Transportation Institute
UNIVERSITY of FLORIDA

Exploring the potential of shared e-scooters as a last-mile complement to public transit

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7th Annual UTC Conference for the Southeastern Region @ FAU

Herbert Wertheim College of Engineering
Transportation Institute

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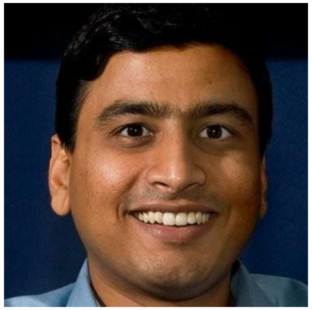
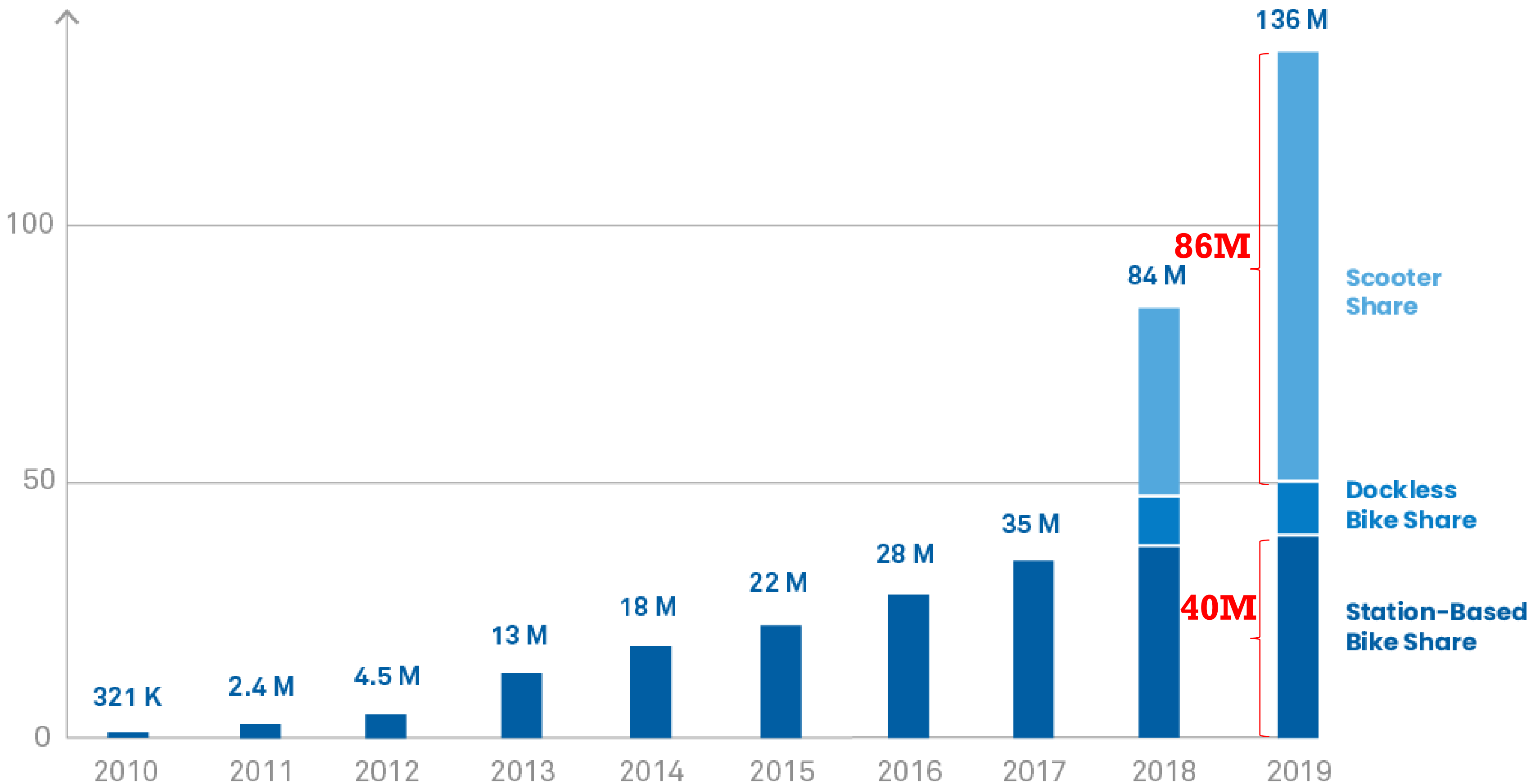


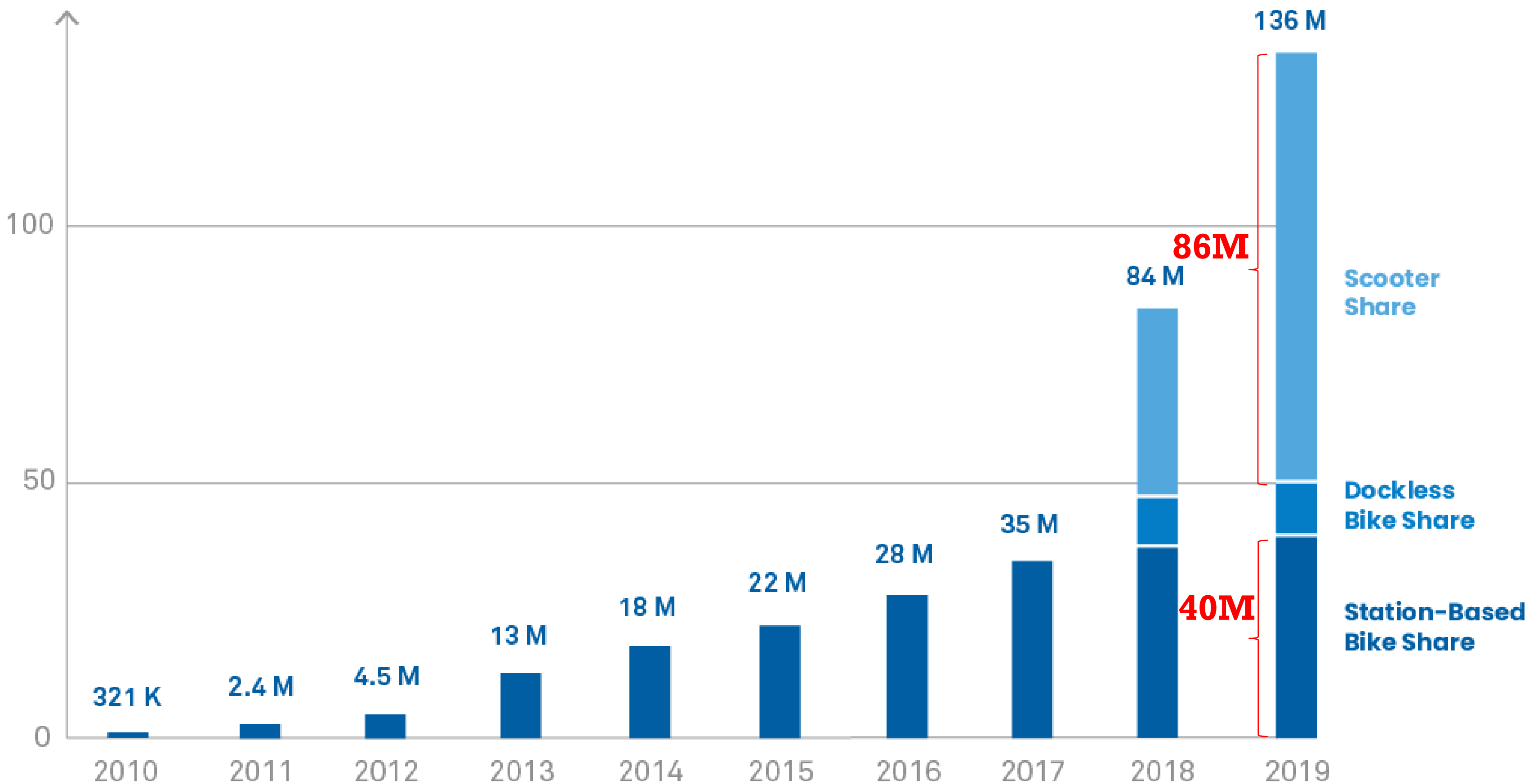
Siva Srinivasan
Associate Professor
University of Florida

The rise of shared micromobility



Source: National Association of City Transportation Officials, 2020

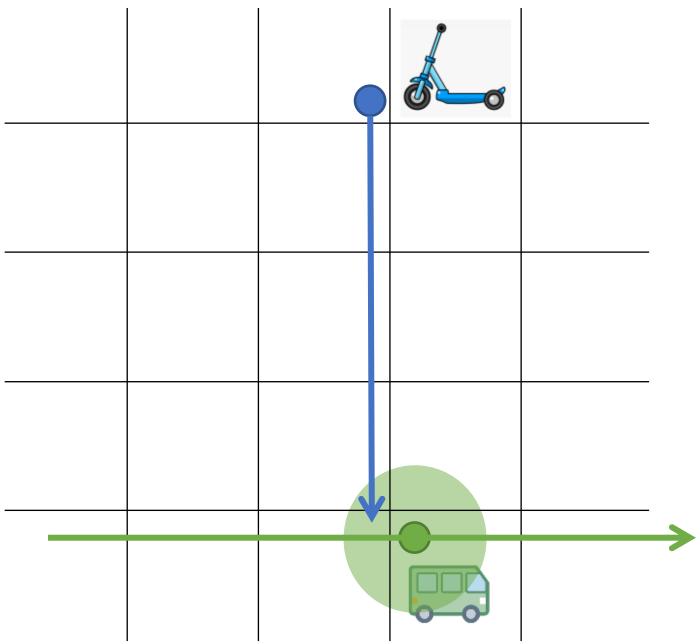
The rise of shared micromobility



Source: National Association of City Transportation Officials, 2020

Shared micromobility has enhanced the resiliency of public transportation systems since 2020 (the COVID era).

Long-term complementary effect: First/last-mile feeder to transit?

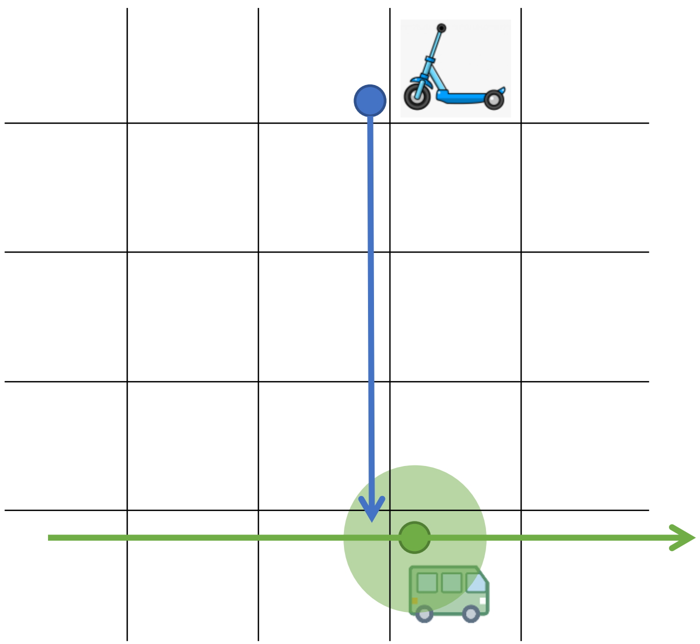


First-/last-mile feeder to transit

State-of-industry report (NABSA, 2021, aggregation of survey results):

- ~50% of people had used e-scooters to connect with transit at least once;
- ~16% of all e-scooter trips are made to connect with transit

First/last-mile feeder to transit?



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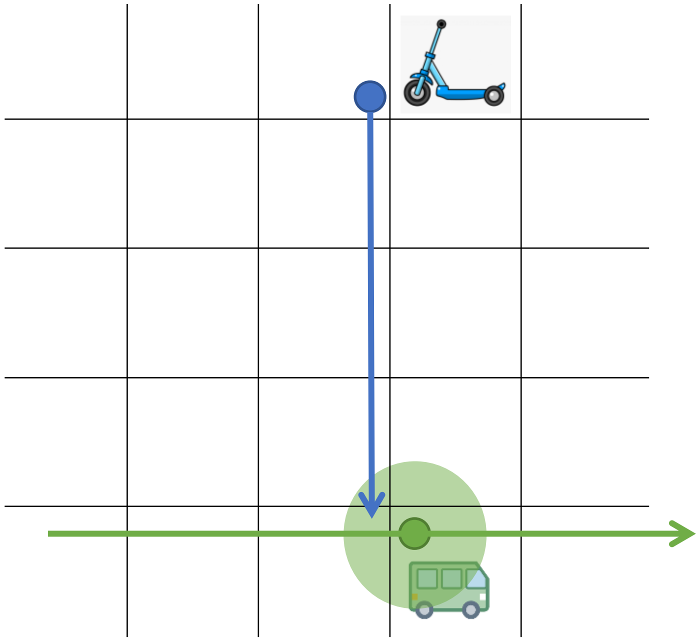
Large **variations** across cities (see survey findings shown in Ziedan et al., 2021, TR-D, Table 1).

First/last-mile feeder to transit?



First-/last-mile feeder to transit

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Analysis of **trips** (Yan et al., 2021):

- Before COVID, **8%-12%** of all e-scooter trips in Washington DC were **rail-connecting** trips.

What can be done to <u>increase</u> the use of e-scooters as a last-mile feeder to public transit?

1) Place enough e-scooter parking spaces (and charging stations) at transit stops

2) Improve the bike infrastructure surrounding transit stations

3) App and fare integration

4) Bundled pricing

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4) **Bundled pricing**

How effective are these strategies?

So far, little has been done yet in practice to promote the integration of e-scooters with transit…

A stated-preference survey

385 total responses, 271 valid responses

University of Florida Transportation Institute

March 2 ·

Residents, workers, and frequent visitors of Washington D.C.:

Researchers at the University of Florida Transportation Institute need your help with completing a survey to understand people's travel behavior as it relates to e-scooters and public transit.

The survey is part of a project that aims to understand people's travel behavior and to help e-scooters function as an essential component of the transportation ecosystem. The researchers are collaborating with Spin, an e-scooter company, on this project.

Please consider helping out by completing the 15-minute survey at the link below. For your participation, you will receive a $5 Spin rider credit. Thank you!

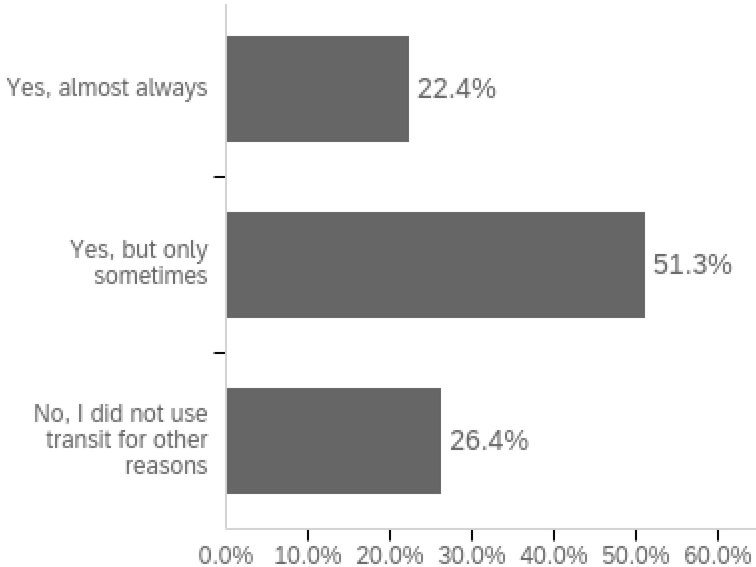
Survey link: https://ufl.qualtrics.com/jfe/form/SV_0TGdz2aBDwY7fFk

SPIN

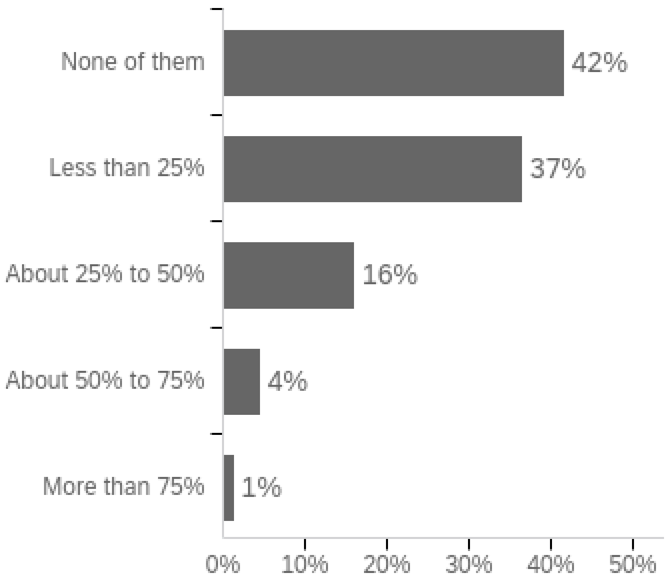
Socioeconomic profile of survey respondents

	Respondent Count	Sample Percentage	City Percentage
Sample size	257	100.0%	
E-scooter user[1]	137	53.3%	
Transit user[1]	115	44.7%	
Gender			
Female	105	40.9%	52.6%
Male	152	59.1%	47.4%
Race/ethnicity			
Hispanic	7	2.7%	11.3%
White	177	68.9%	46.0%
Black	28	10.9%	46.0%
Have a college degree	224	87.2%	59.7%
Age			
18-24	27	10.5%	12.6%
25-29	62	24.1%	14.3%
30-39	90	35.0%	24.8%
40-49	44	17.1%	14.9%
50-59	17	6.6%	12.7%
60-69	9	3.5%	11.0%
70 or over	8	3.1%	9.8%
Household income			
Less than $25,000	14	5.8%	16.2%
$25,000-$49,999	27	11.3%	13.1%
$50,000-$74,999	34	14.2%	12.1%
$75,000-$99,999	44	18.3%	11.0%
$100,000-$149,999	53	22.1%	16.2 %
$150,000 or more	68	28.3%	31.3%

Survey questions related to the last-mile issue

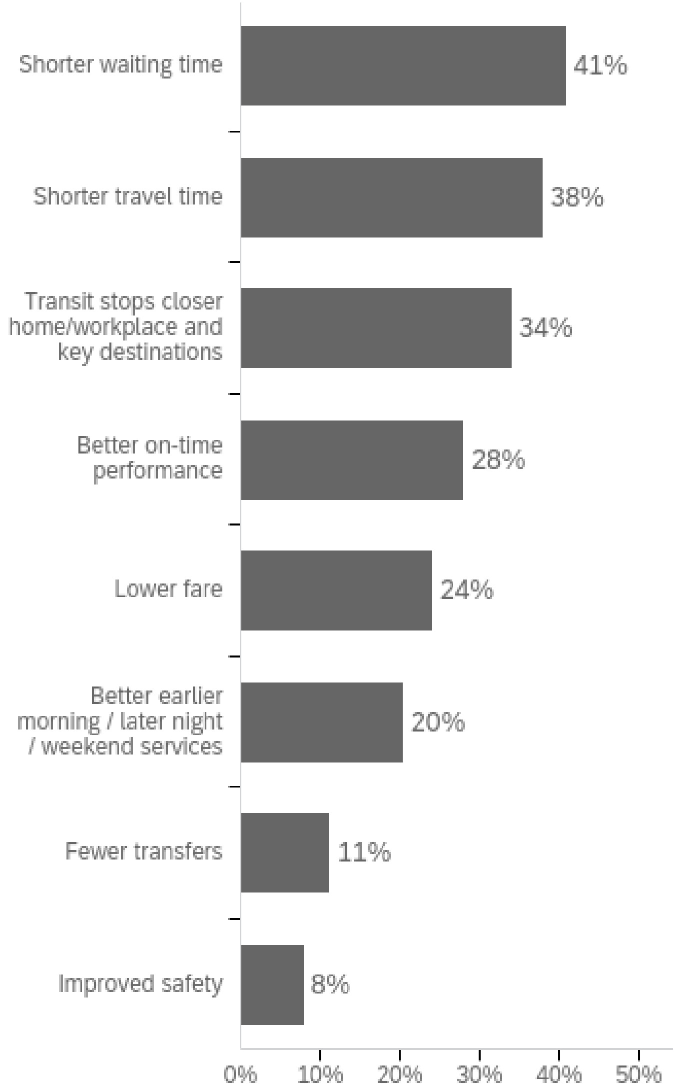


If the last-mile problem a main reason for not using public transit (N=278)

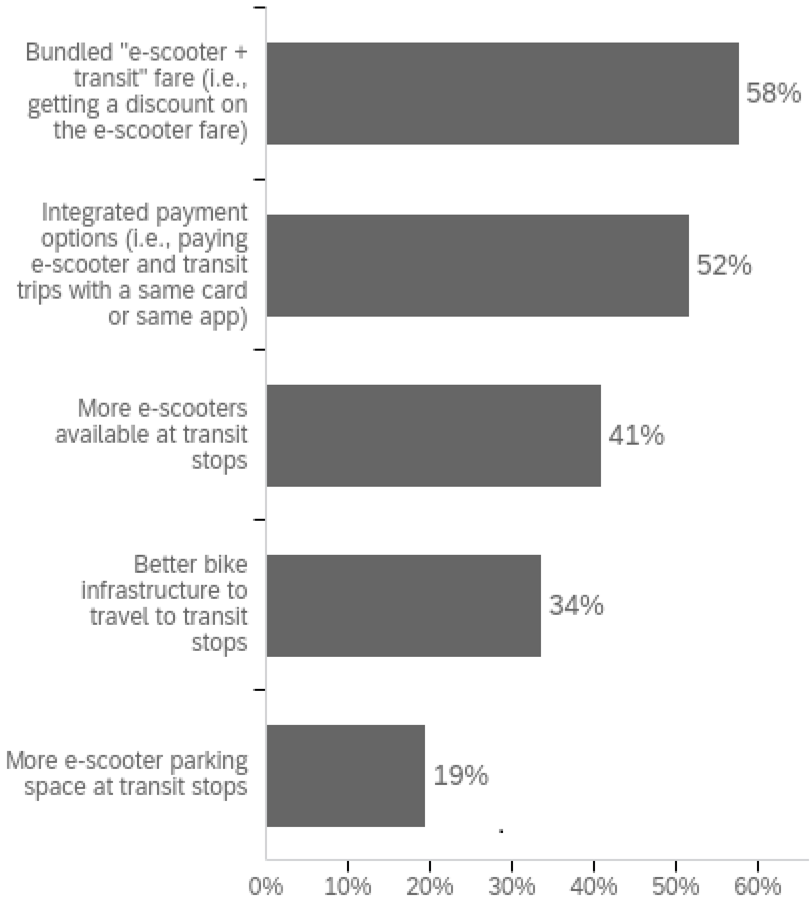


Percentage of e-scooter trips serving as feeder trips to public transit (N=157)

Survey questions related to the last-mile issue



Improvements that will increase use of public transit (N=269)



Changes that can increase use of e-scooters to connect with public transit (N=150)

Behavioral experiments to solicit traveler responses to scenarios of combined “transit+e-scooter” trips

Consider the following choice situation:

	Personal vehicle	E-scooter	E-scooter+Metro
Travel cost	\$3.1	\$7.4	\$4.57
Total travel time	20 min	20 min	13.1 min

Note: the travel cost for personal vehicle includes parking costs and estimated gas costs.

Which travel option would you choose?

- Personal vehicle ○
- E-scooter ○
- E-scooter + Metro ○

Design stated choice experiments (SCEs) by pivoting off a self-reported trip

In this trip, approximately how many **minutes** did you spend on each of the following? Please replace the 0s below with **numbers**.

Based on your response above, the four numbers to be inserted should add up to 20 minutes.

	Minutes spent
Walk to car	1
Drive/ride in the car	15
Find parking	3
Get to destination from parking lot	1
Total	20

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Which travel option would you choose?

- Personal vehicle
- E-scooter
- E-scooter + Metro

Experiment design of the stated choice experiments

TABLE 1: Profiles of the nine stated choice experiments

Experiment	E-scooter speed	E-scooter pricing	Transit type[1]	incentive
1	12 mph	\$1 to unlock, ¢32 per min	Rail	Waiver of unlock fee
2	6 mph	\$1 to unlock, ¢32 per min	Bus	Waiver of unlock fee
3	9 mph	\$1 to unlock, ¢32 per min	Rail	50% off e-scooter fare
4	12 mph	\$1 to unlock, ¢32 per min	Bus	25% off e-scooter fare
5	9 mph	\$1 to unlock, ¢32 per min	Bus	25% off e-scooter fare
6	9 mph	\$1 to unlock, ¢40 per min	Bus	Waiver of unlock fee
7	6 mph	\$1 to unlock, ¢32 per min	Bus	50% off e-scooter fare
8	12 mph	\$1 to unlock, ¢40 per min	Bus	50% off e-scooter fare
9	6 mph	\$1 to unlock, ¢40 per min	Rail	25% off e-scooter fare

[1]Note: For bus, the travel speed is set as 10 mph and the transit fare is set as \$2; for rail, the travel speed is set as 35 mph and the transit fare is set as \$3.

Each person answered **five** SCEs customized to their own trip experience

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- Personal vehicle ○
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- E-scooter + Metro ○

Discrete choice modeling

$$U_{Car} = ivtt * IVTT + ivtt * OVTTDIST + ovttdist * OVTTDIST + costinc * COSTINC$$

$$U_{Walk} = ASC_{Walk} + ivtt * OVTTDIST + ovttdist * OVTTDIST$$

$$U_{Transit} = ASC_{Transit} + ivtt * IVTT + ivtt * OVTTDIST + ovttdist * OVTTDIST + costinc * COSTINC$$

$$U_{FHV} = ASC_{FHV} + ivtt * IVTT + ivtt * OVTTDIST + ovttdist * OVTTDIST + costinc * COSTINC$$

$$U_{Es} = ASC_{Es} + ivtt * OVTTDIST + ovttdist * OVTTDIST + costinc * COSTINC$$
$$+ Esuser_{Es} * ESCOOTERUSER + AgeBelow40_{Es} * AGEBELOW40 + white_{Es} * WHITE + male_{Es} * MALE$$

$$U_{Es+T} = ASC_{Es+T} + ivtt * IVTT + ivtt * OVTTDIST + ovttdist * OVTTDIST + costinc * COSTINC$$
$$+ esuser_{Es+T} * ESCOOTERUSER + transituser_{Es+T} * TRANSITUSER + lowincome_{Es+T} * LOWINCOME$$
$$+ AgeBelow40_{Es+T} * AGEBELOW40 + white_{Es+T} * WHITE,$$

Six travel modes:

- Driving
- Walking
- Transit
- For-hire vehicle (Taxi & Uber/Lyft)
- E-scooter
- E-scooter+ transit

Model outputs

Variable	Alternatives	Multinomial logit		Mixed logit	
		Coeff.	z value	Coeff.	z value
Constants					
Walk	Walk	0.973**	2.40	-0.131	-0.21
Transit	Transit	-0.014	-0.06	-1.150	-1.14
For-hire vehicle	For-hire vehicle	-0.747**	-2.37	0.196	0.23
E-scooter	E-scooter	-1.686***	-5.40	-2.294	-1.31
E-scooter+transit	E-scooter+transit	-1.486***	5.37	-3.980	-1.33
level of service variables					
In-vehicle travel time	All modes	-0.052***	-6.60	-0.189***	-6.64
Out-of-vehicle travel time (divided by trips distance)	All modes	-0.198***	-6.86	-0.638***	-6.38
Trip cost (divided by household income)	All modes	-0.333***	-5.48	-2.862***	-6.93
Random parameter standard deviations					
Walk	Walk			1.091***	3.74
Transit	Transit			1.131**	2.54
For-hire vehicle	For-hire vehicle			0.605**	2.11
E-scooter	E-scooter			0.815**	2.35
E-scooter+transit	E-scooter+transit			1.121**	1.99
In-vehicle travel time	All modes			0.189**	6.64
Out-of-vehicle travel time (divided by trips distance)	All modes			0.638***	6.38
Trip cost (divided by household income)	All modes			2.862***	6.93
Sociodemographic variables					
Male	E-scooter	0.079	0.42	-0.019	-0.03
	E-scooter+transit	0.029	0.15	-0.465	-0.99
Age below 40	E-scooter	0.368*	1.94	0.757	1.12
	E-scooter+transit	0.022	0.10	0.314	0.53
White	E-scooter	-0.642***	-3.13	-1.153*	-1.65
	E-scooter+transit	-1.095***	-5.37	-1.941***	-3.30
Household income <$25,000	E-scooter+transit	0.591**	2.56	0.620	1.05
E-scooter user	E-scooter	1.013***	5.37	1.221*	1.93
	E-scooter+transit	0.339*	1.73	0.292	0.53
Transit user	E-scooter+transit	0.198	1.06	0.444	1.03
Number of observations		238		238	
Log likelihood at convergence		-773.34		-568.04	
Log likelihood at NULL		-1021.65		-1021.65	
McFadden Pseudo R2		0.24		0.44	

- Results largely consistent with expectation
- **Non-white and low-income** people have a **stronger tendency** to choose the **"e-scooter+transit"** option (Sanders et al., 2020, TR-A)
- Significant preference heterogeneity among respondents

Simulating market shares under various bundled "transit and e-scooter" pricing schemes

Bundled pricing incentive	Car	Walk	Transit	FHV	E-scooter	"Es + T"	Market share gains
Baseline	18.4%	16.9%	28.8%	6.7%	18.3%	10.9%	
25% off e-scooter fare	18.3%	16.8%	28.6%	6.6%	18.1%	11.6%	**0.7%**
50% off e-scooter fare	18.2%	16.8%	28.3%	6.5%	17.9%	12.3%	**1.4%**
$1 off e-scooter fare	18.3%	16.8%	28.5%	6.6%	18.1%	11.7%	**0.8%**
$3 off e-scooter fare	17.8%	16.5%	27.5%	6.3%	17.1%	14.7%	**3.8%**

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Potential Market share gains would be greater if the last-mile e-scooter trip leg is longer.

Next steps

1) Supplementary survey data collection in **Arlington, VA** and a similar survey conducted in **Los Angeles** (ongoing)

2) **Validating** stated-preference survey results with Spin trip GPS data

3) Examining where & when e-scooters are used as a last-mile feeder

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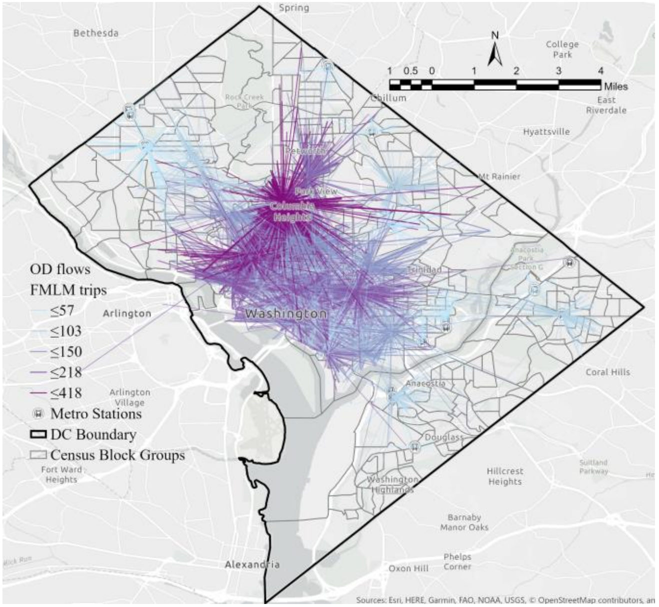

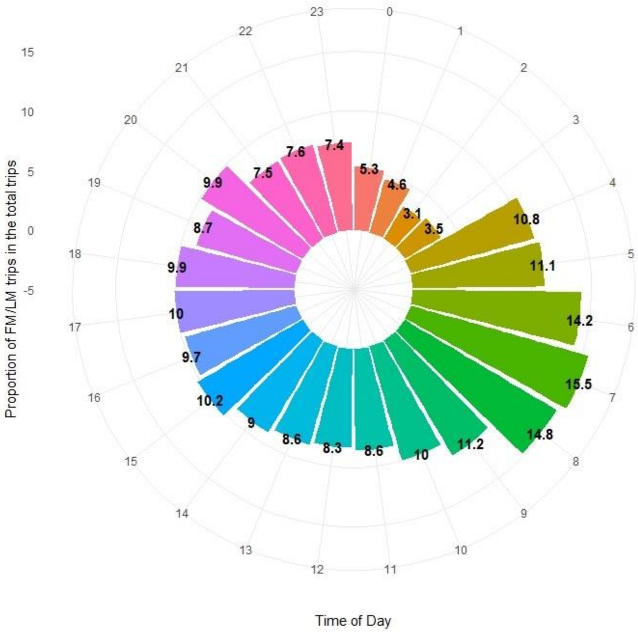

Conclusion remarks

1) Integrating e-scooters and transit can promote **equity.**

2) Cities with a **less dense transit network** have more to gain from bundled pricing incentives;

3) Bundled pricing has potential; need to be coupled with other strategies such as **app/fare integration and infrastructure improvements**

Micromobility collaborative research program

Data

Processing GBFS data

Collecting survey data

Research areas

Modeling demand

Micromobility & public transit

Micromobility & social equity

Policy/practice

AI-enabled real-time operations

Planning for Mobility hubs

Micromobility Policymaking

Tech transfer

Micromobility management platform (3-min video demo)

RESEARCH PROJECTS

UF College of Design, Construction and Planning

UF Transportation Institute UNIVERSITY of FLORIDA

SERMOS LAB

Collaborators

SPIN

Ford

UAB THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

FAU FLORIDA ATLANTIC UNIVERSITY

FIU FLORIDA INTERNATIONAL UNIVERSITY

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

UF Transportation Institute
UNIVERSITY of FLORIDA

Thank you for your attention!

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