  - Available but I never use it: 1%
  - Less than one day a month: 1%
  - 1-3 days a month: 1%
  - 1-2 days a week: 8%
  - 3 or more days a week: 36%
Attitudes Towards Transit and Vehicle Ownership

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)

Most of the time, I have no reasonable alternatives to driving. (N=1,068)

I definitely like the idea of owning my own car. (N=1,069)
Attitudes Towards Transit and Residential Location

Public transit is a reliable means of transportation for my daily travel needs. (N=1,068)

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)

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

Primary Purpose of Last Ridehailing Trip (N=514)

- 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)

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

- Public transit: bus (N=307)
  - Changed usage, but not because of ridehailing: 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, but not because of ridehailing: 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)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No need to park/parking was expensive or scarce</td>
<td>16%</td>
</tr>
<tr>
<td>For more physical exercise</td>
<td>9%</td>
</tr>
<tr>
<td>To save time</td>
<td>20%</td>
</tr>
<tr>
<td>To save money</td>
<td>5%</td>
</tr>
<tr>
<td>Public transit was not available</td>
<td>9%</td>
</tr>
<tr>
<td>Public transit was not convenient</td>
<td>2%</td>
</tr>
<tr>
<td>Private vehicle was not available</td>
<td>4%</td>
</tr>
<tr>
<td>Just to enjoy the ride/try the new service</td>
<td>73%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

Note: More than one choice could be selected.

**Alternative Mode**, if NO Bike/E-Scooter Sharing Service (N=56)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive private vehicle, alone</td>
<td>13%</td>
</tr>
<tr>
<td>Drive private vehicle, with others</td>
<td>5%</td>
</tr>
<tr>
<td>Ride in private vehicle, with others</td>
<td>5%</td>
</tr>
<tr>
<td>Ride the light rail</td>
<td>2%</td>
</tr>
<tr>
<td>Use Uber/Lyft</td>
<td>7%</td>
</tr>
<tr>
<td>Use my own bike or scooter</td>
<td>5%</td>
</tr>
<tr>
<td>Walk</td>
<td>45%</td>
</tr>
<tr>
<td>I would not have made this trip</td>
<td>18%</td>
</tr>
</tbody>
</table>
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

- Shopping/errands: 30%
- Social/recreational: 29%
- Eating/drinking: 14%
- Returning home: 0%
- Commute location: 19%
- Just to enjoy the ride/try the new service: 9%

Characteristics of last bike/e-scooter trip (N=70)
Familiarity with Autonomous Vehicles (N=1051)

- Never heard of AVs: 11%
- Heard about them, but not familiar: 35%
- Somewhat familiar: 41%
- Very familiar: 12%
- Actually ridden an AV: 1%
- Never heard of AVs: 11%
- Heard about them, but not familiar: 35%
How much longer would you be willing to commute in an AV, compared to your current commute? (N=631)

Would not accept a longer commute: 33%
Up to 5 additional minutes: 19%
5-15 additional minutes: 28%
15-30 additional minutes: 15%
More than 30 additional minutes: 5%
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%
- Eventually buy an AV, 52%
- Never buy an AV, 43%
Engage in Activities During an AV Trip

ALL SCENARIOS (N=1052)

0%  5%  10%  15%  20%  25%  30%  35%  40%  45%

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?

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

- Reduce vehicular travel demand
  - Telecommuting and IoT connectivity
Land Use and Parking: Car-Free Communities and Lifestyles

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.

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

1. Mobility
2. Resource efficiency
3. Economic competitiveness

May be best addressed with...

1. Multiple Technologies and services
2. Mixes of public and private providers (embrace partnerships)
3. Different pricing and funding strategies
Thank you!