A DAY IN THE LIFE OF CHICAGO'S E-SCOOTER PILOT PROGRAM

Measuring System Performance Using Real Time Data

BY C. SCOTT SMITH, PH.D., AND JOSEPH P. SCHWIETERMAN, PH.D.

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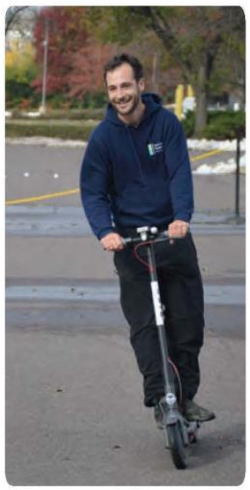

JULY 2019

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SUMMER 2019 | CHADDICK INSTITUTE POLICY BRIEF

THE STUDY TEAM

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COVER PHOTOGRAPHY TOP: MICHAEL STOKES, CREATIVE COMMONS LEGAL CODE
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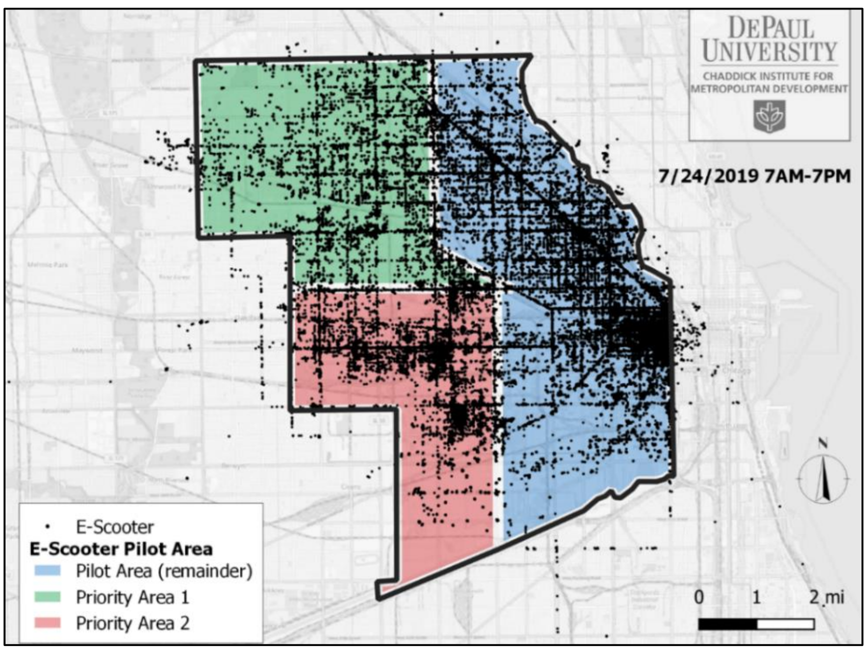
We are nearly two months into Chicago's E-Scooter Pilot Program, which is set to run between June 15 and October 15 this year. Yet there exists only a limited amount of information about how the system has performed, both *generally* (with regard to the number of vehicles and frequency of trips) and *specifically* (with respect to how the ten permitted operators have collectively performed relative to the city's relatively strict service-level requirements).[1]

This policy brief seeks to offer perspective on the performance of e-scooters by recounting "a day in the life" of the program on **Wednesday, July 24, 2019**—a sunny day with a high of about 75° Fahrenheit, allowing for attractive conditions for scootering. The report draws on information downloaded via real time data streams made available via operator-specific APIs. (Hosting an Application Programming Interface, or API, with information about the number, location, and availability of e-scooters is a requirement for program participation.[2]) The data, including a unique vehicle identifier and latitude and longitude for each deployed scooter, were collected at two-minute intervals between 7am and 7pm on this day, translating into 3,600 queries yielding 571,124 observations. Together, these data allowed for a relatively fine-scale analysis of scooter use and movement over time.

Figure 1. Distributions of E-Scooters over 12-Hour Study Period at Two-Minute Intervals, July 24, 2019



[1] *Reports about trip volumes include Lynda Lopez's July 30, 2019 article in StreetsBlog Chicago, which highlights a report by Lime stating that its scooters have accounted for over 65,124 miles in about six weeks, and Mary Wisniewski's June 27, 2019 article in the Chicago Tribune, which reports that the program had logged 60,000 trips in its first week. With regard to incidents, John Greenfield's July 30, 2019 article in StreetsBlog Chicago details six scooter-related injuries. Compliance-related reports in Curbed Chicago on July 12, 2019, Block Club Chicago on July 12, 2019, and NBC on July 23, 2019 discuss how several of the scooter companies had been cited by the City of Chicago for a failure to comply with the program's relatively strict speed and safety requirements.*

[2] Accessing API data streams for the e-scooter company VeoRide requires authorization, so most data for that provider used in this report was provided directly by VeoRide staff. See Methodology Notes on page 11.

The aggregated two-minute snapshots of e-scooter locations throughout the single-day period are depicted in Figure 1. The figure suggests that some leakage occurs, **with a little over two percent of the total e-scooter trip durations spilling over to areas outside the permitted pilot area** over the single-day study period. Some of these trips, however, involve riders traveling outside the pilot area on trips between origins and destination within the pilot area.

On this day…

1. Operators are generally deploying fewer e-scooters than the 250 authorized in the pilot program, with some deploying fewer than 100. Among the ten operators, the total number of e-scooters deployed varied from a maximum of 1,631 at 11:51 am to a minimum of 1,339 at 6:28 pm, with an overall average of 1,486 vehicles available.

Past reports have largely assumed that the companies are maximizing their allotted share of 250 e-scooters. Our analysis, however, suggests that most deploy, on average, considerably smaller numbers. The average number of e-scooters by operator calculated over the two-minute intervals during our study day is shown in Table 1. Wheels, on average, deployed slightly over 283. Lime and JUMP deployed 221 and 165 respectively. Clevr Mobility had less than 10 e-scooters available during the study period (see note a). The API for e-scooter company VeoRide was not open to public access on July 24 without an advance arrangement with the provider; however, the VeoRide team provided us archival data and subsequently provided access to its API that was used for portions of the analysis (see page 11).

The average number of e-scooters simultaneously deployed on the street was 1,486, well below the 2,500 maximum. A second and more recent snapshot, collected at a single point in time on Monday, August 12, 2019, showed 1,754 e-scooters, suggesting that the number has risen while remaining well below the maximum. Much of the rise was attributable to Bolt, Lyft, Sherpa, and Spin.

Table 1. Average Number of E-Scooters Deployed by Operator

	E-Scooters Deployed	
E-Scooter Operator	Wednesday, July 24, 2019*	Monday, August 12, 2019**
Wheels	283.4	298
Lime	221.3	210
VeoRide (note a)	210.0	210
JUMP (Uber)	164.7	140
Bird	149.9	141
Sherpa	144.5	213
Lyft	126.1	200
Bolt	93.7	159
Spin (note b)	90.8	181
Clevr Mobility (note b)	2.0	2
Total	**1,486.4**	**1,754**

** Average number available between 7am – 7pm, with data collected in two-minute intervals*

*** At a single point in time on this day (11:24am)*

a. VeoRide's estimate is based on information provided directly from the provider to the data team. This data was determined to be representative of both July 24 and August 12, 2019. See page 11.

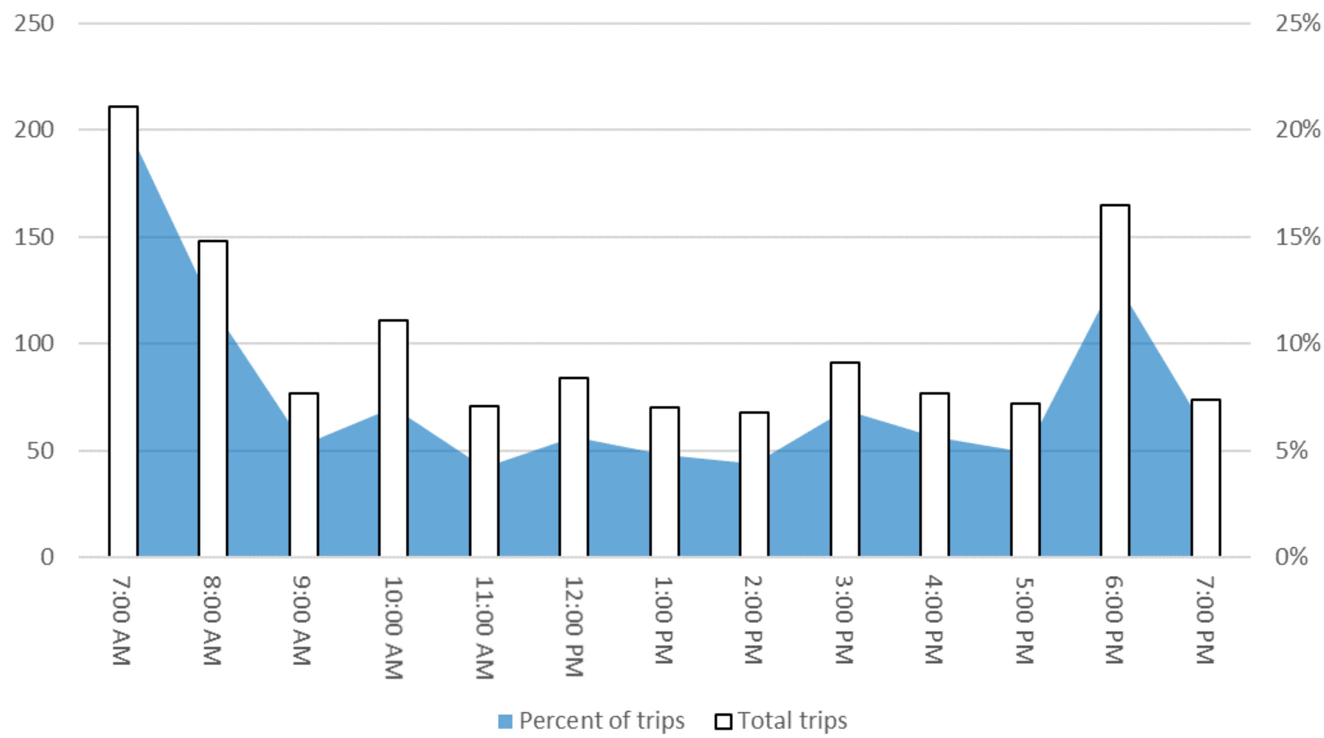
b. Our reconciliation analysis suggests that a small number of e-scooters for these operators may be missing from APIs for Spin and Clevr Mobility. The discrepancy is estimated to be less about 20 e-scooters for Spin and seven or eight for Clevr. See page 11.

Are API data streams accurate? The possibility exists for discrepancies between API data streams and actual e-scooters available on the street. However, our reconciliation analysis suggests that differences are small, provided that analysis accounts for warehouses and storage areas. See methodology discussion on page 11.

2. During the twelve-hour period observed, usage was highest during the morning peak, with 37% of all trips occurring between 7am and 9am. The afternoon/evening peak, from 5pm to 7pm, conversely, accounted for 23% of the trips.

The observed peaking pattern suggests that riders tend to use e-scooters near the beginning of their morning commutes and toward the end of their evening commutes—a pattern consistent with the hoped-for "first mile/last mile" role of e-scooters. The higher levels during the early morning likely reflects a heightened sense of urgency that users feel going *to* work compared to returning *from* work. It may also reflect a more optimal geographic distribution of e-scooters at the start of the day due to night-time rebalancing.

Figure 2. Number and Percentage of E-Scooter Trips by Hour of Day, July 24, 2019, 7am-7pm



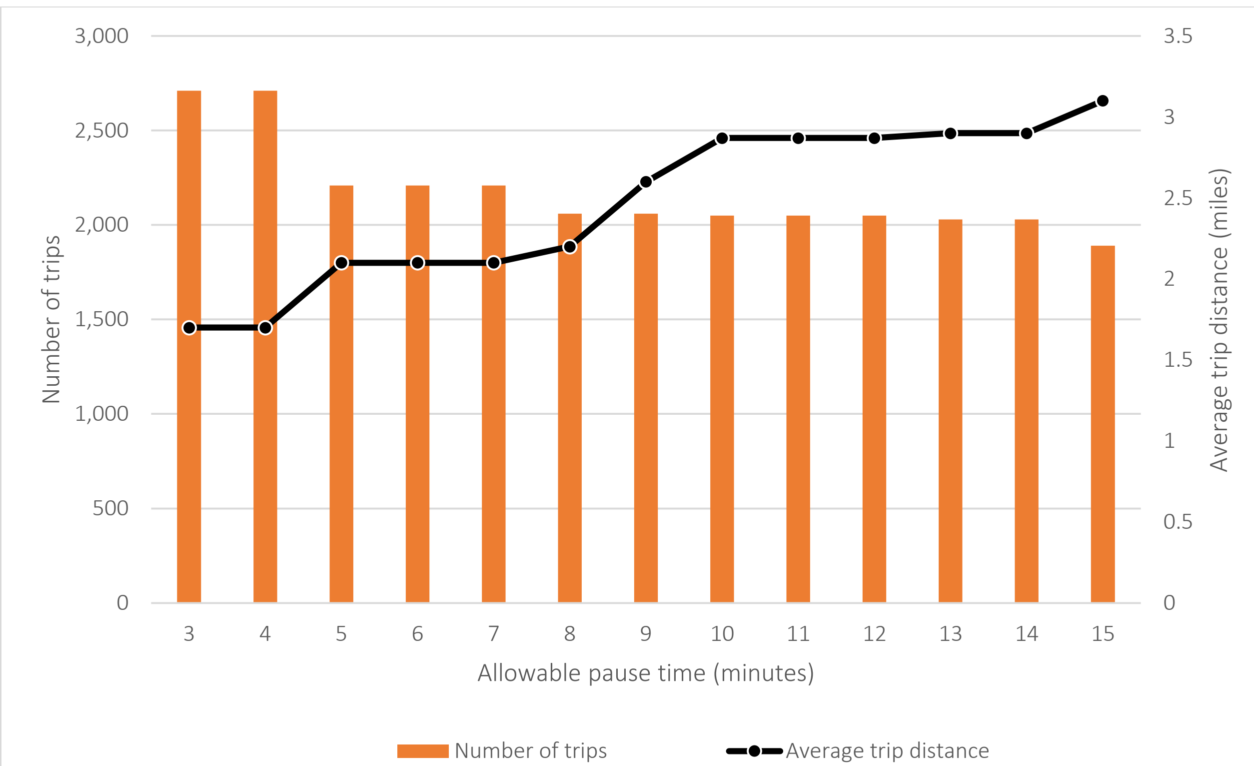
Note: this data does not include VeoRide, which provided data in aggregate form that did not allow for time-of-day analysis.

3. Analysis of API data from the ten operators indicates there were 2,620 unique trips over the 12-hour period, with a mean distance of 2.0 miles. This estimate is based on a three-minute *pause standard*, i.e., a standard in which the assumption is made that after an e-scooter pauses at a specific location for a least ten minutes, the next movement is counted as a separate trip. If the pause standard is increased to 10 minutes, the number of trips rises to about 2,032 and trip distances rise to 2.8 miles.

In order to understand the manner in which scooters are being used, we estimated travel duration, the actual number of trips, and trip distances. This was done by ordering the data first by e-scooter then by time of day to detect any changes in vehicle locations. The initiation of trips (or trip starts/origins) were identified when an e-scooter was estimated to have moved at least 50 meters in two minutes, whereas a pause time exceeding three minutes marked the end or destination of a trip.

The sensitivity of the allowable pause time parameter to trip frequencies and average trip distances is shown in Figure 3. Excluded from the analysis were e-scooter movements that exceeded 15 mph; the maximum (allowable) e-scooter velocity. It was thought that higher-velocity displacements were likely due to the hauling of e-scooters by a motorized vehicle for the purpose of charging or rebalancing.

Figure 3. Sensitivity Analysis of *Pause Time* E-Scooter Trip Estimation Parameter



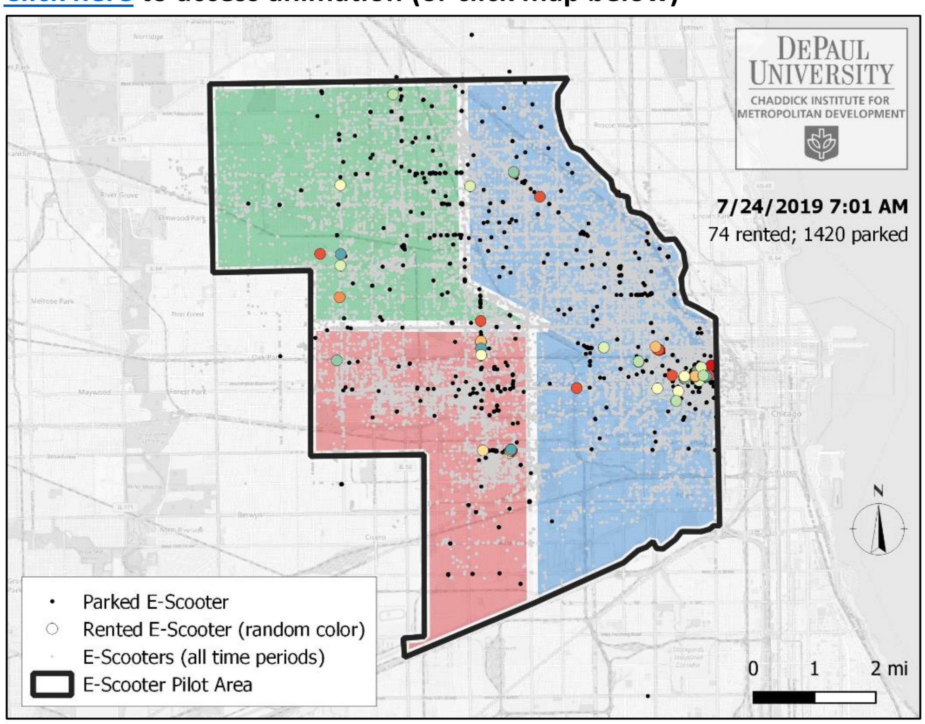
This chart shows estimates of the number of trips for the ten e-scooter operators based on the amount of pause time, i.e., intervals in which the scooter is essentially stationary. If movements after three minutes of pause time are counted as separate trips, 2,620 trips occurred over the 12-hour period. With a 10 minute pause time, 2,032 trips occurred. Average travel distances may include a mix of one-way trips and roundtrips, depending on the number of minutes the e-scooter pauses.

Our estimations of total trips have a similar order of magnitude as reported elsewhere, with some of the differences likely reflecting different estimation methods. Our method counts some roundtrips as a single journey, if the pause time at the destination is below the designated threshold. For example, if a user travels to a convenience store for a quick two-minute stop and then returns home, that journey is counted as one trip using our methodology.

4. Our animation showing e-scooter locations at two-minute intervals offers insights into how e-scooters moved around over the course of the day. It shows that when a particular e-scooter is in use, others are typically available nearby for other customers, and that long-distance trips more than a few miles remain relatively rare, with the highest activity areas near Halsted Street and Wicker Park.

The animation lasts four minutes and shows the enormous variation in usage patterns over the period of time. Active trips (i.e., rented as opposed to parked e-scooters) are depicted in the animation. The share of these trips ranges from a minimum of 71 trips per hour between 11am and noon and a peak of 211 per hour between 7am and 8am. *(Note that while colors are randomly assigned to each active e-scooter, the color is consistent for each trip to allow for some visual tracking of trip-specific movements).* Over 50 percent of these trips took place within four, one-hour periods (7am-8am [20.5%]; 8am-9am [11.7%]; 5pm-6pm [13.0%]; and 6pm-7pm [5.9%]), suggesting that customers tended to use the e-scooters during the peak AM and PM commuting periods. These four hours also comprised over 70 percent of all e-scooter miles traveled and 67 percent of the total trip duration over the study period. The assumption made in the scenario analysis that commuters are the highest-frequency users is supported by these numbers.

Click here to access animation (or click map below)



To copy link to animation, refer to page 11

5. The Near West Side and West Town community areas were the most popular origins and destinations during the study period, followed by Austin and Logan Square. Pockets of relatively intensive use were also prevalent in North Lawndale, West Garfield Park, and other lower-income neighborhoods.

The Near West Side had the largest number of trip starts (622), a total more than the second, third, and fourth ranked origins combined.(Table 2). West Town had 408 trip starts, followed by Logan Square (118) Austin (88). The prevalence of trips involving the Near West Side and West Town reflects both the demographic character of these areas (with many Millennials and young professionals) and their relatively high population density.

Table 2. E-Scooter Pilot Rank and Trip Counts by Origin and Destination by Community Area over July 24, 2019 Study Period

Rank	Community Area	Origins	Rank	Community Area	Destinations
1	*Near West Side*	622	*1*	*Near West Side*	465
2	*West Town*	408	*2*	*West Town*	454
3	*Logan Square*	118	*3*	*Logan Square*	133
4	*Austin*	88	*4*	*Austin*	90
5	*North Lawndale*	55	*5*	*West Garfield Park*	70
6	*Hermosa*	52	*6*	*Belmont Cragin*	63
7	*Belmont Cragin*	51	*7*	*Avondale*	57
8	*Humboldt Park*	40	*8*	*East Garfield Park*	54
9	*Avondale*	39	*9*	*Humboldt Park*	51
10	*Portage Park*	29	*10*	*North Lawndale*	47
11	*East Garfield Park*	24	*11*	*Portage Park*	25
12	*West Garfield Park*	23	*12*	*Irving Park*	23

Among destinations, the distribution was more balanced, with roughly an equal number of trips ending in the Near West Side (465) and West Town (454), followed by Logan Square (133) and Austin (90). West Garfield Park is a prominent *destination* (70), whereas it has only 23 origins. The data suggest that more trips leave the Near West Side than enter it, possibly due to the abundant availability of e-scooters in this area compared to other neighborhoods. (It is easier to find a scooter to leave the neighborhood than to find one to travel to it). Irving Park had a low number of both origins and destinations, partly due to the fact that only about half of the community area is in the pilot zone. These estimates are based on a ten-minute pause standard, a highly conservative scenario with respect to trip estimation (see description, page 4).

Heavy use at the far eastern end of the pilot zone suggests that the eastern boundary is a significant constraint on usage, and that introducing e-scooters to adjacent areas east of Interstate 94 (e.g., the Kennedy and Dan Ryan expressways) would significantly increase trip counts. VeoRide data, provided to us only in aggregate form, are not included in the above estimates.

Figure 4. Distribution of E-Scooter Trip Origins, July 24, 2019 (7am-7pm)

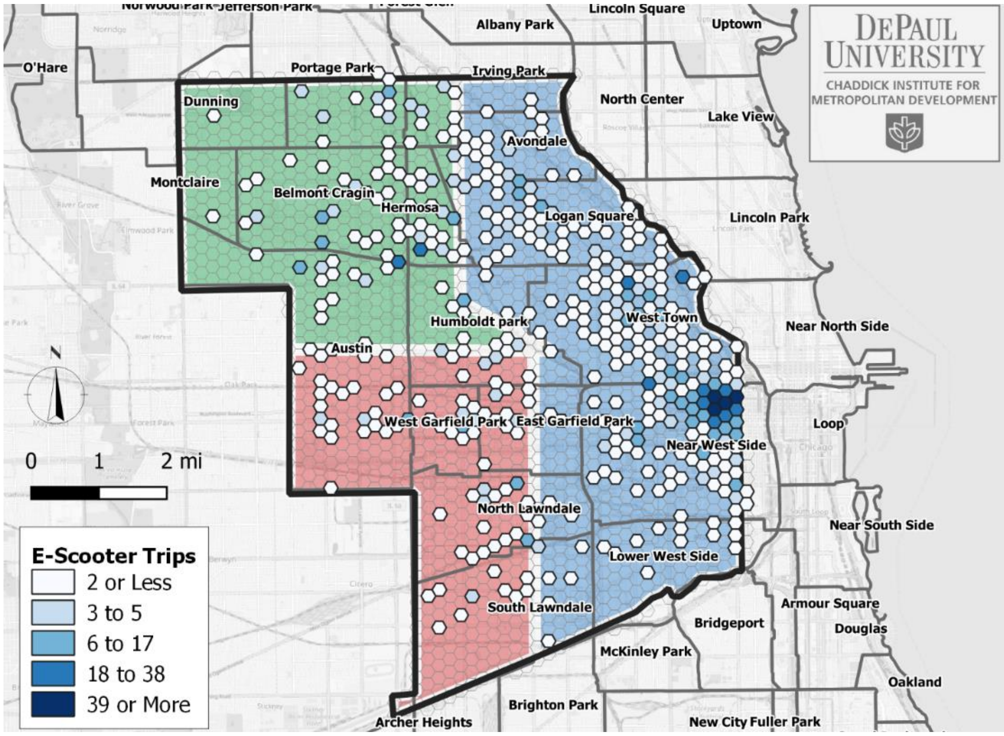
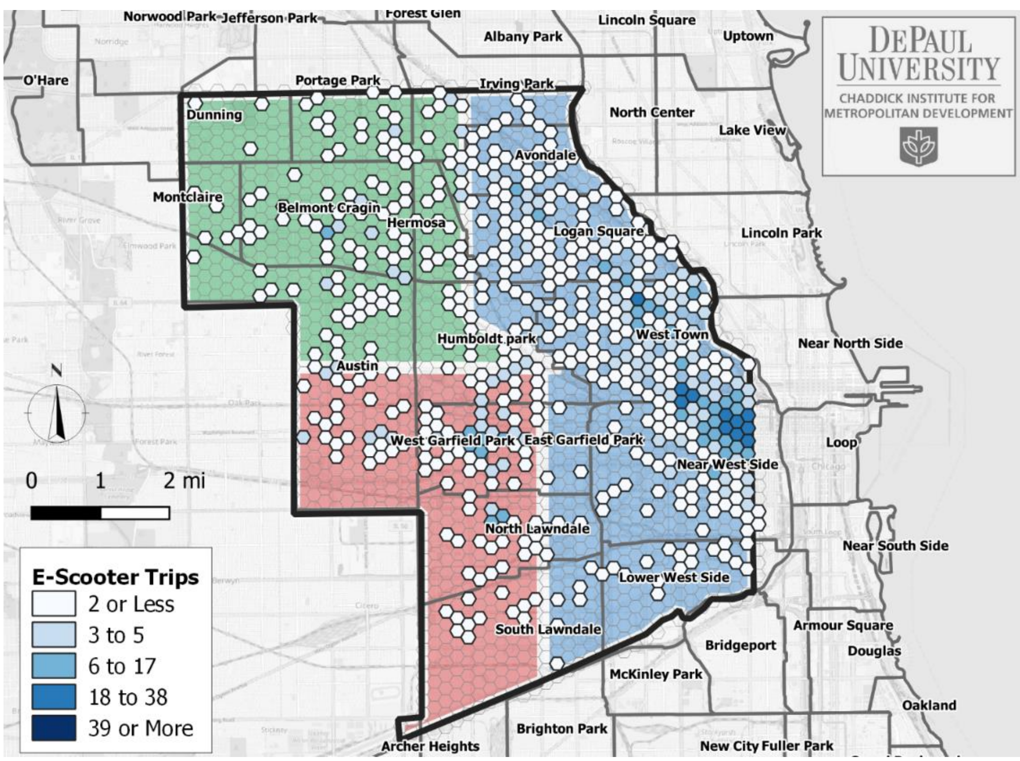


Figure 5. Distribution of E-Scooter Trip Destinations, July 24, 2019 (7am-7pm)

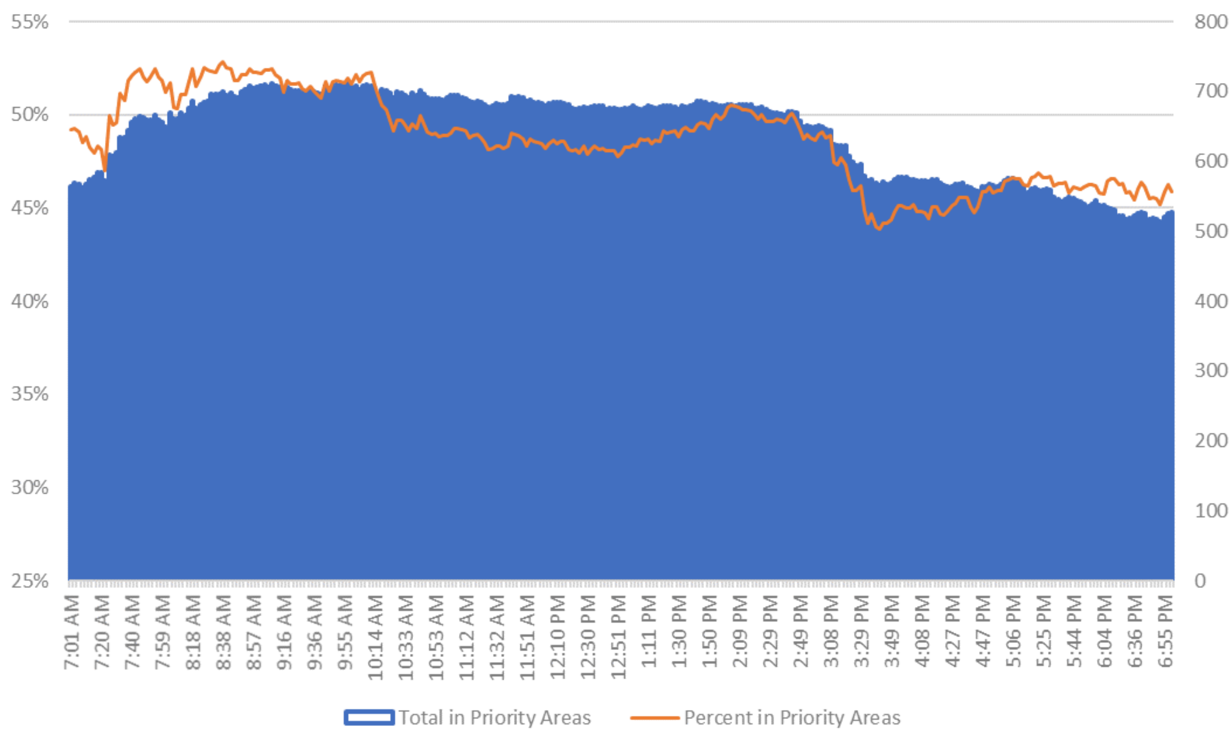


These maps, showing trip frequency by origin and destination, show that usage is most intensive in the Near West and Near Northwest Side neighborhoods. Pockets of heavy usage also exist in East Garfield Park and North Lawndale. Bunching along Halsted Street on the Near West Side suggests that much pent-up demand exists for e-scooter use to points farther east.

6. Over the study period, on average, 48.7% of e-scooters were located within the two priority areas. The percentage ranged from a high of 52.8% around 8:38am to below 43.8% in the afternoon (Figure 6). The pattern suggests that many users pick up scooters in priority areas and travel to points outside of these areas, requiring continuous rebalancing throughout the day.

We also briefly examined the degree to which scooters are equitably distributed by examining shares of scooters within the pilot program's *priority areas* throughout the day. The program's two priority areas are located on the city's far west side, where there is less public transit and little to no Divvy bike access. The companies are required to position at least 25 percent of their e-scooter fleet within each of the priority areas every morning (Figure 6). E-scooter providers may have developed new ways to reallocate vehicles since the 24th of July.

Figure 6. Share of Scooters in Priority Areas, July 24, 2019, 7am-7pm



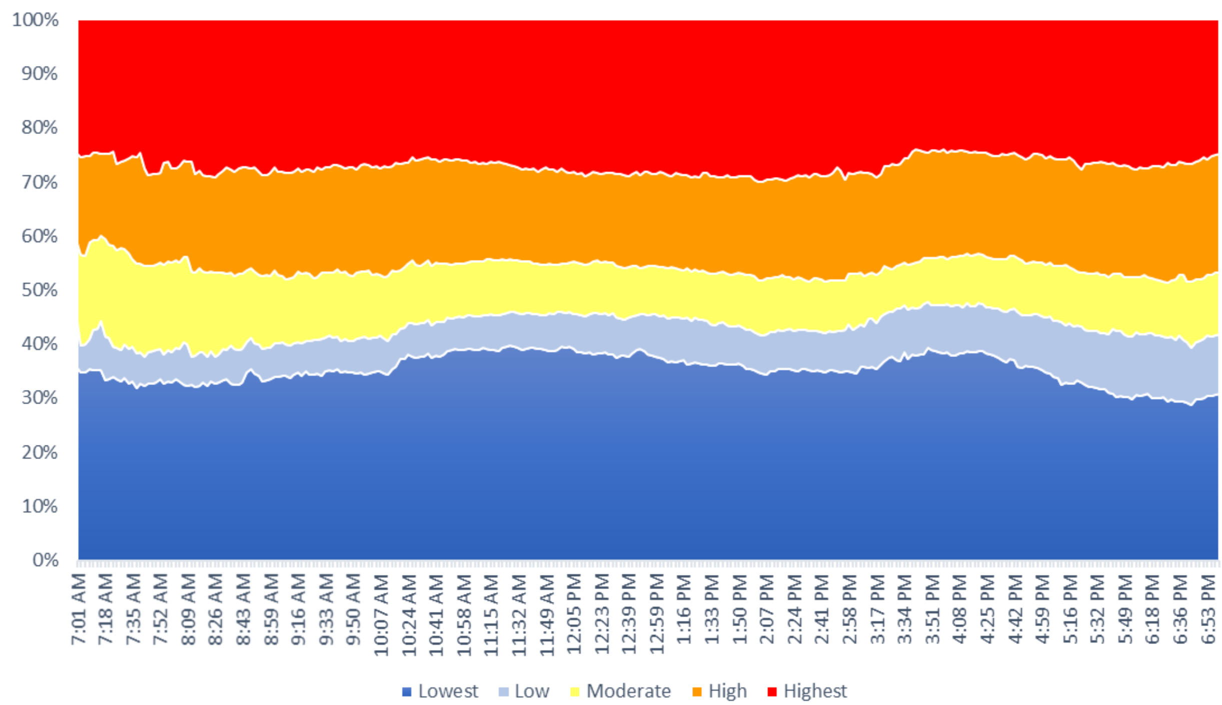
Note: Excludes VeoRide data, which was provided in aggregate form, not allowing for locational analysis.

7. A notable aspect of the system's performance is the relatively steady proportion of e-scooters in areas with high or very high levels of economic hardship. The number of e-scooters in these disadvantaged areas never falls below 40% and is typically closer to 45%. This distribution is much more balanced across neighborhood types than is typically achieved by dock-based bikesharing systems.

We used an economic hardship index to further examine the distribution and utilization of e-scooter performance across neighborhoods with different demographic characteristics. The index is composed of six variables drawn from the 2017 American Community Survey 5-year estimates, namely: percent overcrowded; percent unemployed; percent with less than a high school diploma; percent dependent population; percent spending more than 30 percent of income on housing; and percent with no health insurance. The six variables were gathered at the census tract level and spatially joined with e-scooter locations for each two-minute interval.

The e-scooters are widely distributed across areas of varying economic hardship. Similarly, the share of e-scooter vehicles in the high to highest economic hardship categories varies from just under 38 percent in early morning to more than 47 percent around 3pm (Figure 7). Overall, slightly over 43 percent were in relatively affluent neighborhoods (the low and lowest economic hardship communities combined). The pilot appears to be achieving its goal of providing access to a wide range of income groups. Maintaining e-scooter distributions in certain high-need areas throughout the day, however, may be difficult to achieve and enforce.

Figure 7. Share of Scooters by Economic Hardship Category, July 24, 2019, 7am-7pm



The percentage of e-scooters in areas of **high and very high economic hardship** ranged from **37 – 48 percent**, depending on the time of day. Our research showed that only 22.3 percent of Divvy stations were in areas of high and very high hardship. Similarly, more than 20 percent of e-scooters were in areas with very high hardship during most of the day, compared to 7.7 percent of dock-based Divvy stations in 2017.[3] The expansion underway at Divvy, however, which will bring bikes to all 50 wards, will help significantly improve access to shared bikes in many parts of the city.

[3] For our analysis of Divvy bicycle stations in 2017, please refer to Table 3 of our Dimensions of Divvy report, available for free at chaddick.depaul.edu.

Conclusions

The “A Day in the Life” review of Chicago’s e-scooter pilot using publicly available data shows that:

- E-scooters are filling a mobility niche, with trips spread widely around the pilot region and having an average distance of around two miles. The peaking near the start of the morning rush and toward the end of the evening rush indicates that they are being used as first mile/last mile solutions by commuters.

- **The number of e-scooters available remained well below the maximum level authorized in the pilot program.** There are a variety of possible explanations, such as a propensity for providers to adjust numbers deployed between weekends and weekdays, a desire to focus only on particular geographic areas, or higher-than-expected maintenance issues.

- **Based on a reasonable definition of a “trip” using pause time as a measure, the results support earlier reports that several thousand e-scooter trips are made daily**. More precise estimates will require proprietary data based on actual transactions made by customers.

- Usage is heaviest in the Near West Side and West Town community areas, while also being heavy in Austin and Logan Square. Extensive use at the far eastern end of the pilot zone suggests that latent demand exists for e-scooter use to points closer to Lake Michigan.

- **E-scooters are widely dispersed throughout areas of varying economic hardship.** These vehicles are more prevalent in areas with high and very high hardship than is typically observed for dock-based bikesharing systems.

- **Scooter companies appear to be complying with the mandate that 50% of e-scooters be located in priority areas in the early morning, although this share dropped below this threshold later in the day**. Although a high proportion (as many as 52%) of e-scooters is available in the priority areas in the morning, it consistently fell below this amount in the afternoon period. Of course, new strategies for balancing may have been introduced since July 24, 2019, when the data was collected.

Appendix: Methodology Notes

The data team measured e-scooter availability and usage by monitoring Application Programming Interface (API) data streams. It limited its focus to APIs coded as being available, as indicated in one of the coded fields in the data stream. Generally, vehicles are *not available* when they are being charged, transported, or stored. Data were collected in real time using links to APIs on the city's official website to assure that only those from the pilot program were captured.

Due to technical requirements relating to using VeoRide's API, which can be used only with authorization, data from that provider was provided directly to the study team. (The Chaddick team thanks VeoRide for accessing archival data to provide counts of traffic on July 24, 2019.) This data, along with subsequent analysis by the study team on the typical weekday availability by that provider, resulted in the estimate that an average of 210 e-scooters were available on both July 24 and August 12, 2019. Furthermore, the company's estimates of e-scooter usage between 5 am and 10 pm on July 24 allowed us to conclude that approximately 420 trips were made during our 12-hour study period. (The carrier reported that 509 trips were made over the entire 5 am – 10 pm period). Due to the fact that this data was provided in aggregated form, however, it is not included in the time-of-day analysis and animation within this report.

Several factors could result in the number of e-scooters identified on API streams differing from the actual number available to consumers. The resulting measurement error, however, is likely to be small. For example, e-scooters that are in storage but not deactivated appear on API data streams, and thus require manual adjustments to assure avoiding overestimates. E-scooters may also be in locations not identifiable on API steams, perhaps due to their placement inside buildings, which could result in an underestimate.

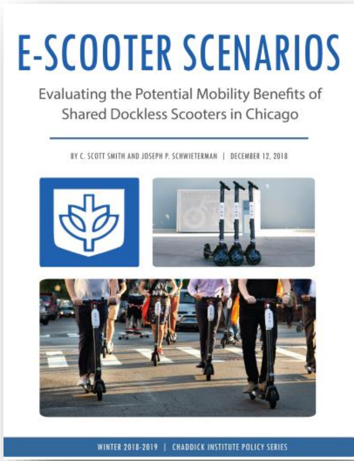
To assess the degree to which this may result in measurement error, the Chaddick team compared the distribution of e-scooters identified on the API analysis with e-scooters as they appear on company apps available to users. This required conducting counts of e-scooters in individual neighborhoods on these apps, one area at a time. (Since most apps show e-scooters only in small geographic areas, this requires zooming in, resulting in considerable uncertainty when measuring availability in this way; such uncertainty makes the API approach we used preferable). This analysis confirmed that the number of scooters available was very close to the number tallied using the API query, with a few exceptions.

- Wheels has a large warehouse in the study area, within which more than 100 e-scooters were apparently erroneously shown as being available. Once the e-scooters in this warehouse were removed from the count, the API number closely matched those on the streets.

- A small number of available e-scooters for Spin and Clevr Mobility appear to be missing from the APIs. The effects are small, with the apparent undercount for Spin by around 20. Clevr Mobility was found to have nine scooters visible on its app on August 12, 2019.

The Chaddick team will continue to explore ways to refine its methodology through the end of the pilot period on October 15, 2019. We are working with the VeoRide team to conduct more extensive API analysis of that provider's e-scooter activity, which will be provided in future updates of this report. We welcome feedback at chaddick@depaul.edu.

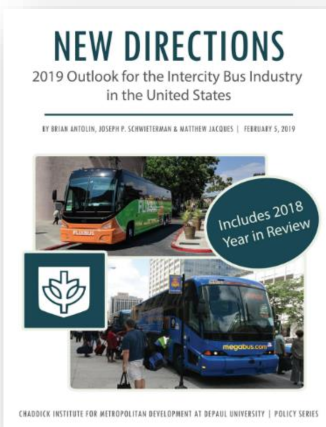
NOTABLE RELATED STUDIES BY THE CHADDICK INSTITUTE



E-Scooter Scenarios: Evaluating the Potential Mobility Benefits of Shared Dockless Scooters in Chicago

December 12, 2018

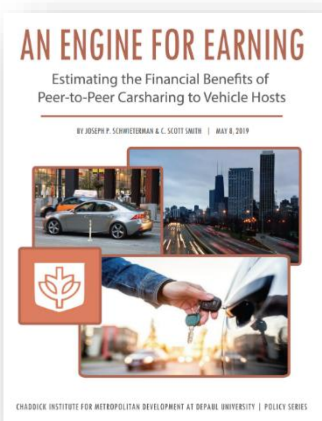
Our analysis of the potential time saving benefits of e-scooter travel in various parts of the city of Chicago. Full report here.



New Directions: 2019 Outlook for the Intercity Bus Industry in the United States

February 5, 2019

Our analysis of the intercity bus landscape including new premium service offerings, e-ticketing, and increased state government partnerships. Full report here.



An Engine for Earning: Estimating the Financial Benefits of Peer-to-Peer Carsharing to Vehicle Hosts

May 8, 2019

Our analysis exploring the financial benefits to hosts who make their vehicles available via peer-to-peer carsharing platforms. Full report here.

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This policy brief was prepared independently by the Chaddick Institute without funding or involvement from companies or organizations affiliated with e-scooters. The authors can be reached at chaddick@depaul.edu or by calling 312.362.5732.

Link to e-scooter animation: https://drive.google.com/file/d/1CwzqxPmIPjXqDqWR7AJox4AlcZUYZqXv/view