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Quantifying and Understanding the Access Time to Dockless Micromobility: A Case Study in Washington, D.C.

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OVERVIEW

- To inform the **modeling of micromobility operations** and evaluate the **equity aspects of micromobility programs**, this research
  - Quantifies the **access time to dockless micromobility.**
  - Analyzes micromobility's **spatial and temporal variation patterns.**
  - Investigates micromobility's **correlation with socio-demographic variables** (i.e., population density, employment density and low-income population).

MOTIVATION

- Access time to a micromobility vehicle is not only an important performance metric that **affects micromobility demand,** but is also a variable that **micromobility operators** need to consider in order to plan for **efficient micromobility operations.**

- Access to micromobility is also **a critical indicator for city agencies to ensure equitable access from a regulation perspective.** For example, Seattle, WA, requires 10% of its fleet to be assigned to disadvantaged communities. Baltimore, MD, requires 25% of its fleet to be available in underserved communities.

- Shared micromobility programs have been deployed in several cities. The need to understand and quantify access time to micromobility service is growing, but the topic has not yet been fully studied.

Literature Review

- Access to transit services shares some similarities with access to shared micromobility. Insights from the studies on access to transit:
  - Transit catchment area affects transit demand.
  - Ideal access range to transit services should vary by trip characteristics and built-environment factors.
  - Access to transit services is positively correlated with poverty level and affects the overall transit accessibility.

- Existing analysis on access to micromobility:
  - Mostly focused on docked-station-based system. Metrics such as population within catchment area and average number of bikes available per resident per day have been used by researchers.
  - Access distance imposes a greater penalty on micromobility demand compared to transit demand.
  - For dockless micromobility, metrics such as average distance to k-closest scooters and area under the scaled cumulative relative frequency curve are used in literature.

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METHOLOGY

Metric

Access time to reach dockless micromobility service (i.e., walking time needed to reach the nearest shared dockless micromobility vehicle).

Data Collection

Step 1: Divide the study region into 0.1 × 0.1-mile grids. Areas covered by water bodies were excluded.

Step 2: Query dockless micromobility company application programming interfaces (APIs) to obtain real-time vehicle locations.

Step 3: Use grid cell centroids as origins and search for the nearest available micromobility vehicle.

Step 4: Calculate the distance between centroids and nearest vehicle locations and convert it to walking time (speed = 3 mph).

Step 5: Aggregate grid-level access time to census block group level by taking the median.

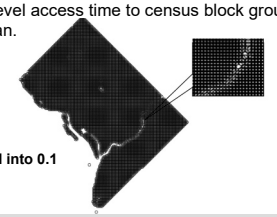


Figure 1. D.C. region divided into 0.1 × 0.1-mile grids to evaluate micromobility access time.

Data collected every 15 minutes between May 2 and May 13, 2022.

Data contain the location information for more than 11,000 micromobility vehicles in Washington, D.C.

Table 1 Micromobility API Data Structure

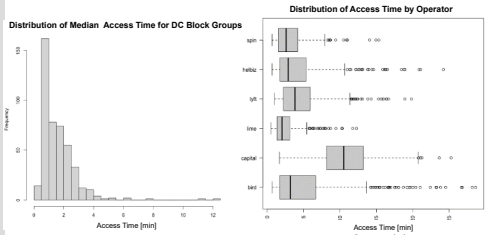
Variables	Providers					
	Bird	Capital	Lime	Lyft	Helbiz	Spin
data.bikes.lat	x	x	x	x	x	x
data.bikes.lon	x	x	x	x	x	x
data.bikes.is_reserved	x	x	x	x	x	x
data.bikes.is_disabled	x	x	x	x	x	x
data.bikes.vehicle_type	x		x	x		x
data.bikes.type		x			x	
data.bikes.bike_id	x	x		x	x	x

Note

- data.bikes.lat: the latitude of vehicle locations.
- data.bikes.lon: the longitude of vehicle locations.
- data.bikes.is_reserved: if a bike is reserved or not; if yes, it is not considered an available vehicle in the search.
- data.bikes.is_disabled: if a bike is functioning or not; if no, it is not considered an available vehicle in the search.
- data.bikes.vehicle_type and data.bikes.type: the vehicle types including scooter, bike, and e-bike.
- data.bikes.bike_id: vehicle identification.

RESULTS

Access Time Overall Distribution

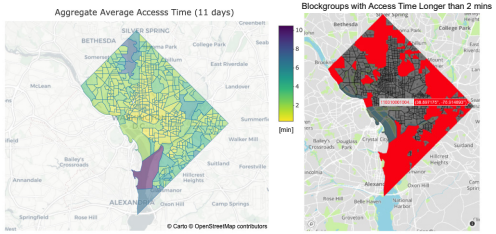


- Based on data across all operators, the typical access time to dockless micromobility was **0.5–2 minutes.**
- When the data of operators were evaluated separately, among operators, Lime had overall shorter access time than other operators.

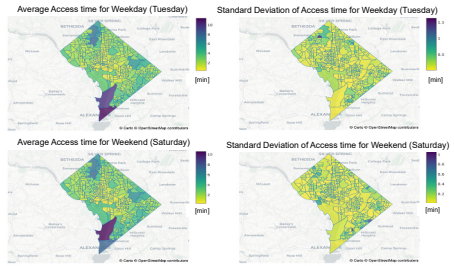
- Census block groups **closer to the city center** had **shorter access time** to micromobility service (<2 min. on average).
- Census block groups **on the edges of the core city** or **large census block groups near the city center** have **longer access times to micromobility service.**

- The access time stays quite stable for various times of day or days of the week.

Spatial Distribution of Access Times



Temporal Distribution of Access Times



Correlation with Sociodemographic Variables

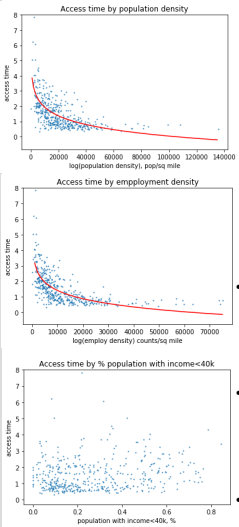


Table 2 Regression Coefficients and Metrics for All Models

Variables	Access time & pop density	Access time & employ density	Access time & pop % income<40k
Intercept	9.570***	8.46***	1.296***
Log(pop density)	-0.828***		
Log(employ density)		-0.77***	
Low-income pop %			1.021***
R-square	0.36	0.41	0.028
Adjusted R-square	0.36	0.41	0.026

Note: *** represents significant level 0.01

- **More densely populated or employed areas** imply **lower access times**, as operators typically target locations with higher probability of demand.
- Access time to micromobility **does not vary** much for census block group with higher percentage of **low-income (<$40,000) population**.
- Access to dockless micromobility in Washington, D.C. is equitable in terms of access time.

CONCLUSIONS

- Access time to dockless micromobility ranges from 0 to 4 min. in the D.C. region, and the most frequently observed range is 0.5 to 1 minute.

- City center tends to have shorter access time than the outskirts. Census block groups with higher than 2-minute access time are mostly located far from the city center.

- Access time to dockless micromobility services is quite stable in D.C. Standard deviation of access time across all 15-minute segments over the course of a day is mostly within 0.5 minutes for weekdays and 0.2 minutes for weekends.

- Shorter access time usually aligns with higher population density and employment density. Low-income population (defined as the percentage of population with income lower than $40,000) did not explain the access time variation, which points to equitable micromobility access for low-income groups in D.C.

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