Micromobility Screening for City Opportunities Online Tool (SCOOT)

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Sustainable Transportation Lab
University of Washington

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Project ID#: VAN044

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Project Start Date: October, 2020
- Project End Date: December, 2022
- Percent Complete: 60%

Budget

- Total project funding:
  - DOE Share: $299,888
  - Contractor Share: $35,000
- Funding for FY 2021: $189,425
- Funding for FY 2022: $145,463

- Barriers Addressed
  - New capabilities for mobility systems research
  - Mobility system technology characterization
  - Applied R&D to support partners and stakeholders

- Partner
  - The University of Washington is the only organization on this project

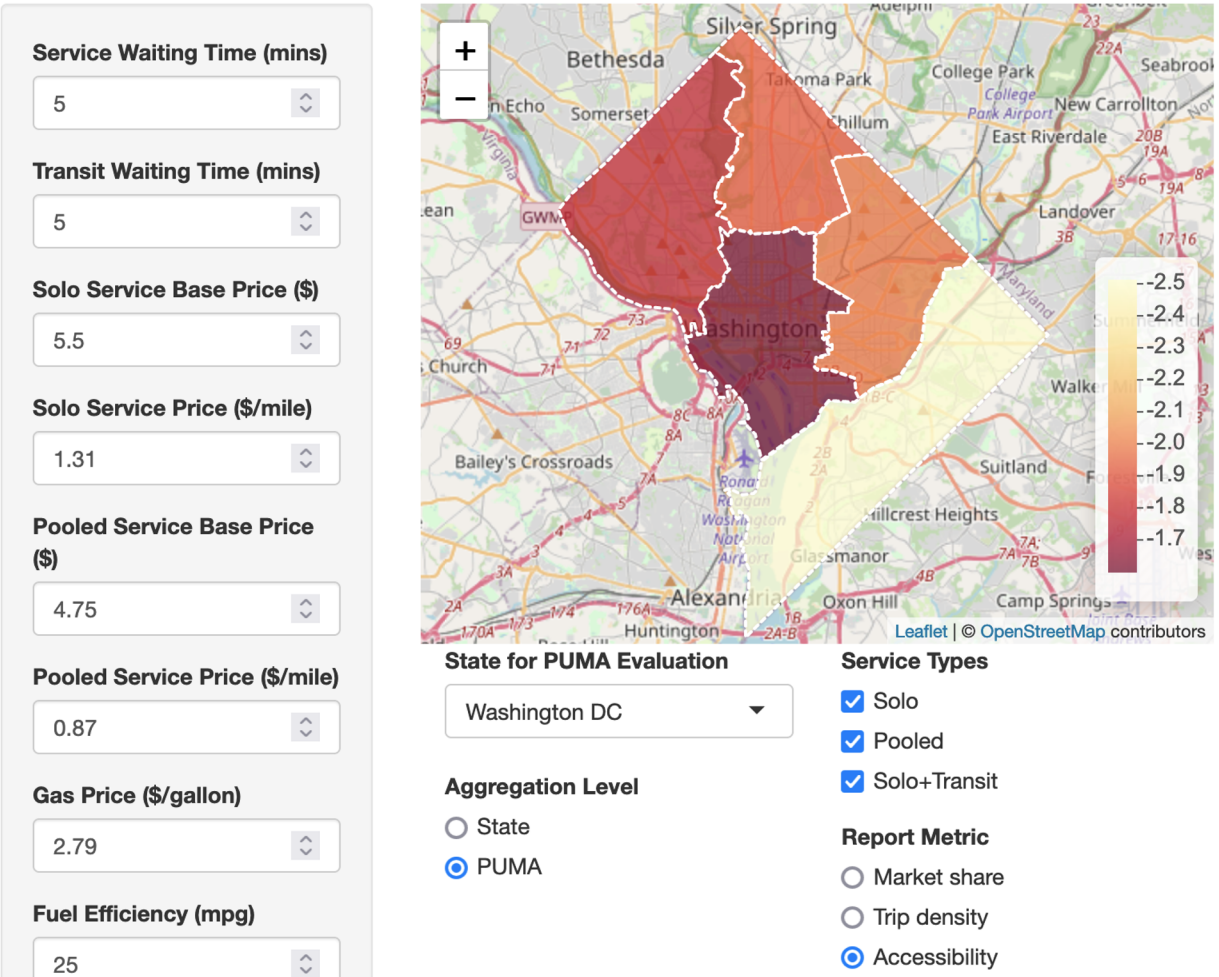
Relevance: Develop a tool to support cost-effective deployment of micromobility and enhance energy productivity

Goal

- Build on prior work analyzing ridehailing commute trips and accessibility at PUMA level
- Census tract level analysis for all MSAs
- Multiple trips purposes
- Sensitive to infrastructure & deployment
- Outputs mobility energy productivity

Past Year

- Reviewed literature
- Designed, programmed, & deployed survey
- Built constituent models & synthetic population



Relevance: Work supports reduced energy costs, increased security, and aligns with VAN goals

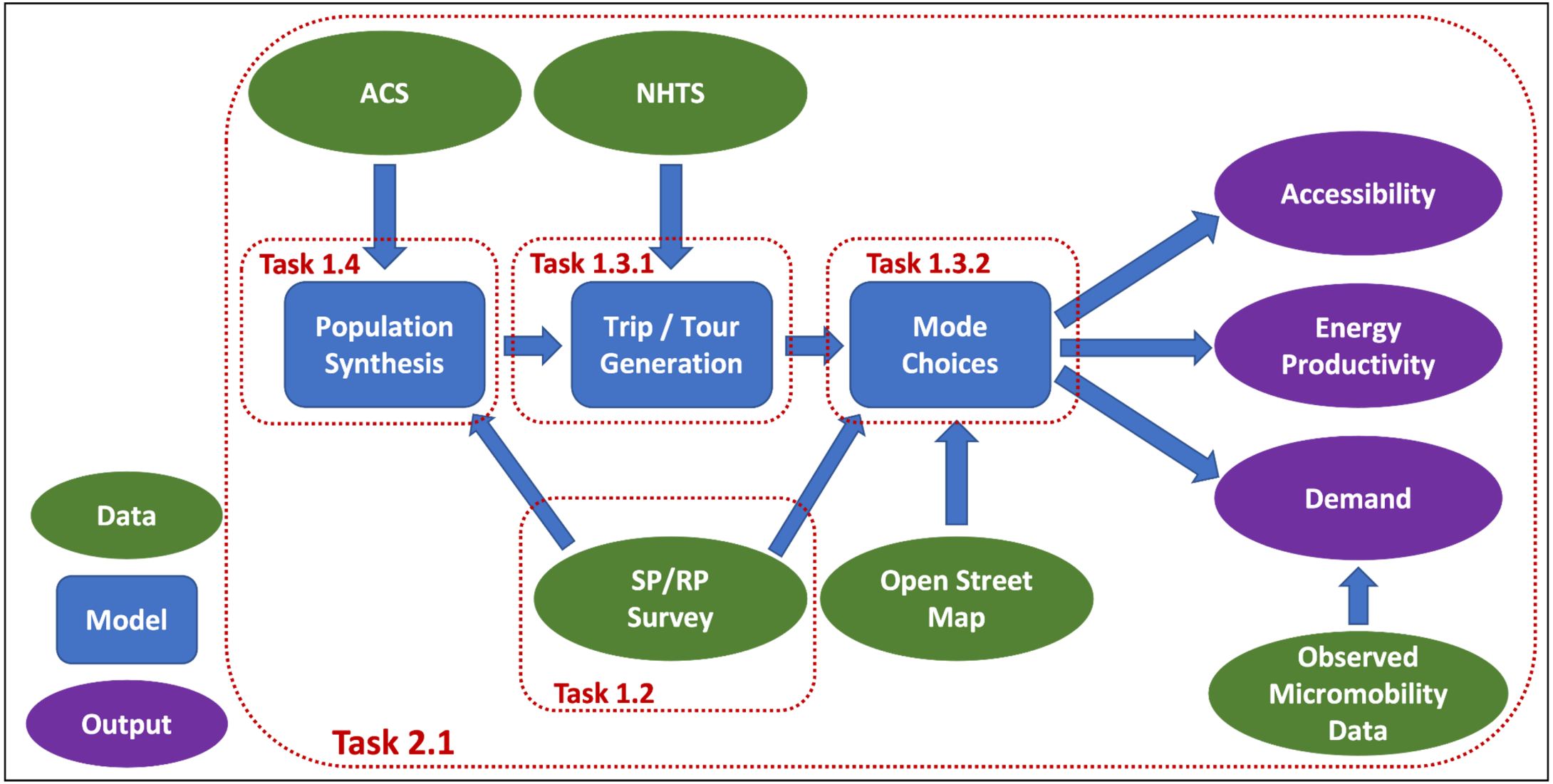
Increased Energy Security: Micromobility uses electricity, meaning less price volatility and less reliance on imported petroleum fuels.

Reduced Energy Costs: Energy use per mile is less than 1/10 that of an electric car.

Clean Energy Technology: Zero tailpipe emissions.

VAN Goal	This Project
Which vehicle use domains offer the potential to provide clean mobility benefits and at a reasonable cost to both businesses and the consumer? In which applications can specific new technologies make the greatest impact?	New modeling framework is sensitive to individual, neighborhood, infrastructure, and mode-specific attributes.
Support quantitative assessment of vehicle and mobility technology impacts, in terms of efficiency, affordability, resiliency, and security.	Supports identification of areas with high and low potential demand for micromobility, enabling cost-effective deployment and assessing benefits to accessibility and energy productivity.
Provide insight into transportation and energy use problems for a broad range of internal and external stakeholders.	Develop a web tool that allows Census-tract level analysis of micromobility travel patterns for every MSA in the country, available to local governments and MPOs.

Approach: Building constituent sub-models, then integrating into complete framework

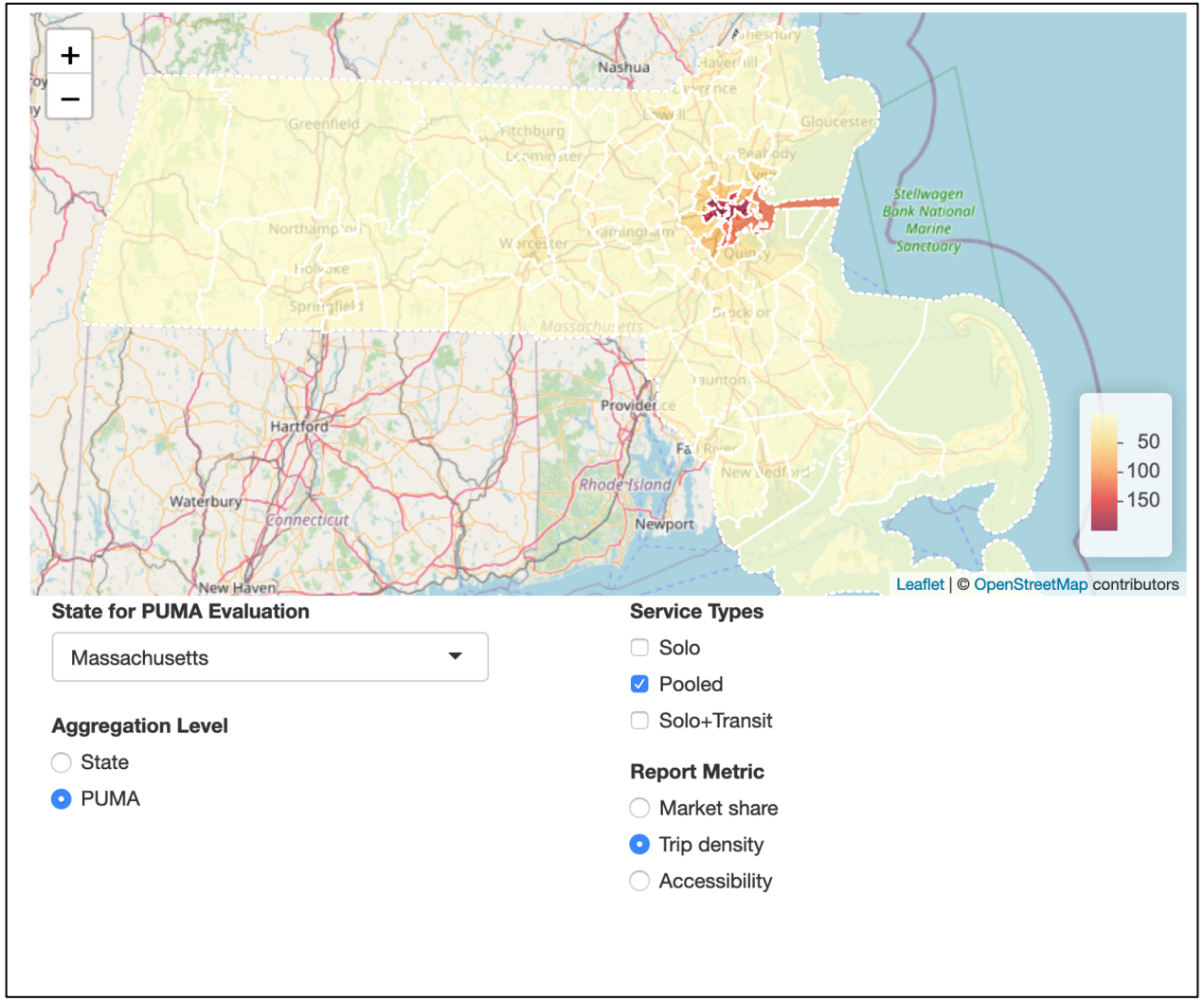


Approach: Validate and refine framework; Create and host a user-ready web tool; make underlying data & code available

- Task 2.1.2: Validate SCOOT framework using observed counts of shared bike & scooter trips from selected cities

- Task 2.2: Interactive webtool
  - User specific service & built environment characteristics
  - Displays key outputs for accessibility, energy productivity, and service demand
  - Implement in R Shiny

- Task 2.3: Technology transfer
  - Reporting
  - Code and data made available



Approach: Unique aspects of this work to address technical barriers

General Barrier: Which vehicle use domains---including vehicle design, powertrain technologies, increased automation, and a better understanding of travel patterns---offer the potential to provide clean mobility benefits and at a reasonable cost to both businesses and the consumer? In which applications can specific new technologies make the greatest impact?

Technical Barrier Addressed	How This Work Addresses
Build, maintain, and exercise relevant analytical models: New modeling framework & capabilities for researching micromobility systems	➢ Unique data set linking attitudes, perceptions, and choices ➢ National level population synthesis and trip simulation ➢ Integrate population synthesis, trip generation, mode choice models for all MSAs in country
Support quantitative assessment of vehicle and mobility technology impacts: Quantify impacts of micromobility systems	➢ Trips ➢ Accessibility ➢ Mobility Energy Productivity
Develop an applied tool for local governments, advocates, and researchers	➢ Web tool to map impacts & demand across regions ➢ Support evaluation of measures targeting availability, pricing, infrastructure, micromobility mode types ➢ Make underlying code and data available to all

Approach: Milestones for 2022

Go/No-Go Decision Point (Start of 2022)

- ➢ Validation data (geographically disaggregated trip counts) identified for multiple cities.
- ➢ Models of trip count estimated and are sensitive to at least one variable of interest.
- ➢ Models of micromobility mode choice estimated and are sensitive to at least one variable of interest.
- ➢ A synthetic sample of at least 100 individuals per census tract has been generated.

Technical Milestone	Description	Status
Demand models implemented in SCOOT	SCOOT uses trip count and mode choice models to generate simulated numbers of micromobility trips based on attributes of individuals in synthetic sample	In progress
SCOOT trip counts validated	SCOOT's predicted trip counts validated against real counts for available cities	Validation data tracking ongoing
Interactive tool developed	SCOOT fully implemented allowing internal users to specify assumptions and view results	Not started
SCOOT meets performance targets	SCOOT supports analysis of micromobility demand and impacts at the census tract level and can return results for an average MSA in 90 seconds	Not started

Technical Accomplishments and Progress:

Reviewed 50+ articles on micromobility mode choice & trip generation

Internal Factors

- Expected performance
- Environmental concern
- Perceived risk
- Residual effect
- Young, white, male
- Higher education & income

External Factors

- Urban density
- Land use
- Infrastructure
- Weather

System Attributes

- Vehicle availability
- Vehicle distribution
- Battery status
- Speed
- Price

Key Gaps Identified

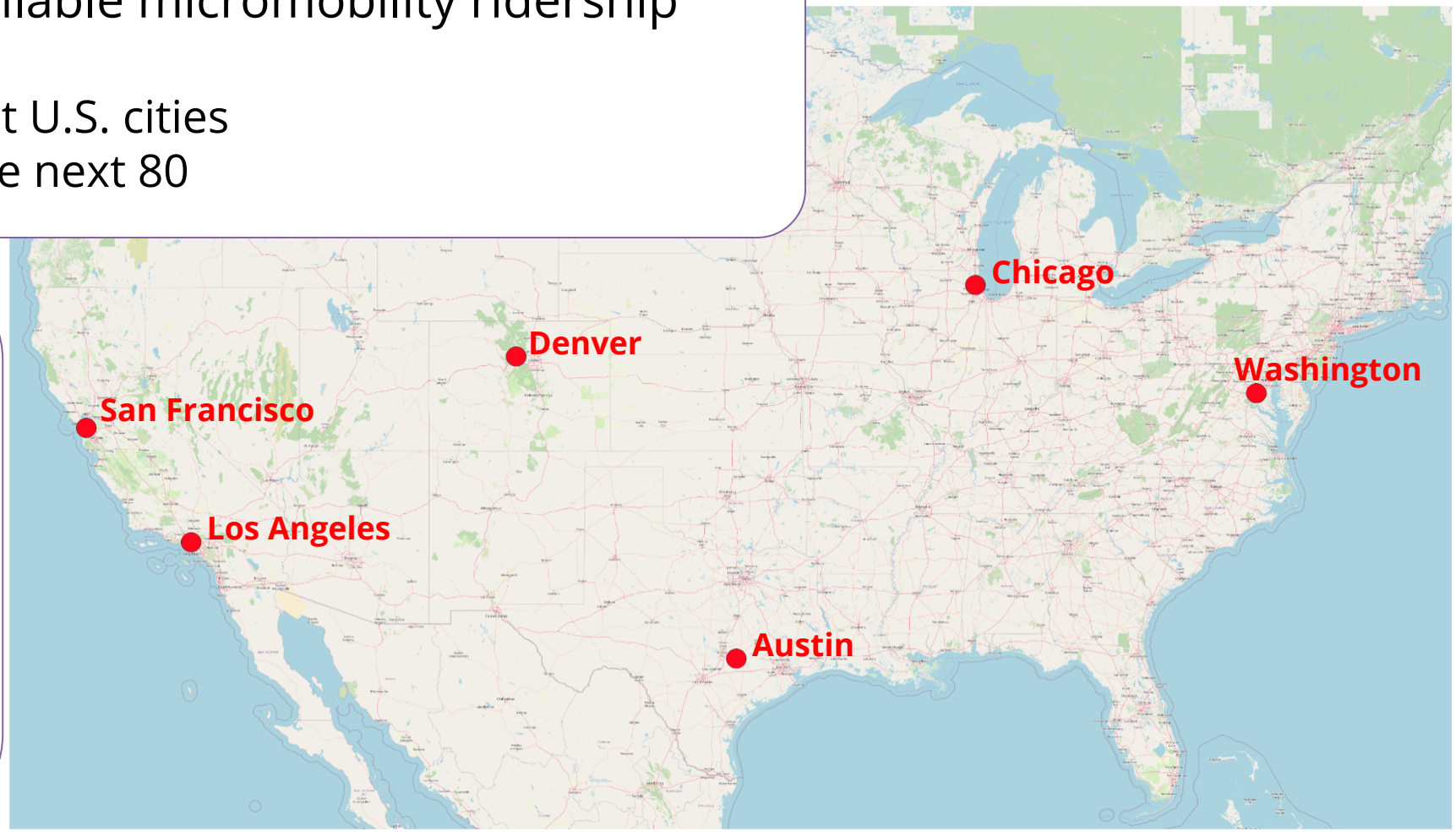
- ➢ Dockless services.
- ➢ Effects of individual latent attitudes on intention to use micromobility.
- ➢ Assessing the impacts of micromobility services.

Technical Accomplishments and Progress:
Identified cities for validation data monitoring

✓ **Milestone 1**: Background research complete

- Inventoried publicly available micromobility ridership data from
  - All of the top 20 largest U.S. cities
  - 20 more cities from the next 80

- Six cities selected for:
  - Spatial and temporal disaggregation
  - Spatial and temporal coverage
  - Types and providers of micromobility services
  - Restrictions on access or use of data
  - Geographic variation



Technical Accomplishments and Progress:

✓ **Milestone 2**: Survey design complete

Designed a stated preference / revealed preference questionnaire

- ➢ Socio-demographic questions
- ➢ Recent trip
- ➢ Choice experiment
- ➢ Psychometric questions

Link intention to use micromobility with individual, service quality, and context variables

Please think about the most recent trip you made for any of the following purposes:

To go to work

To go to work related business

Please provide details of this trip

This information will be used to create customized travel scenarios in the next sections of the survey.
Your information will remain unidentifiable.

Day of the trip: day

Start time of trip: hour | minute | AM/PM

The trip started from... Choose...

Origin of the trip

origin cross street 1 (eg. 12th Ave NE)

origin cross street 2 (eg. NE 65th St)

origin city name (eg. Seattle)

Choose State...

Destination of the trip

destination cross street 1 (eg. NE 45th St)

destination cross street 2 (eg. Memorial Way NE)

destination city name (eg. Seattle)

Choose State...

Mode of trip: Mode

Please choose the specific information for the vehicle you used: Year... | Make...

Did you travel with others on this trip? Traverler(s)

How long was the trip (minutes)? input minutes

Weather condition: No rain, 80 F

Bike lane availability: 80% of the trip has dedicated bike lane

Question 1: If the following were the only options available, which service would you prefer for this trip?

	Dockless eScooter	Dockless eBikeshare	Docked eBikeshare
Travel cost	$ 0.00	$ 1.75	$ 1.75
Riding Time	4 min	6 min	4 min
Pick-up Distance	3 min walk to the eScooter	0 min walk to the eBike	3 min walk to the station
Drop-off Distance to Destination	Less than 1 min	Less than 1 min	1 min walk

First Choice	○ Dockless eScooter	○ Dockless eBikeshare	○ Docked eBikeshare
Second Choice	○ Dockless eScooter	○ Dockless eBikeshare	○ Docked eBikeshare

Question 2: For this trip,

○ I would prefer the mode I actually used (Walk, jog) in the previously reported recent trip

○ I would prefer my first choice as described above

Weather condition: Light rain, 40 F

Bike lane availability: Half of the trip has dedicated bike lane

Question 1: Which service described below do you prefer?

	○ Dockless eScooter	○ Dockless eScooter with Transit
Travel cost	$0	$0 (scooter) + $2(transit) = $2
Riding Time	30 min	10 min (scooter)+ 9 min (transit)= 19 min
Waiting Time for the eScooter to come	0 min	1 min

Question 2: For this trip,

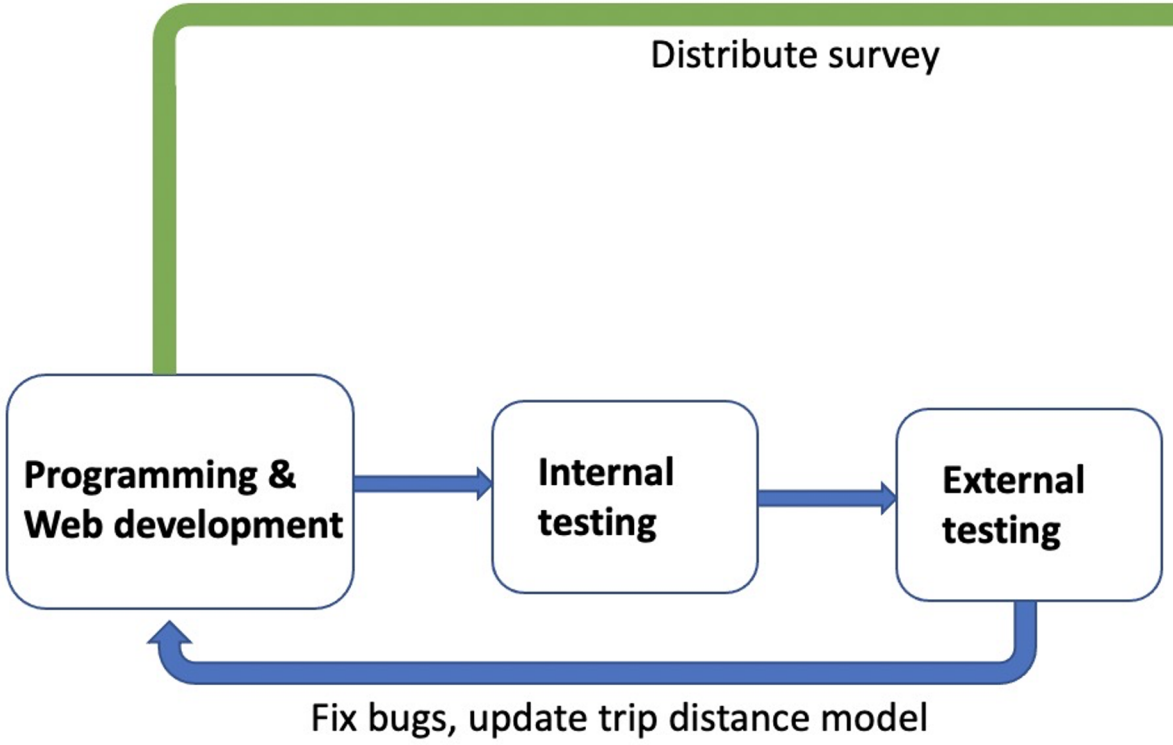
○ I prefer the mode I actually used (Bus) in the previously reported recent trip

○ I prefer my choice as described above

Technical Accomplishments and Progress:

✓ **Milestone 3**: Data collection complete

Programmed and administered survey to 2500+ respondents



First wave data collection
December 10 to December 17, 2021

- Collected 1971 responses across the U.S. from Amazon MTurk.
- Minimum of 95% task acceptance rate on MTurk
- In proportion to the population living in each state.

Second wave data collection
December 30 to December 31, 2021

- 593 responses
- Minimum of 95% task acceptance rate on MTurk
- Recruited from across the U.S.

Technical Accomplishments and Progress:

Estimated choice model including micromobility & conventional modes

	Car	Transit	Ridehailing	Walk	Bike	E-scooter	Dockless Bikeshare	Docked Bikeshare	E-scooter + Transit	
Constant		x	x	x	x	x	x	x	x	
Travel time	x	x	x	x	x	x	x	x	x	x
Travel cost/individual income						x	x	x	x	
Trip purpose		x	x	x	x	x	x	x	x	
Household size	x		x							
Employment status			x			x	x	x	x	
Bike lane					x	x	x	x	x	
Precipitation					x	x	x	x	x	
Access walking time						x	x	x	x	
Drop off walking time								x		
Autonomous Scooter						x			x	
Autonomous:waiting time						x			x	
Personal bike						x	x	x	x	
Population density						x	x	x	x	

Within each row, cells of the same color indicate coefficients were fixed across the corresponding modes.

Technical Accomplishments and Progress:

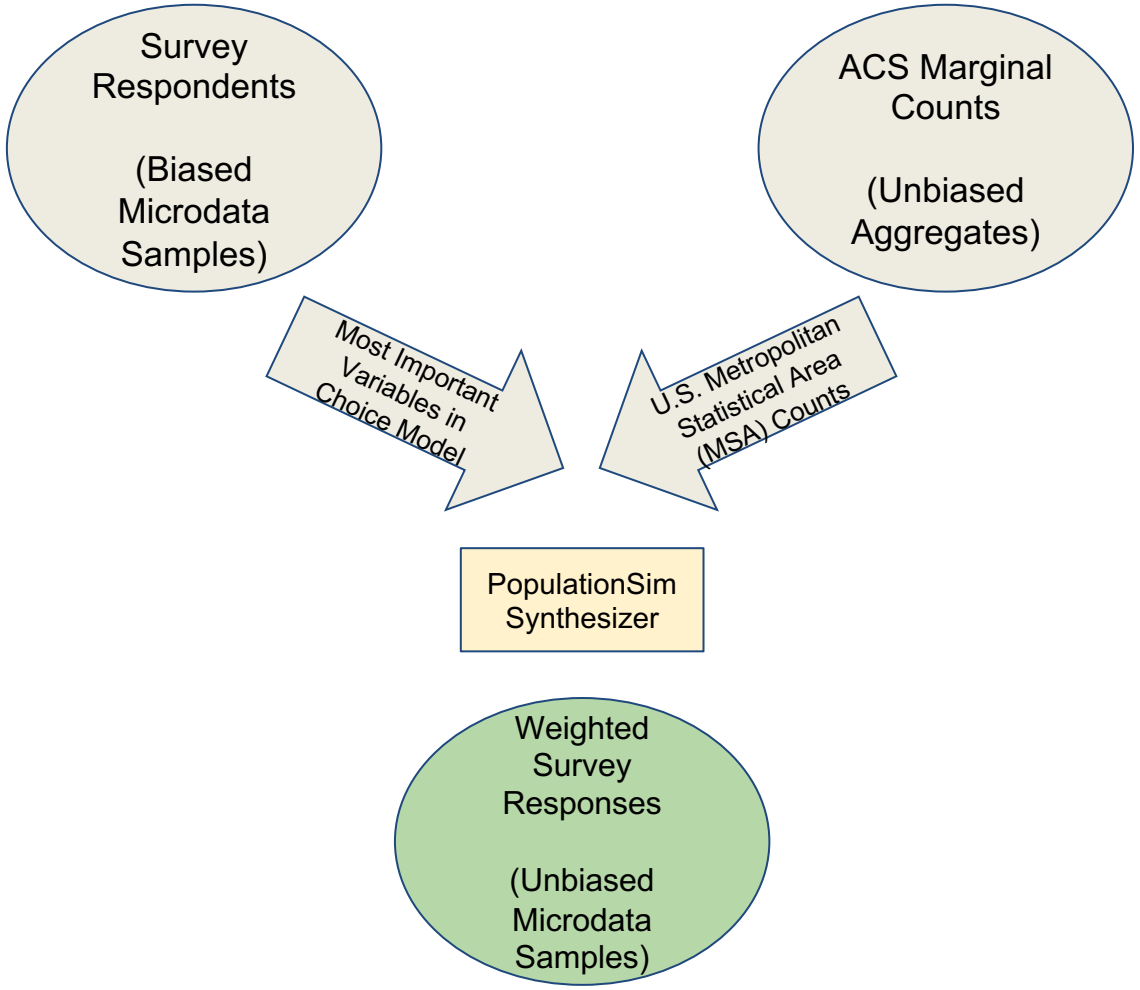
8808 choice task observations from 1753 respondents used in modeling

Key findings:

- Micromobility modes have negative utility of travel time, travel cost, home-based social trips, and precipitation
- Micromobility modes have positive utility for non-home-based trips, employed people, personal bike owners, and in high density areas.
- Bikeshare has lower disutility of travel time than scootershare.
- Transit + scooter mode has lower disutility of travel time than scooter alone.
- Waiting time for an autonomous scooter has less disutility than walking time to reach a regular scooter.

Technical Accomplishments and Progress: Synthesized populations for all metropolitan statistical areas (MSAs)

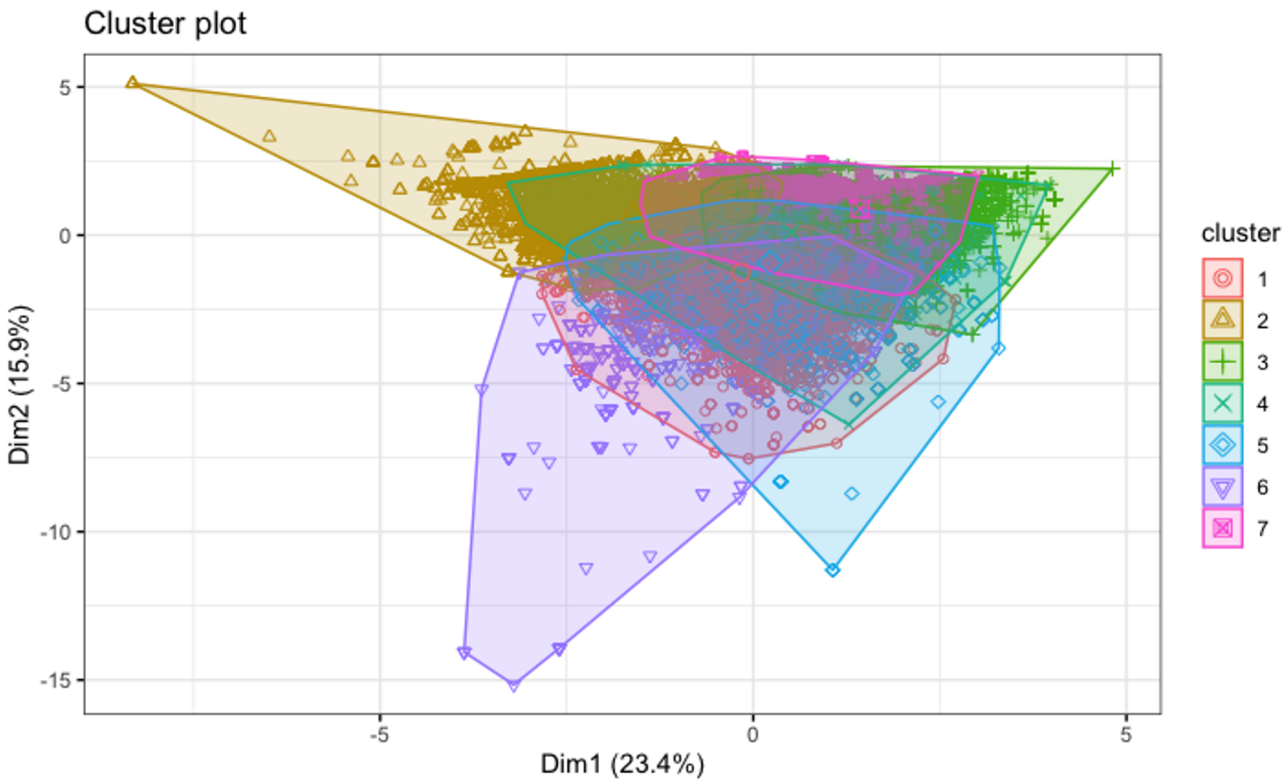
✓ **Milestone 4**: Synthetic sample generated



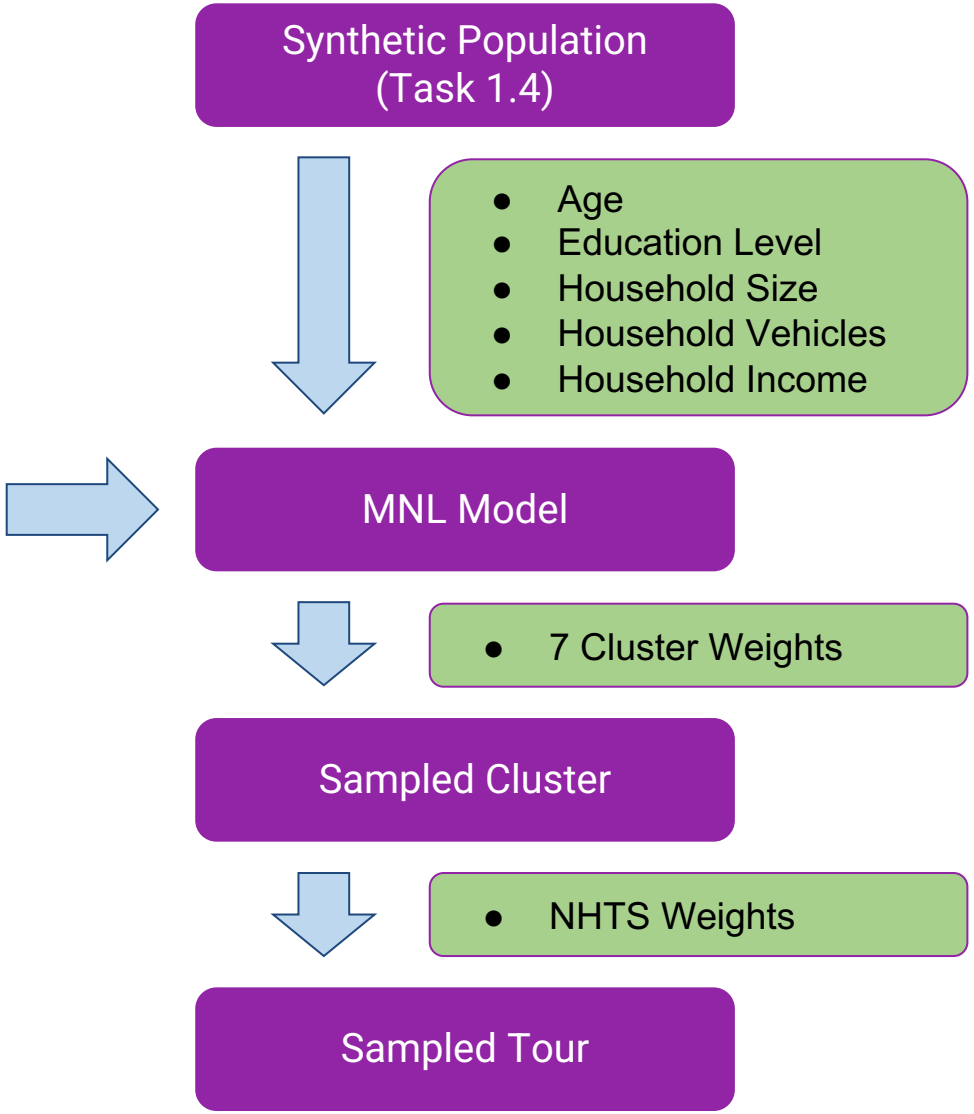
- Gather ACS tables for chosen control variables
  - Age (full population, table S0101, 18 levels)
  - Personal Income (population 15 and over, table B19325, 8 levels)
  - Sex (full population, table S0101, 2 levels)
  - Education Level (population 18 and over, table S1501, 7 levels)
- Use PopulationSim to determine weights for our survey sample
  - Run once for each unit of analysis (MSA/Census Tract)

Technical Accomplishments and Progress:
Simulate tours and trips for members of synthetic population

✓ **Go/No-Go**: Necessary components are ready



Tours in NHTS were clustered by distance, start time, number of trips by purpose



Response to Previous Year Reviewers' Comments

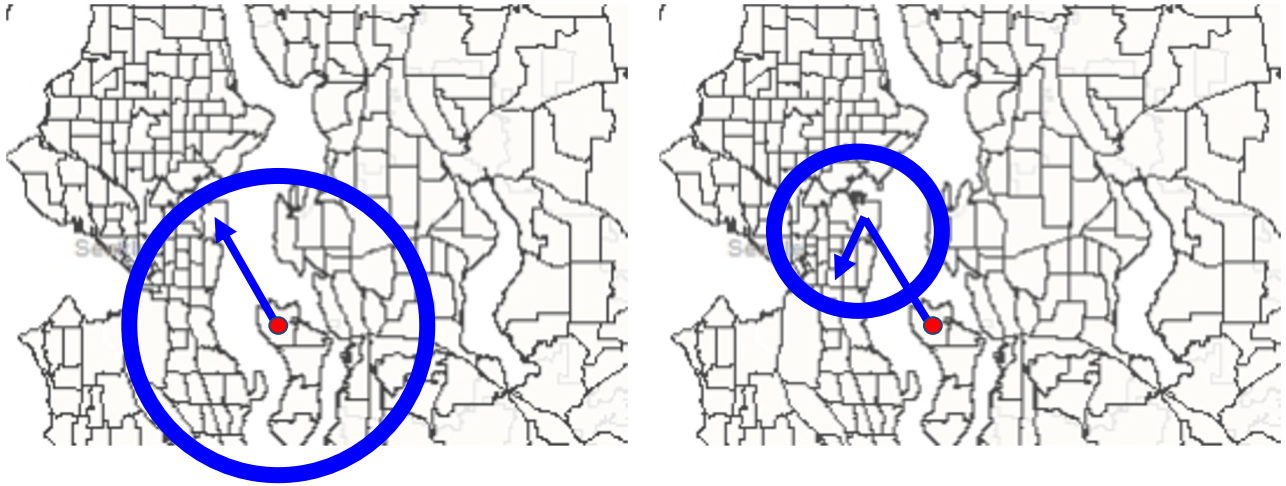
This project was not reviewed last year.

Collaboration and Coordination with Other Institutions

The UW is the only institution on this project.

Remaining Challenges and Barriers

- Computational complexity
  - The bottleneck in our analysis is selecting trip destinations.
  - Focusing on improving spatial processing efficiency by pre-processing indexes or applying more computing power
- Assemble SCOOT and implement as web tool
  - Goal is to support real-time analysis in any MSA



Allows modeling micromobility/infrastructure availability for individual trips in each tour, and validation with census tract trip counts…

…also computationally very intensive.

Proposed Future Research

Within this Project

- Validate trip count data & refine modeling
- Calculate accessibility & energy productivity
- Implement web tool
- Publish data & code

...And Beyond

- Incorporate psychometric variables in choice modeling and population synthesis.
- Improve tour simulation by accounting for land use and activity patterns.
- Higher spatial resolution, e.g. point to point accessibility, could inform geofencing and rebalancing policies.

Technical Milestones (FY22/FY23)	Description
Demand models implemented in SCOOT	SCOOT uses trip count and mode choice models to generate simulated numbers of micromobility trips based on attributes of individuals in synthetic sample
SCOOT trip counts validated	SCOOT's predicted trip counts validated against real counts for available cities
Interactive tool developed	SCOOT fully implemented allowing internal users to specify assumptions and view results
SCOOT meets performance targets	SCOOT supports analysis of micromobility demand and impacts at the census tract level and can return results for an average MSA in 90 seconds

Any proposed future work is subject to change based on funding levels.

Summary

Objective	Approach	Accomplishments	Planned and Future
• Develop a new analytical tool that uses real-world data to estimate energy use and associated impacts of micromobility services	• Population synthesis • Trip/Tour generation • Mode choice model • Impact estimation	• Literature review • Survey design and data collection • Micromobility mode choice model • Population synthesis with survey microdata • Tour and Trip Generation, Destination Tract Selection	• Integrate component models into SCOOT framework • Implement web tool • Publish code & data • Additional modeling with RP/SP survey data • Modeling point to point accessibility

Any proposed future work is subject to change based on funding levels.

TECHNICAL BACKUP SLIDES FOLLOW

Choice model results

N=8088 choice tasks LL=-5742.142

*: 2-tail significance at α=0.10. **: 2-tail significance at α=0.05. ***: 2-tail significance at α=0.01.

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
Walk				
Constant	-2.780	0.326	<0.001	***
Travel time (min)	-0.008	0.004	0.054	*
Trip purpose (ref: home-based work)				
Home-based other	0.575	0.438	0.190	
Home-based shop	0.764	0.386	0.048	**
Home-based social	0.517	0.478	0.279	
Not home-based	1.950	0.392	<0.001	***
Bike				
Constant	-1.750	0.248	<0.001	***
Travel time (min)	-0.015	0.002	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	-0.281	0.278	0.313	
Home-based shop	0.195	0.283	0.491	
Home-based social	-0.417	0.343	0.224	
Not home-based	1.220	0.228	<0.001	***
Bike lane (1: less than 50% bike lane available; 0: else)	-0.117	0.071	0.096	*
Precipitation (ref: no rain)				
Heavy rain	-0.613	0.087	<0.001	***
Light rain	-0.434	0.085	<0.001	***

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
Car				
Travel time (min)	-0.069	0.008	<0.001	***
Household size	-0.279	0.029	<0.001	***
Transit				
Constant	-2.190	0.404	0.027	**
Travel time (min)	-0.029	0.004	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	0.544	0.565	0.336	
Home-based shop	0.835	0.637	0.190	
Home-based social	1.770	0.751	0.018	**
Not home-based	0.934	0.480	0.052	*
Ridehailing				
Constant	-3.330	1.610	0.039	**
Travel time (min)	-0.030	0.008	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	0.843	0.989	0.394	
Home-based shop	2.080	1.550	0.178	
Home-based social	1.460	1.010	0.148	
Not home-based	1.070	0.773	0.164	
Employment(1: employed; 0: else)	2.510	1.530	0.102	
Household size	-0.514	0.245	0.035	**

Same time for waiting for scooters with AT has less disutility than for walking to nearest scooter

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
E-scooter				
Constant	-2.320	0.204	<0.001	***
Travel time (min)	-0.043	0.005	<0.001	***
Travel cost / individual income in thousands (unitless)	-0.799	0.117	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	-0.015	0.123	0.901	
Home-based shop	0.080	0.125	0.524	
Home-based social	-0.238	0.138	0.085	*
Not home-based	0.614	0.101	<0.001	***
Bike lane (1: (1: 50% or less bike lane available; 0: else)	-0.117	0.071	0.096	*
Precipitation (ref: no rain)				
Heavy rain	-0.613	0.087	<0.001	***
Light rain	-0.434	0.085	<0.001	***
Access walking time (min)	-0.075	0.012	<0.001	***
Autonomous (1:AT available; 0:else)	0.071	0.073	0.328	
Autonomous Waiting time (min)	-0.029	0.017	0.085	*
Personal bike ownership (1: bike owner; 0:else)	0.505	0.082	<0.001	***
Employment(1: employed; 0: else)	0.433	0.126	<0.001	***
Population density at home zip code (1000 people/sq.mile)	0.006	0.003	0.051	*

Same travel time for bikeshare has less disutility than for scooter

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
Dockless bikeshare				
Constant	-2.340	0.202	<0.001	***
Travel time (min)	-0.015	0.002	<0.001	***
Travel cost / individual income in thousands (unitless)	-0.799	0.117	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	-0.015	0.123	0.901	
Home-based shop	0.080	0.125	0.524	
Home-based social	-0.238	0.138	0.085	*
Not home-based	0.614	0.101	<0.001	***
Bike lane (1: less than 50% bike lane available; 0: else)	-0.117	0.071	0.096	*
Precipitation (ref: no rain)				
Heavy rain	-0.613	0.087	<0.001	***
Light rain	-0.434	0.085	<0.001	***
Access walking time (min)	-0.075	0.012	<0.001	***
Personal bike ownership (1: bike owner; 0:else)	0.505	0.082	<0.001	***
Employment(1: employed; 0: else)	0.433	0.126	<0.001	***
Population density at home zip code (1000 people/sq.mile)	0.006	0.003	0.051	*

Same time for access docked bikeshare has similar disutility to drop off

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
Docked bikeshare				
Constant	-2.870	0.211	<0.001	***
Travel time (min)	-0.015	0.002	<0.001	***
Travel cost / individual income in thousands (unitless)	-0.799	0.117	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	-0.015	0.123	0.901	
Home-based shop	0.080	0.125	0.524	
Home-based social	-0.238	0.138	0.085	*
Not home-based	0.614	0.101	<0.001	***
Bike lane (1: less than 50% bike lane available; 0: else)	-0.117	0.071	0.096	*
Precipitation (ref: no rain)				
Heavy rain	-0.613	0.087	<0.001	***
Light rain	-0.434	0.085	<0.001	***
Access walking time (min)	-0.075	0.012	<0.001	***
Dropoff walking time (min)	-0.071	0.027	0.009	***
Personal bike ownership (1: bike owner; 0:else)	0.505	0.082	<0.001	***
Employment(1: employed; 0: else)	0.433	0.126	<0.001	***
Population density at home zip code (1000 people/sq.mile)	0.006	0.003	0.051	*

Same travel time for transit has less disutility than for scooter

Variable	Estimate	Std.Err	Pr(>|z|)	Significance
E-scooter + transit				
Constant	-2.520	0.199	0.027	**
E-scooter travel time (min)	-0.043	0.005	<0.001	***
Transit travel time (min)	-0.029	0.004	<0.001	***
Travel cost / individual income in thousands (unitless)	-0.799	0.117	<0.001	***
Trip purpose (ref: home-based work)				
Home-based other	-0.015	0.123	0.901	
Home-based shop	0.080	0.125	0.524	
Home-based social	-0.238	0.138	0.085	*
Not home-based	0.614	0.101	<0.001	***
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Heavy rain	-0.613	0.087	<0.001	***
Light rain	-0.434	0.085	<0.001	***
Access walking time (min)	-0.075	0.012	<0.001	***
Autonomous (1:AT available; 0:else)	0.069	0.073	0.345	
Autonomous Waiting time (min)	-0.029	0.017	0.087	*
Personal bike ownership (1: bike owner; 0:else)	0.505	0.082	<0.001	***
Employment(1: employed; 0: else)	0.433	0.126	<0.001	***
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