

Mobility Lab



ARLINGTON COUNTY SHARED MOBILITY DEVICES (SMD) PILOT EVALUATION REPORT



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Prepared for Arlington County, Virginia

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EXECUTIVE SUMMARY

In September 2018, the County Board in Arlington voted to launch a nine-month SMD demonstration project (pilot) intended to evaluate the community impacts of dockless electric-assist (e)-bikes and electric stand-up scooters, together referred to in the pilot program and throughout this report as shared mobility devices (SMDs). In June 2019, the pilot was extended for another six months until December 31st 2019, to allow enough time for staff to complete the necessary evaluation and recommendations.

By doing so, Arlington County joined many other cities, such as Portland, Oregon and Santa Monica, California, in piloting SMDs in their respective jurisdictions. Results from pilot programs undertaken in other cities indicate the potential for SMDs to advance sustainability, promote equity, and increase accessibility and mobility. They also document potential challenges such as community complaints pertaining to sharing the right-of-way and safety.

This report provides the results of the evaluation of the nine-month Arlington County pilot program, including trends in deployment, utilization and feedback from the community to understand SMD adoption and system performance in the context of Arlington specifically. SMD performance was primarily evaluated against Arlington County's transportation goals as documented in the Master Transportation Plan (MTP), pertaining to increased mobility, accessibility, equity, sustainability and efficient management of transportation options.

The analysis proceeded in three main steps, looking first at **pilot operations** (i.e. the supply-side), then **service utilization** (i.e. the demand-side) and finally the **community's reaction to the pilot** for both SMD riders and non-riders.

The key takeaways of this evaluation report are threefold. First, deployment and utilization of SMDs in Arlington have increased over the duration of the pilot with a firmly positive response from riders in Arlington. This report supports evidence pointing to SMDs providing a viable complement to the County's transportation ecosystem that increases mobility options and provides potential sustainability benefits. **Second**, certain aspects of the pilot have shown mixed results for the community, including the focus on equity concerns, with one measure being a disparity in deployment (normalized by residential population) between North and South Arlington), and the need for clearer communication of rules and regulations to the Arlington community. Finally, the **third** key takeaway is that there remain some challenges with the integration of SMDs in Arlington that will need to be addressed. This includes safety concerns from the standpoint of riders, pedestrians and drivers in Arlington, pointing to the need for more adequate infrastructure (e.g. protected bike lanes), and community concerns over parking and clutter on the sidewalk resulting from the program.

Based on the results, eight main recommendations were derived as follows:

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| <p>I. Accelerate <u>infrastructure investments</u> to address rider and community <u>safety and comfort</u> concerns; focus on available route detail data</p> <ul style="list-style-type: none">• Evaluate the possibility of increasing the share of protected bike lanes in key SMD corridors with the Rosslyn-Ballston corridor as a high priority given high ridership and elevated vehicle and pedestrian traffic. <p>II. Continue working on innovative ways to <u>address parking</u></p> <ul style="list-style-type: none">• Communicate more stringent parking restrictions for operators – if addressable through technology – such as systematic restrictions by operators from parking at or near an intersection, outside residential or commercial entrances, in the middle of a sidewalk or near handicap parking space.• Provide operators with map of desired deployment areas in each neighborhood and conversely of no-parking areas.• Monitor and enforce operator response time in addressing parking complaints, where applicable.• Examine further potential for SMD-specific parking infrastructure such as corrals or lock-to devices. <p>III. Create, monitor, and refine equity expectations, go beyond geography</p> <ul style="list-style-type: none">• Monitor and enforce as required proportional deployment in specific target areas.• Perform more detailed equity and access analysis to ensure SMDs are being deployed in lower-income areas.• Aim to assess equity from three standpoints (1) accessibility (in terms of location and the need for a smartphone to unlock the mobility service), (2) existence of equity programs, and (3) payment methods (e.g. needing a credit card). <p>IV. Focus on and invest in <u>communicating the rules and regulations to the public, including riders and non-riders</u></p> <ul style="list-style-type: none">• Establish clear guidelines and messaging that is consistent across county resources and operator information platforms (websites, apps, and devices).• Monitor operators’ messaging to ensure rules, regulations and rider resources are clearly communicated.• Suggest or mandate creative ways in which operators can better communicate rules and regulations including, more innovative methods such as quizzes¹.• Clearly state when rules are different from neighboring jurisdictions such as Washington, DC.• Continue to conduct community outreach events, soliciting feedback and communicating how the county is addressing key community concerns flagged in this evaluation. |
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¹ Any such initiative should be done while balancing the importance of the convenience to riders so as not to negatively impact demand and the overall rider experience.

V. Continue monitoring operations and requiring complete and robust data from operators

SMDs are growing significantly while still at an early stage in terms of technology, best practices, and operational guidelines, making close monitoring a critical requirement for their continued operation.

- Require operators to comply with the data template and to submit additional operational data that they have not submitted yet (e.g. idle time, thefts and vandalism, broken SMDs, vehicle-specific trip and incident-level data).
- Require unified data (in terms of variables provided and format) from operators, allowing easier processing and cleaning of the data, which would leave more room for research and analysis.
- Monitor the difference between Washington DC and Arlington in terms of the service level (SMDs per 1,000 people).
- Monitor the difference between SMDs and Capital Bikeshare bikes in terms of the service level (SMDs per 1,000 people).
- Monitor incident rates such as broken SMDs and crashes with a specific focus on systematic or operator-specific patterns pointing to structural challenges.

VI. Share results and county initiatives with the public, make the integration of SMDs into Arlington an inclusive and interactive conversation

- Share key SMD-related studies with the public including how the County is thinking about sidewalks, the rationale behind opening them up to SMD ridership and how it envisions the coexistence between SMDs, pedestrians and bikers.
- Inform the public on how the County is dealing with speed limitations without compromising on safety, including how speed limits, if applicable, are monitored and how operators are held accountable.
- Address perceptions of lack of safety, a key challenge to SMD popularity or even acknowledgment. This could include undertaking a specific study on SMD safety, exploring alternatives available (e.g. helmets, bike lanes) and misconceptions, and share findings with the public.
- With assistance from Arlington law enforcement, provide insight into the SMD enforcement process and potential deterrents for infractions.
- Share the results of this pilot evaluation as well as experiences from pilots in other cities to provide comparison and benchmarking, which are critical with early-stage technologies.

VII. Collect or compile more robust data within and outside the SMD program and mandate periodic evaluation of SMD trends

A broader array of data sources could enable more accurate analysis of SMDs in Arlington. This could include:

- Daytime population for Arlington using more granular measures than county-wide can help with a better comparison of (1) who actually is demanding SMDs at any point and (2) between areas that receive higher levels of commuters/workers (e.g. North vs. South Arlington).
- More detailed income data than above or below median household incomes could help examine equity concerns more accurately.
- Request crash data from law enforcement and health services to start differentiating between scooters and other modes when dealing with incidents to improve tracking.
- Repeat SMD evaluations to assess SMD trends and truly characterize the service and its long-term evolution (e.g. crashes).

VIII. Undertake additional research or studies including more detailed analysis of specific issues of interest flagged in the pilot evaluation

This evaluation provides a valuable starting point in terms of flagging the most critical issues but has foregone detailed focus on specific issues in the interest of a holistic assessment of the SMD pilot. Several more detailed analyses could be undertaken with available data and separate longer-term studies and/or surveys incorporating learnings from this evaluation could help improve SMD system performance, rider experience and community responses, including:

Short term studies with available data

- Examining key results (e.g. perceptions) by sample segment including perception and experience by gender, primary mode, and frequency of use.
- Examining trip characteristic differences by corridor.
- Looking at trip characteristics by time of the day and weekends versus weekdays.
- Examining geographic distribution of operational problems – are incidents concentrated in one or more areas in Arlington? Do they correlate with elements of the infrastructure or land use?
- Taking a closer look at “late night travel”, potentially complemented with an intercept survey to characterize such trips and their link to accessibility.
- Examining the community’s reaction to the pilot before and after the installation of corrals - did complaints, operational challenges and trip change after the installation of corrals?
- Performing more sophisticated modeling of SMD behavior using attitudinal and demographic variables in order to understand the determinants of satisfaction, frequency, trip purpose etc.
- Conducting more sophisticated content analysis of the Mobility inbox data.
- Conducting more sophisticated correlation analysis based on bivariate maps obtained and discussed in this report.

Long-term studies with additional data

- Studying the impact of e-scooters on accessibility and comfort for people with disability.

- Collaborating with other pilot programs and leveraging findings from Arlington utilization rates to estimate an “adequate” level of service that planners should aim for in designing SMD programs. This would be a similar effort to the ITDP bike share planning.
- Evaluating acceptable levels of broken SMDs for new technologies or a new mobility service.
- Evaluating communication techniques for best retention rates within apps (tests, games etc.).
- Examining travel behavior from the perspective of mode substitution between cars/TNCs and SMDs.
- Developing performance measures for shared mobility devices.
- Developing a scoring system/service standard for performance measures to rank and evaluate operators, mandating a minimum service level for continued operation in Arlington County.

The results and the recommendations of this report should be read within the context of Arlington County and the data collected during the pilot. The limited time SMDs have been in operation and the corresponding limited data and research means that the characterization of SMDs and how cities manage them will continue to evolve. This makes it important for local policymakers to continue monitoring and collecting data in order to derive structural and systemic trends, accurately characterize these services and ensure their integration into the Arlington County transportation landscape that yields desired benefits while mitigating negative externalities.

Arlington County’s SMD pilot program: key highlights

Service operations (i.e. “Supply”)

- The pilot was launched with an average of 706 daily SMDs deployed with two operators and ended with 806 SMDs deployed in June with six operators. It fluctuated in between, with the lowest deployment occurring during winter months.
- Most of the SMD deployment was concentrated in the Rosslyn-Ballston (45%) and Route 1 corridors (10%) with Columbia Pike less well-served by SMDs when accounting for respective residential population.
- Arlington County received more service per population (4.0 SMDs per 1,000 people) than Washington DC (2.4 SMDs per 1,000 people) and Capital Bikeshare bikes in Arlington (3.1 SMDs per 1,000 people).
- North Arlington received 1.3 to 2.5 times more service than South Arlington.
- Ten main operational challenges were identified in the pilot consisting of: (1) inconsistent deployment of SMDs, (2) problematic deployment sites such as bus stops and pedestrian right-of way on sidewalks, (3) high operating speed, (4) sidewalk riding, (5) broken SMDs, (6) stolen and vandalized SMDs, (7) idle SMDs, (8) incorrectly parked SMDs, (9) crashes and injuries and (10) data. Five of the operational challenges are also breaches of the MOA.
- There were 69 crashes in total between October 2018 and June 2019. Those resulted in approximately 29 injuries².
- In terms of the adequacy of the pilot-related information supplied during to the pilot:
 - 20% of non-riders received their information on the SMD pilot from Arlington County’s website.

² See body of the report for a discussion of crash data and safety analysis limitations.

- 20-22% of SMD riders and 43% of non-riders did not know what the “laws” are.
- Less than half of respondents (45%) indicated that they had received information from operators on local regulations, and less than a third (30%) indicated that they received information from operators on how to file a complaint.

Service utilization (i.e. “Demand”)

- There was a total of 453,690 SMD trips in Arlington County between October 2018 and June 2019.
- The lowest-trip months were January and February (around 23,000 trips each month) and the highest trip month was May (around 80,000 trips).
- The average trip distance was 0.94 miles and 90% of trips were for less than two miles. SMD riders traveled a total of 425,124 miles in Arlington between October 2018 and June 2019.
- The average trip duration was 14 minutes.
- 25% of trips occurred during peak travel times with 12% of trips taking place during the morning peak and another 13% of trips (approximately 58,500 trips) during the afternoon.
- 70% of trips took place during weekdays while 30% of trips took place on weekends, although Saturday ridership was the highest day of ridership over the nine-month period
- Most riders remain within the bounds of the County, with 89% of trips starting and ending in Arlington.
- Most trips and routes clustered around the two main transit/commercial corridors – the Rosslyn-Ballston corridor and Route 1 corridor.
 - The Rosslyn-Ballston corridor included 60% of trip origins and 55% of trip destinations. Within the Rosslyn-Ballston corridor, key e-scooter arterials included the Key Bridge (in and out of Washington DC), N Lynn Street, Wilson Boulevard, Clarendon Boulevard, and 9th Street in between Clarendon and Wilson boulevards is also used.
 - The Route 1 corridor included 17% of trip origins and 35% of trip destinations. For this corridor, 12th St S, S Eads St, and S Crystal Dr were areas of highest use.
 - The Columbia Pike corridor recorded fewer trips, with 4% of trip origins and 5% of trip destinations.
- In terms of infrastructure use, bike lanes were most used with 62% of e-scooter riders always-to-often using bike lanes, followed by shared lanes with cars (24%). The least-used facility was trails.
- SMD- riders **preferred to ride on protected bike lanes** (67% of respondents chose it as a top or second choice) followed by regular bike lanes (47% of respondents chose it as either a first or second choice). The least- preferred facility was sharing travel lanes with cars, and sidewalks were second-least preferred.
- Trips occurred in areas of high transit supply with scooter trips originating 0.38 miles away from a Metrorail station and ending 0.48 miles away from a Metrorail station. Ballston Metrorail has the most trips in its vicinity (78,000 parking events within 500 meters³).
- The feedback form pointed to social and/or entertainment (21% of e-scooter riders) as the category most cited as a primary trip purpose for using e-scooters in Arlington, followed by shopping or errands (18% of e-scooter riders) and connecting to Metrorail (18% of e-scooter riders).
- When asked about the mode they **would have used** to make the trip, 37% of e-scooter riders and 22% of dockless e-bike riders indicated replacing walking, while one in five SMD riders indicated replacing

³ 500 meters is equivalent to 0.31 miles.

a ride-hailing trip, and 13% indicated replacing a personal car or other motor vehicle (for a total of 32% of e-scooter riders having replaced an automobile trip).

- The online feedback form provided some preliminary insights into SMD rider profiles. In particular, a larger proportion of rider respondents were male (63%) than were female (37%), and rider-respondents reported a relatively lower average age than non-rider (more than 63% of e-scooter riders born after 1980 (compared to 22% for non-SMD riders). In terms of occupation and education, the largest proportion of riders was made up of full-time employees (66% for e-scooters and 63% for dockless e-bikes) and with a lower rate of advanced degrees (34% for e-scooter riders) than non-rider respondents (51%), yet still educated.

The community's reaction to the pilot

- When asked about **why they use** SMDs in Arlington County, the majority of e-scooter rider respondents (55%) selected *"to get around faster"* as one of their top three choices. This was followed by *"convenient"* (44%) and *"fun to ride"* (36%).
- When asked about why **they haven't used** e-scooters in Arlington in a close-ended form, the first popular choice was "I don't think e-scooters are safe" selected by 58% of non-SMD riders and 32% of dockless e-bike riders and the third most popular choice was "I feel unsafe riding in the street" selected by 36% of non-SMD riders and 21% of dockless e-bike riders. This suggests that the main barrier to using e-scooters in Arlington pertain to the adequacy of the infrastructure or a safe place to ride.
- When asked about **specific measures that could lead them to start using SMDs**, most non-SMD riders (68%) said that "none of these changes would encourage them to start using SMDs". For e-scooter riders, the most popular responses for what would make them use e-scooters more often were *"safer places to ride"* (51% for e-scooter riders and 44% for dockless e-bike riders), and *"more e-scooters available in Arlington"* (42% for e-scooter riders and 27% for dockless e-bike riders).
- When asked what infrastructure would make them feel safer, most SMD riders (e-scooter riders and dockless e-bike riders) wanted bike lanes separated from motor vehicles traffic with a physical barrier while most non-SMD riders wanted designated e-scooter parking.
- When asked which type of problems they encountered, 36% of e-scooter rider respondents chose *"none of the above"*. Of the remaining 64%, the majority (60%) encountered either mechanical issues with their e-scooters or issues unlocking/locking e-scooters via the mobile app.
- When asked about safety and comfort around e-scooters as pedestrians and drivers, the analysis revealed a difference in perception between SMD riders and non-SMD riders.
 - 73% of non-SMD riders who responded to the survey did not feel safe as pedestrians around riders on e-scooters as opposed to 41% of dockless e-bike riders, and just 15% of e-scooter riders.
 - 65% of non-SMD riders reported often to always encountering blocked sidewalks due to e-scooters being improperly parked compared to 43% of dockless e-bike riders and only 16% of e-scooter riders.
 - 76% of non-SMD riders reported being very uncomfortable to uncomfortable as drivers in Arlington County around riders on e-scooters compared to 47% of dockless e-bike riders and only 21% of e-scooter riders.
- The online feedback form also included **open-ended questions** about the impact of improperly parked SMDs. Out of the people who responded to this question (2,876, 71%), a plurality (884 responses, or

31% of total open-ended responses received) qualitatively suggested that SMDs block the path of pedestrians in sidewalks, driveways, and other common-use areas in Arlington County. After that, the responses were mixed with the same share of respondents (14%) qualitatively stating a safety concern on one hand and no to minimal negative impact on the other.

- The analysis also **examined voluntary, self-initiated emails** received to the Mobility Inbox (mobility@arlingtonva.us). A total of 727 emails were received to the Mobility inbox. The number received each month decreased significantly over the course of the pilot, from October (226 e-mails) to June (38 e-mails). This is consistent with staff’s experience running a similar email account for the free-floating car-sharing services during that pilot program.
- Key topics in the emails received to the Mobility inbox included: “parking” followed by sidewalk riding, safety, rider behavior and underage riding.
- Additionally, **outreach community events in Arlington** were an important source of community feedback. Most intercepted respondents confirmed that the pilot has challenges, but the majority expressed an interest in resolving issues rather than ending the program. This summarizes an important (qualitative) perspective of people who potentially did not have access to the online feedback form. The documented difference or more positive reaction to the pilot should be taken into consideration when evaluating the Arlington Community’s reaction to the pilot, potentially offsetting in part some biases in self-selected complaints received through the Mobility Inbox or the feedback form.

SMDs vs. Capital Bikeshare: key measures

	SMD (pilot period)	Capital Bikeshare (2018)
Total trips	453,690	261,129
Total distance (miles)	409,548	511,887
Average trip distance (miles)	0.94	1.96
Average trip duration (minutes)	14	16
Service level	4.0 SMDs/1,000 people	3.1 SMDs/1,000 people

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Glossary of terms

Dockless e-bikes: electric-assist bikes that do not require a stationⁱ.

E-scooter: electric-assist scooters (e-scooters) that do not require a stationⁱⁱ.

Rosslyn-Ballston Corridor (RB Corridor): Spanning two square miles, is composed of the Rosslyn, Ballston, Courthouse, Clarendon, and Virginia Square neighborhoods of Arlington, VA.

Route 1 corridor (formerly Jefferson Davis, now Richmond Highway) Corridor: Includes key nodes in Pentagon City and Crystal City and is served by four Metrorail stations.

Shared Mobility Devices (SMD): SMDs were the devices vendors entered into the pilot program, including pedal bikes, electric-assist bikes (e-bikes), and electric-assist scooters (e-scooters) that do not require a station, as is required by the County's station-based [Capital Bikeshare](#) serviceⁱⁱⁱ.

Glossary of abbreviations

ARL: Arlington County, VA

ICT: Information and Communication Technology (e.g. smartphones)

MOA: Memorandum of agreement

MPH: Miles per hour

R-B Corridor: Rosslyn-Ballston corridor

ROW: Right of Way

SMD: Shared Mobility Devices

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CHAPTER 1: INTRODUCTION

Transportation is an inherently complex and dynamic sector. It is multidisciplinary, ever-evolving and cuts across many vital dimensions for communities such as public health, livability, sustainability and the regional economy. While these numerous linkages make transportation interesting to examine, plan for and regulate, its complexity also makes such efforts all the more challenging.

Today, the transportation ecosystem is as dynamic as ever with the advent of technology-fueled and shared mobility solutions such as car and bike-sharing, ride-sourcing and, most recently, dockless bikes and e-scooters. In the United States, since first emerging at a commercial scale in 2017, e-scooters and dockless bikes have gained market share at a faster rate than any new mobility service in recent history^{iv}. The National Association of City Transportation Officials (NACTO) estimated the combined trip count of scooters and dockless bikes throughout the U.S. in 2018 to have outpaced that of the nearly decade-old station-based bikesharing systems^v. The ubiquity of smartphones and ease of app-based transactions, flexibility and convenience of dockless parking and pick-ups, lack of pre-requisites and ease of use of e-scooters have all contributed to the rapid growth in ridership.

However, the sudden emergence of dockless e-bikes and e-scooters, or shared mobility devices (SMDs) as defined by Arlington's pilot, across urban areas throughout the world has created a new challenge for local governments. Local policymakers now face the challenging task of effectively integrating the influx of new transportation devices within the existing transportation ecosystem. This involves achieving a delicate balance between facilitating the growth of popular innovative solutions with potential long-term sustainability benefits on one hand and creating an effective regulatory framework that mitigates its potential negative externalities for the existing transportation infrastructure, pedestrians and residents on the other.

To deal with these partially conflicting objectives, some local governments around the U.S. (such as Santa Monica, CA, Portland, OR, and Washington, DC) created pilot programs with operators. These pilots provided an opportunity for policymakers to study SMD operations and conclude on the impact of these services on the urban environment and local communities.

In Arlington, the County Board approved a nine-month SMD pilot project at the September 25, 2018 County Board meeting. The project is intended to evaluate the impacts of dockless bikeshare bikes and electric stand-up scooters (i.e. SMDs). The pilot was originally intended to go from October 1, 2018 until June 30, 2019 but was subsequently extended through December 31, 2019 at the June 2019 County Board meeting to allow enough time for staff to complete the necessary evaluation and recommendations. This report summarizes that evaluation.

The objective of the evaluation is to understand what the collected data on SMDs over the first nine - month period of the pilot can tell us about the performance of these new shared mobility options, how we manage them, regulate them and plan for them. For this purpose, the performance of SMDs in Arlington was checked against five main goals as described in Arlington County's Master Transportation Plan (MTP)^{vi}:

- **Providing High-Quality Transportation Services**
- **Moving More People Without Traffic and Advancing Environmental Sustainability**
- **Promoting Safety**
- **Establishing Equity**
- **Managing Effectively and Efficiently**

This report documents the pilot program’s evaluation objectives, methods and results. The first chapter provides an overview of Arlington’s SMD pilot and a review of the limited literature on SMDs to provide context for the analysis. The second chapter describes the research approach, including the evaluation questions, main datasets and methodology used for the analysis. The third chapter describes the results in terms of: (1) pilot operations, (2) utilization, and (3) the community’s reaction to the pilot.

CHAPTER 2: BACKGROUND

Before delving into the evaluation methods and results, this chapter provides an overview of Arlington County demographics and transportation, a brief description of the pilot and a quick review of shared mobility devices pilot findings to-date. This is meant to provide context for the rest of the analysis.

A brief overview of Arlington County⁴

The results of the evaluation of the pilot should be read within the context of Arlington County. The local environment is unique in many ways, including demographics and socio-economic conditions, geographic proximity to the Washington DC metropolis and an abundance of transportation options. Below are key points to keep in mind while reading the results of the pilot as described in this report.

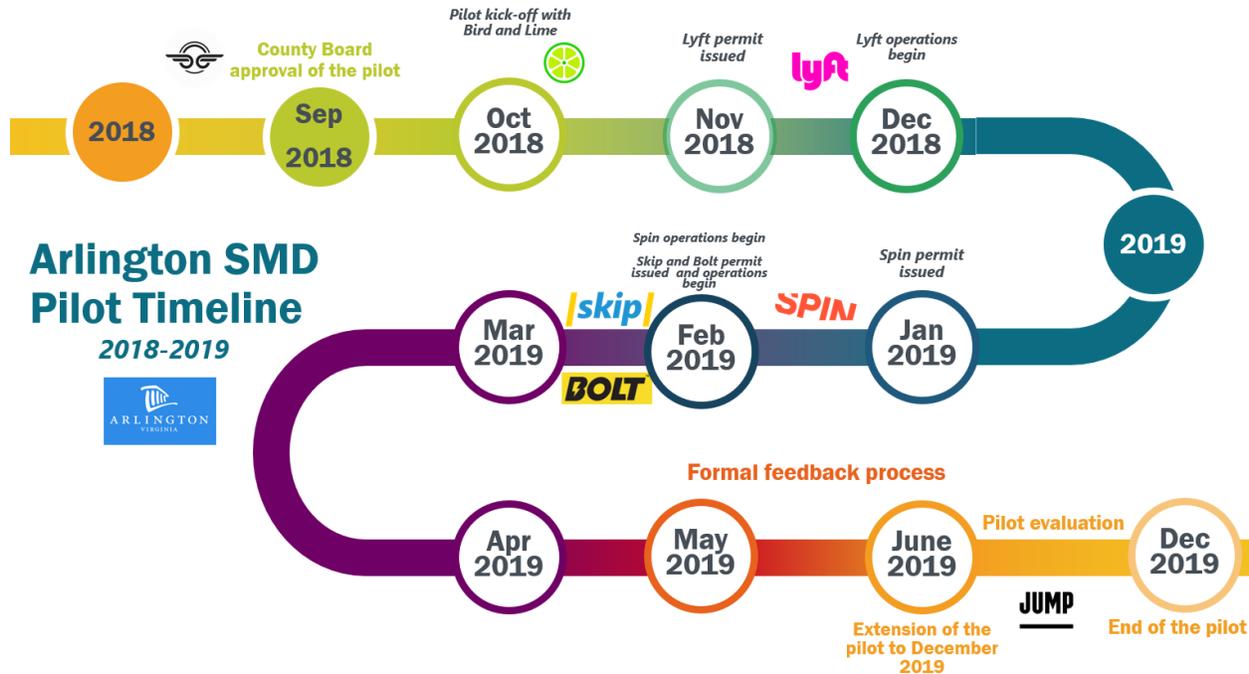


- Arlington has an estimated population of 226,400 residents.
- Arlington has an estimated 227,000 at-place employees.
- Arlington County is the most educated county in the Nation: 74% of residents have a bachelor’s degree or higher and 39% have a graduate or professional degree.
- Arlington offers many transportation options with 11 Metrorail stations, 17 ART bus routes, 92 Capital Bikeshare stations, and over 100 miles of biking, walking, and jogging trails.
- The average household size in Arlington is 2.2, below the average size of 2.6 in the U.S.^{vii}
- The median household income is \$112,138/year, slightly less than double the U.S. average.
- 2015 Arlington commute patterns as estimated by the 2015 Arlington Resident Travel Survey:^{viii}
 - Commuters drove alone to work for 41% of their total weekly trips
 - Commuters rode a train for more than 27% of their trips and ride a bus for 12% of their weekly trips
 - Commuters rode a bike for 5.2% of their weekly trips
 - Commuters walked for 4.3% of their weekly trips
 - Commuters rode taxi for 0.2% of their commute trips and Uber/Lyft for 0.5% of their commute trips

⁴ This summary is based on Arlington [2019](#) as developed by Arlington County; Image taken from [Arlington County Profile 2018](#).

A brief overview of the pilot

Timeline. The SMD pilot program’s timeline is illustrated in **Figure 1** below and covers the period between the initial approval of the pilot in September 2018 to the end of the pilot extension in December 2019.



*Figure source: Developed by Mobility Lab, ACCS. Template from Microsoft Office 365 templates.

Figure 1 Arlington SMD Pilot Timeline

The participants. As described in the timeline, seven operators were issued permits to operate in Arlington County: Bird, Bolt, Lime, Lyft, Skip, Spin and Jump. Jump did not deploy any SMDs between October and June and is therefore not part of this evaluation. Lime is the only company to have deployed dockless e-bikes during the evaluation period.

The agreement. The issued Memorandum of Agreement (MOA)⁵ describes the conditions for participation in the pilot as follows⁵:

- Companies are required to pay an \$8,000 permit application fee per mode to assist with County costs for monitoring, management and evaluation (an additional \$5,000 fee would be levied for the pilot extension)
- Fleet cap of 350 devices per mode per company with opportunities for growth based on performance;
- Speed limits of 10 mph (adjusted to 15 mph during the course of the pilot) and 20mph⁶ for e-scooters and e-bikes, respectively
- Data-sharing requirements similar to those of the regional Capital Bikeshare service

⁵ From Arlington County Board Report June 2019.

⁶ The top speed for e-bikes was adjusted up from 15 mph to 20 mph during the course of the Pilot.

- Various operational requirements regarding parking, device safety, ridership restrictions, and customer service

Community resources. Arlington County created a specific email address for community feedback (complaints and compliments) at mobility@arlingtonva.us, identified as the Mobility Inbox. In addition, Arlington County communications staff participated in a series of 10 community events during the pilot.

Equity considerations. The SMD services were not restricted to or from any area in Arlington. In addition, operators offered five equity-oriented options for individuals who qualify for a state or federal assistance program: (1) Bird’s text to ride feature and one bird program, (2) Bolt forward, (3) Lime access, (4) Lyft community pass and (5) Skip’s rider accessibility program. These include a combination of solutions from waiving the unlocking fee (\$1) to a discount (e.g. 50%) on all rides to a low fee for unlimited free 30-minute rides. Detailed information on equity programs is available to riders on the Arlington County website at <https://transportation.arlingtonva.us/scooters-and-dockless-bikeshare/>.

A brief overview of SMD literature to-date

Dockless e-bikes and e-scooters are relatively new entrants in the urban transportation landscape, with limited data collected and research performed to truly characterize these services and their impact on transportation systems. Nevertheless, **the early literature reveals some unified themes along several important dimensions.**

SMDs are popular and gaining market share at a rapid pace. The most comprehensive assessment of SMD penetration data to date comes from NACTO^x. They suggest that the number of SMD trips taken surged from less than a million trips in 2017 to an estimated 47.5 million trips in 2018. According to Populus, a company that processes a wide array of SMD data, this rapid expansion of trips taken by SMDs suggests that this service appeals to a diverse group of people. This adoption rate, according to studies they have reviewed, could push the market for micro-mobility to include between 8% to 15% of all trips under five miles and grow to \$200 billion to \$300 billion in the U.S. alone^{xi}. Data also shows significant market penetration in Europe^{xii}.

This market adoption comes with significant potential for expanding transportation options^{xiii} , promoting equity and advancing sustainability. SMDs represent an expansion of transportation options for some types of trips such as short trips (i.e, Portland’s pilot showed that 71% of e-scooter riders use e-scooters most frequently to get to a destination)^{xiv}, first and last-mile connections to transit but also provide desirable services to under-served segments of the population. Early signs of higher adoption rates for women^{xv} and low-income groups^{xvi} relative to existing active transportation options reflect this trend.

In fact, several SMD operators have rolled out equity programs^{xvii,xviii} that could increase accessibility of low-income neighborhoods to affordable transportation options and connectivity to other transportation modes such as transit. Nevertheless, pilot evaluation studies show that there is still room for these services to gain traction as only 43 people were enrolled in equity programs in Portland and less than 100 people per company in San Francisco^{xix}. In comparison, Portland numbers are slightly below Capital Bikeshare numbers in Arlington, that had 131 participants with active accounts in the Community Partners (equity) Program in calendar year 2018. Those members took 2,857 trips in 2018.

In terms of advancing sustainability, SMDs could act as a complement to a multimodal system, promoting transit use^{xx} and decreasing the need to own a car or travel by car, especially for short trips^{xxi}. Some cities are devoting resources to promote transit connectivity of SMDs, such as Denver requiring e-scooters to be readily available at transit and bus stops^{xxii}. Results from the Portland pilot e-scooter survey revealed that 6% of riders reported getting rid of their car and 16% said they considered it because of scooters.

SMDs have also been found to potentially **(1)** promote adequate infrastructure for sustainable active transportation^{xxiii} and **(2)** provide an active transportation alternative for women to services such as docked bike share, which have historically seen a gender skew due to safety concerns, with SMDs potentially helping close the gender gap in active transportation^{xxiv,xxv}. Results from the Portland pilot showed that e-scooters could be bringing more people (not only women) to active modes whereby 42% of survey respondents who used e-scooters reported having “never” biked before.

While there are clear positives, there are also important concerns that have emerged as a result of SMDs and their management, mainly pertaining to safety, community embrace and infrastructure use.

Several studies published in 2019 looked at the safety of scooters. Santa Monica researchers found that people going into the hospital for scooter injuries was around 50 more times than for bike injuries in the same year (249 vs. 195)^{xxvi}. Another study by the Centers for Disease Control and Prevention (CDCP)^{xxvii,xxviii} examined injuries in Austin to find that there were 20 individuals injured per 100,000 trips for e-scooters taken during the three-month period. In comparison to other modes, by looking at an absolute measure of e-scooter injuries, the City of Baltimore^{xxix} showed that e-scooters are less dangerous than other modes (8.8 injuries per 1,000 drivers each year compared to 0.66 injuries per 1,000 scooter users each year). Other major pilot evaluation reports did not make comparisons, potentially due to the lack of comparative data (e.g. total number of trips and miles traveled for bike and pedestrians) as Portland’s evaluation points to. SMD companies are showing more commitment to prioritize the safety of the community in the services they supply. For example, Lime started a Public Policy and Safety Advisory Board in July 2019 to determine what research and policy initiatives to undergo, and what regulations to advocate for to overcome safety concerns of cities and riders^{xxx}. Studies have shown that a third of incidents occur on first use^{xxxi}, suggesting familiarity and time could help mitigate some of the safety issues associated with a novel technology and inexperienced riders.

In terms of infrastructure use and community embrace, studies have documented complaints mainly pertaining to e-scooters blocking sidewalks^{xxxii}. However, time, familiarity and experience with the services could help bridge this divide to some extent as results from the Virginia Tech survey showed a distinct difference in perception between those who have tried the services and those who had not^{xxxiii}.

Aside from these overarching themes, early results from pilot evaluations such as Portland, Santa Monica, Baltimore City and Washington DC offer useful insights into what people are using SMDs for, their attitudes towards them, the impact of SMDs on sustainability, the differences in adoption based on demographics, frequency of use, and what would make people use them more. These are summarized in **Table 1** below.

Table 1 Review of key results from pilot evaluations across the U.S.

	SMD TRIP PURPOSE	ATTITUDES TOWARDS SMDS	SMDS AND SUSTAINABILITY	SMDS BY DEMOGRAPHICS	FREQUENCY OF SMD USE	WHAT WOULD ENCOURAGE RIDERS TO INCREASE SMD USE?
PORTLAND^{xxxiv}, xxxv (E-SCOOTERS)	Transportation/commute to work or work-related (30%) and fun/recreation (28%)	85% of surveyed Portlanders were “extremely” or “very likely” to recommend e-scooters to a friend	Replacing automobile trips. 34% would have driven a personal car (19%) or hailed a taxi, Uber or Lyft (15%) on their last trip	E-scooters more popular among men (62%) than women (36%).	19% only ridden once and 26% ride one to three times per week	58% said "more e-scooters available," 44% said "safer places to ride 9% said e-scooters with seats.
SANTA MONICA (ELECTRIC SCOOTERS AND BICYCLES)^{xxxvi}	Work (31%) and recreation trips (23%)	N/A	50% of respondent’s most recent trips displaced a car trip Majority of respondents have been using car modes less	Skews young, male, and affluent	44% used it less than once a week, 30% used it one to three times per week and 26% used it more than three times per week.	N/A
WASHINGTON DC^{xxxvii}	N/A	415 public comments The majority supported the program The primary negative concern was clutter, blocked pedestrian	N/A	N/A	Of those who used them: 50% of respondents at least once a week 21% used them daily	N/A

	SMD TRIP PURPOSE	ATTITUDES TOWARDS SMDS	SMDS AND SUSTAINABILITY	SMDS BY DEMOGRAPHICS	FREQUENCY OF SMD USE	WHAT WOULD ENCOURAGE RIDERS TO INCREASE SMD USE?
		travel ways, and parking.				
BALTIMORE CITY^{xxxviii} (E-SCOOTERS AND BICYCLES)	Most cited was “socializing” followed by “commute”	40% for the pilot, 29% against it and 31% had a mixed feeling about it	Providers estimate that the equivalent of 738,150 pounds of carbon emissions was avoided	Younger people again being more likely to have used the vehicles. Usage by gender and by race did not vary as greatly, indicating that the vehicles appeal to a range of riders	32% few times a week 31% few times a month 19% only once or twice	More scooters and safe places to ride most cited options
OTHER RESEARCH REPORTS – NOT CITY-SPECIFIC	Around 35% use it to commute and another 35% use it for recreation/exercise (NACTO)	70% of people in major cities perceive SMDs positively. (Populus)	70% of people viewed e-scooters “as a way to get around without the hassle of owning a car, a substitute for short driving trips, a complement to transit”	The gender gap might be smaller for SMDs than for prior bikeshare services: 3.2% of women have tried electric scooters, compared to 4.4% of men.	N/A	N/A

*N/A indicates that it was not discussed in the published study

CHAPTER 3: RESEARCH APPROACH

Given this context, the research team developed a research and evaluation approach that would enable Arlington County to uncover what it could learn from the utilization and performance of SMDs in Arlington during the pilot in order to better plan for and regulate the penetration of SMDs into the local transportation ecosystem.

To this end, the evaluation approach consisted of examining whether and how performance measures and community feedback pertaining to these innovative mobility services fit within Arlington County's transportation goals as laid out in Arlington's [Master Transportation Plan \(MTP\)](#). In addition, the research approach also targeted informing what additional planning, rules or regulations from local policymakers could be required to improve this fit. The detailed research and evaluation objectives and data used for this research effort are presented in this section.

Main research and evaluation objectives

The research and evaluation objectives of this study are presented in this section in the form of the questions it seeks to answer to the extent possible given data available, organized within the framework of the six goals set forth in Arlington's MTP as described in **Figure 2** below:

Goal 1: Provide high-quality transportation services

Defined by MTP as: Provide high-quality transportation services for all riders and modes.

- Has the level of SMD service in Arlington during the pilot been adequate given rider demand?
- Is the public receiving enough information on how to interact with these “new” services?
- Is the Arlington infrastructure adequate to support a smooth operation of these services?
- Are these services increasing residents’, workers’ and visitors’ access to activities?
- Is the rate of broken SMDs adequate?

Goals 2 & 6: Move more people without traffic & advance environmental sustainability

Defined by MTP as: Provide more travel choices and reduce the relative proportion of single occupant-vehicle (SOV) travel. Reduce the impact of travel on community resources including air and water quality, and increase energy efficiency.

- Are SMDs substituting for car trips?
- Are SMDs providing a differentiated and useful complement to Arlington’s multimodal transportation system in such a way that it would allow riders to require less cars or SOV uses?

Goal 3: Promote safety

Defined by MTP as: Provide transportation system operations that are safe and secure, and enable prompt and effective emergency response.

- Do crash rates confirm that SMDs are relatively safe?
- Do riders and non-riders feel safe around SMDs?

Goal 4: Establish equity

Defined by MTP as: Serve the mobility and accessibility needs of all residents regardless of age, income, or ability.

- Are lower-income residents adequately served by SMDs compared to higher-income residents?
- Do SMDs help Arlington County cater to the needs of disadvantaged segments of the population and promote equity?
- Are SMDs negatively affecting accessibility and comfort for people with disability? (e.g. scooters parking on sidewalks and ramps)

Goal 5: Manage effectively and efficiently

Defined by MTP as: Fund, develop, manage, and maintain transportation facilities and services in an equitable and cost-effective manner.

- Have operators been compliant with the memorandum of agreement (MOA) framing their participation in the Arlington County SMD pilot project?
- Are the current rules and regulations governing the use of SMDs in Arlington adequate given what has been learned from the pilot project?
- Are community’s expectations being managed well for both users and non-riders?
- Are adequate resources being devoted to the management of SMD deployment and operations?

Figure 2 Evaluation objectives and research questions

Data and methodology

At the core of the evaluation and analysis that this study sets out to perform is the collection of primary and secondary data, which together help build a comprehensive picture of the SMD pilot from the perspective of both system performance and impact on the community. Several data sources were available to Arlington County researchers in order to conduct the evaluation of the SMD pilot, including but not limited to *direct data from operators, data collected from residents and riders through online surveys and feedback forms, direct feedback from the community and third-party sources*. The breadth and depth of data used in this study is summarized in **Figure 3** below.

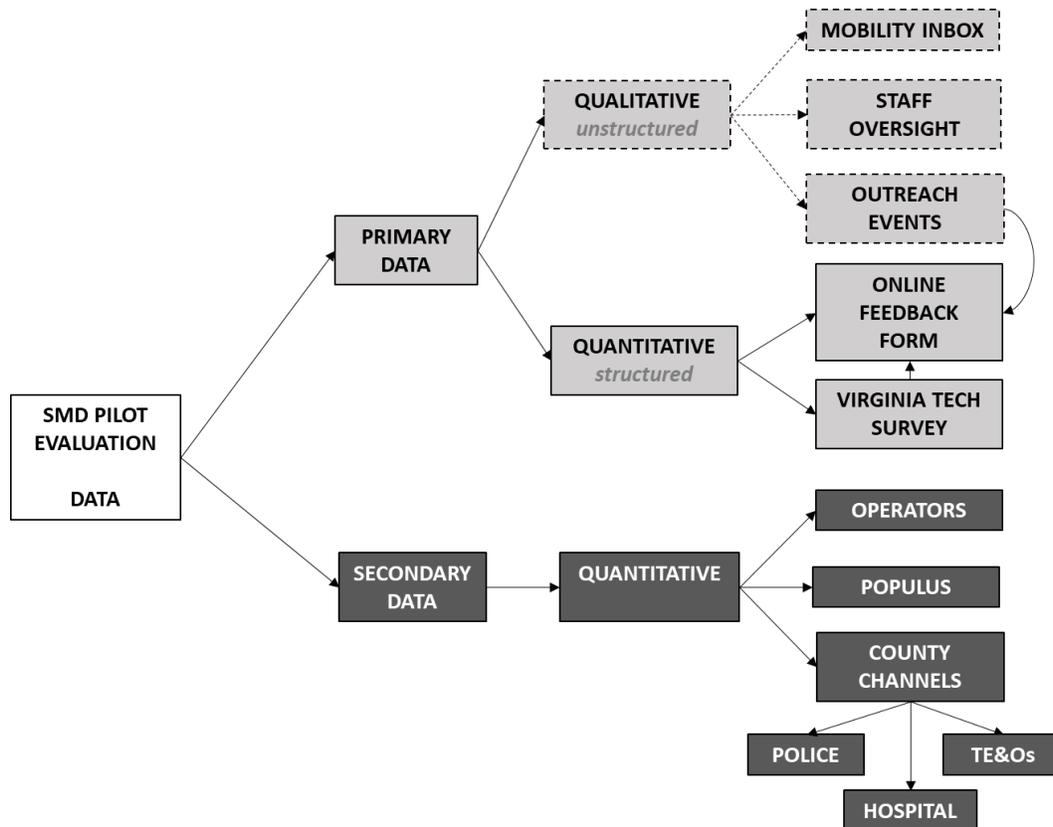


Figure 3 Available datasets for Arlington County's SMD Pilot evaluation

Primary data is defined as data that is solely collected and stored for the purpose of evaluating SMDs in Arlington within the context of the pilot program. **Secondary data** is data collected by Arlington County or other entities (including operators or third-party data providers) for other purposes that were made available to the research team as inputs for the evaluation of SMDs.

Data can be categorized into qualitative and quantitative datasets:

- **Qualitative datasets** are important in terms of offering a platform for the Arlington County community to express (without any pre-determined research questions from researchers) their opinions and experiences with the SMD pilot. This data collection effort is valuable in that it reflects community feedback without being pre-structured by researchers. Examples of such data

include submitting compliments and complaints to the *Mobility Inbox* (mobility@arlingtonva.us), communicating opinions to staff or participating in outreach events.

- **Quantitative datasets** help measure and quantify the performance of SMDs and the opinions of the community and SMD riders on a larger and more statistically significant scale. Quantitative data collection efforts, including an online feedback form and survey (conducted with the help of Virginia Tech University) were based on best practices in survey design.

A detailed summary of the type, description and discrete objective of each dataset collected and used in this study is provided in **Table 2** below. A detailed explanation of the data collection methodology for each subset is provided thereafter.

Table 2 Arlington SMD pilot evaluation datasets

Data	Data Type		Description	Objective
Mobility Inbox	Primary	Qualitative	Dedicated email address: mobility@arlingtonva.us	Platform for Arlington County community to voice opinion; unguided/unstructured feedback
Staff oversight	Primary	Qualitative	Experience with day-to-day operations and insights from outreach activities	Leverage all sources of information available for the pilot
Outreach events - County in-person outreach (pop-up engagements)	Primary	Quantitative /Qualitative	In-person engagement in school and family events, farmer’s market, Metrorail stations and community events	Support the online feedback form the broad community and shared devices- <i>reach people who would not have otherwise clicked the survey</i>
County online feedback	Primary	Quantitative	Online survey to gather information from all stakeholders	Assess rider experience and perceptions regarding the pilot and identify issues; collect data that is not available in the operator’s data
Virginia Tech Survey	Secondary	Quantitative	Online survey by Virginia Tech students on pilot utilization and perception restricted to Rosslyn	Assess utilization, demographics and perceptions
Operator’s data	Secondary	Quantitative	Trip data submitted monthly by operators	Information on deployment and utilization
Populus	Secondary	Quantitative	Interface for all SMD deployment and utilization	Aggregation; real-time representation of deployment and use
County Channels – Arlington County Crash Tracker	Secondary	Quantitative	crash data collected from local law enforcement and health services VHC- Hospital data; Police; TE&Os:	Mainly to obtain crash data

The Mobility Inbox. The Mobility Inbox is an e-mail address and inbox made available via Arlington County’s website soliciting feedback from the community and accessible to all. Starting in October 2018, all complaints received in the Mobility Inbox were screened for keywords and language corresponding to categories of inquiries related to the SMD Pilot Program. These categories include common topics of interest such as: *parking, sidewalk riding, and underage riding*. Using this methodology, one complaint can be tallied under multiple categories (e.g. a single complaint about parking and sidewalk riding would be counted once in each category). As such, the sum of tallies for each category does not equal the number of comments received.

Staff oversight. Since the pilot was launched in October 2018, Arlington County staff and contractors have been closely monitoring its progress, accumulating important experience and knowledge that helped inform operations and provided valuable context to the evaluation. Moreover, Arlington staff at the leadership level communicated any and all direct feedback from the community that fed into this analysis.

Arlington outreach: in-person engagement. Throughout May and June, community engagement staff from the Department of Environmental Services (DES) brought information and displays to ten community events around Arlington (See **Table 3** below) to provide opportunities for feedback. Staff engaged over 970 individuals, collecting 120 intercept feedback forms and receiving over 400 preferences on mitigation options and over 50 new ideas.

Table 3 Arlington County SMD outreach events and timeline

	<i>Date (2019)</i>	<i>Event</i>
1	Friday, May 17	Bike to Work Day: Rosslyn Gateway Park
2	Friday, May 17	New District Brewing: Shirlington
3	Saturday, May 18	Big Truck Day: Columbia Pike Library
4	Sunday, May 19	Ballston Quarterfest: Ballston
5	Saturday, June 1	Marymount Farmers Market: Marymount University
6	Sunday, June 2	Westover Farmers Market: Westover Library Plaza
7	Friday, June 7	Fridays at the Fountain: Crystal City Waterpark
8	Saturday, June 8	Arlington Farmers Market: Courthouse
9	Wednesday, June 12	Rosslyn Farmers Market: Central Place Plaza
10	Saturday, June 15	Columbia Pike Bluesfest: Columbia Pike

Attendees were invited to consider how Arlington could improve its demonstration project by reviewing a display board with different mitigation options. The options presented were selected by reviewing how other cities have been addressing commonly reported issues. Attendees were invited to place stickers on preferred options or propose their own new idea. Depending on the event, attendees were also given the opportunity to complete a shorter version of the feedback form or an information card with a link for the online feedback form. A hundred respondents completed the shorter version of the online feedback form.

Virginia Tech survey. Virginia Tech’s urban affairs and planning studio class for Spring 2019^{xxxix} performed a study on SMDs in Arlington and developed a survey in collaboration with Arlington County that was distributed to the Rosslyn Community. Although limited geographically to the Rosslyn area, this survey served as important template and test-case for the longer feedback form that was designed for Arlington County, discussed below.

Arlington online feedback form. The research team designed an online feedback form aimed at complementing operators’ data to give a better understanding of Arlington’s community’s experience and satisfaction with the SMD pilot. The survey was inspired by Virginia Tech’s survey^{xl} (itself inspired by Portland’s survey to assess its own SMD pilot program^{xli}) but expanded to include questions particular to Arlington County’s evaluation objectives. The feedback form was designed into four sections as described in **Figure 4** below:

General questions and socio-economic demographics

- This section asked respondents about their access to ICT, travel behavior patterns and other socio-economic demographics such as age, gender, race, and education.

E-scooter riders

- This section was open only to e-scooter riders, or people who "have used e-scooters in Arlington", to measure the motivation to use e-scooters, trip characteristics such as trip frequency and purpose, mode replacement due to the use of e-scooters, and attitude and satisfaction. Respondents were also asked what would make them use e-scooters more, in an effort to measure barriers to using SMD.

Dockless e-bike riders

- This section was open only to dockless e-bike riders, or people who "have used dockless e-bikes in Arlington". This section mirrored the section on e-scooters without focusing on attitudes, to limit survey fatigue. The section also gauged respondent's barriers to increasing their current use.

Arlington community

- This section was open to riders and non-riders to understand how they perceived the adequacy of the current infrastructure and rules and regulations, the impact of SMDs on other modes and what type of infrastructure would make them feel safer in the future.

Figure 4 Main sections of the online feedback form

The feedback form was pre-tested internally by Arlington County to check for wording confusion and question fatigue and was revised accordingly before release to the public. The survey was open from May 15 to June 30 and was distributed via the following outlets:

-
- **InsideArlington** - 130,000 subscribers– link sent twice
 - Five newsletters for a total of 305 clicks.
 - 13 newsletters for a total of 1,292 clicks.
 - **Arlington County Social Media** (DES and Countywide)
 - Twitter: DES – 4,889; ARL – 26,200
 - Facebook: DES – 3288; ARL – 29,583
 - **Emails to those who emailed the mobility inbox** – 553 recipients
 - **County commissions and committees**
 - **SMD operators to their riders**
 - *Lime sent it to 14,500 recipients*
 - *Lyft sent to 2,500 recipients.*
-

The feedback form generated a total of 4,063 responses. Due to the diffused nature of data collection and solicitation for feedback, a response rate cannot be computed. All collected data was anonymized and analyzed in aggregate. The research team examined the data quality against (1) **missing responses**, (2) **flatlining** (providing the same answer to most/all questions), (3) **non-sensical comments**, (4) **contradictory responses** and (5) **speeding**. It was determined that none of these quality issues were problematic for interpretation and no responses were removed from the dataset due to the sensitivity of the topic to the Arlington community.

More than two thirds of the respondents to the survey were non-SMD riders (2,840). Among SMD riders, most were e-scooter riders (1,066). Three percent of total respondents (135 respondents) reported having used both e-scooters and dockless e-bikes in Arlington (See **Figure 5** below)⁷⁷. Most respondents lived (98%) and worked (68%) in Virginia. Thirty percent of respondents worked in Washington DC.

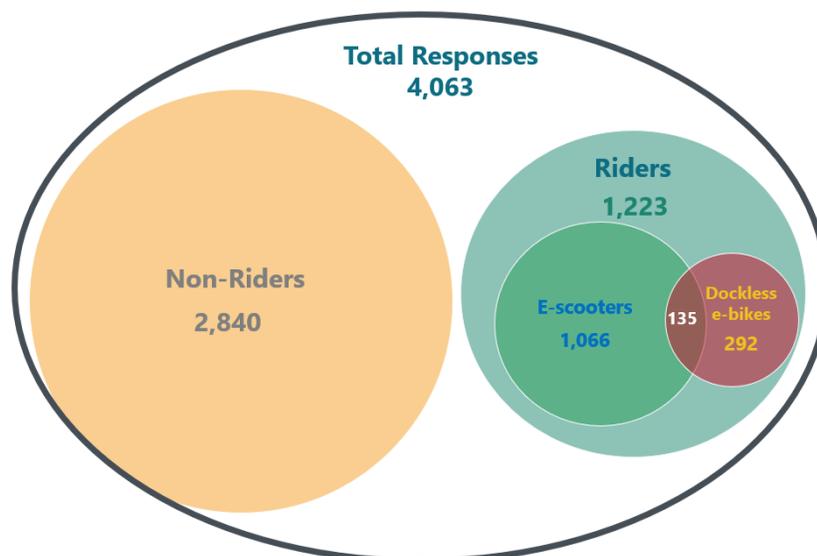


Figure 5 Venn diagram of survey respondent type

Due to limited available resources and time constraints, the feedback form was distributed using a convenience sample rather than random sampling. As such, the results should be read as reflective of the obtained sample and not be generalized to the wider Arlington population. The feedback forms and the results are made available to the public on Arlington County’s website.

Operators’ data reporting. An important part of the evaluation comes from SMD service provider’s data. According to the memorandum of agreement (MOA), operators were required to submit monthly data on **trips** (origin and destination coordinates, start and end times, distance traveled and duration of the trip), **SMDs in service** (daily available SMDs in the County), **operational data** such as the number of broken

⁷⁷ Those who did not respond to the SMD filtering questions (i.e. skipped the questions rather than answered “no”), constituted a small portion of the non-SMD group (7% skipped the question for e-scooter and 8% skipped the question for dockless e-bikes).

SMDs, incorrectly parked SMDs and **complaints** received. Operator's data were processed and cleaned by the research team using filters on distance, time, speed and location.

Populus. Populus is a third-party software that provided valuable insights in the evaluation, including: looking at trips in real time, looking at aggregated operator data in one place, looking at spatial deployment or available SMDs per neighborhood or block level (not available through monthly operator reporting), looking at the utilization of corrals in Arlington County and comparing service level with Washington DC.

County channels. County channels were used for crash data. Arlington County developed a crash tracker that would aggregate data from operators, local law enforcement and health services, and news outlets to track the number and type of SMD incidents and crashes in Arlington County.

CHAPTER 4: RESULTS

This section of the report presents the main findings based on the analysis of the data described in the Research Approach and guided by the context provided in the Background. This chapter starts with describing **pilot operations**, followed by **utilization** and ends by detailing the **community's reaction to the SMD pilot**.

SECTION 1 - PILOT OPERATIONS

Pilot operations refers to the supply-side of the SMD pilot in terms of **(1)** daily average SMDs available in the County and their spatial distribution, **(2)** main operational challenges and **(3)** the efficacy of communicating to the community the rules, regulations and best practices in terms of SMDs. The demand-side of the SMD pilot, or utilization of SMD services, will be examined in the following section.

Daily SMDs in service in Arlington County

Key question: *How many SMDs were available for use in Arlington and how did this availability change monthly?*

The pilot was launched with 706 daily SMDs on average made available by participating providers during the first month (i.e. October 2018). Although fluctuating significantly month to month, average daily SMD availability remained relatively range-bound through most of the fall and winter seasons, in the 600-850 SMDs per day range (see **Figure 6**). Month to month variability could owe to weather conditions and temperature during winter months impacting operations. The average daily count increased considerably in March, with more providers joining the pilot. The average daily vehicle count surged to 1,074 SMDs in March, up more than 50% from the average of 720 SMDs for the period of October 2018 to February 2019, with average SMD counts remaining above 1,100 vehicles through May. Data indicates a fall in SMD supply in June, potentially in large part due to one operator effectively pulling out from the pilot during the second half of the month. The total aggregate SMD cap as determined by the MOA was never reached or exceeded.

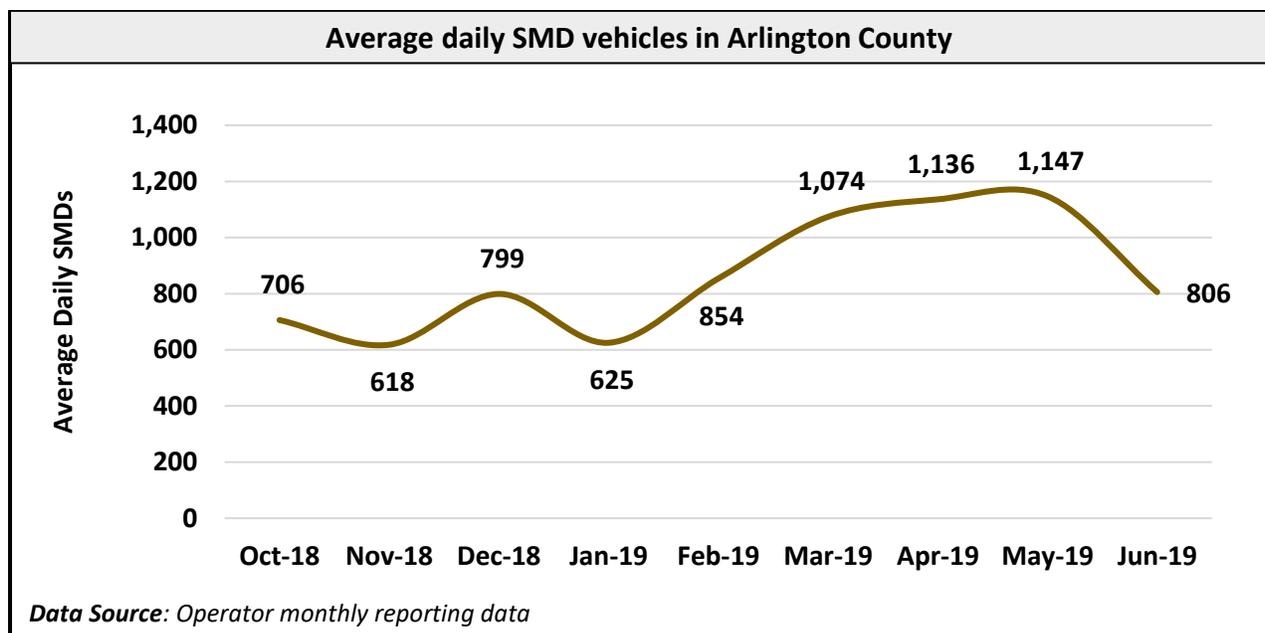


Figure 6 Average daily SMD vehicles in Arlington County by month

Adequacy of the level of service to Arlington under the SMD pilot

Key question: *Is the supply of SMDs in Arlington sufficient? And how does it compare to neighboring jurisdictions?*

While it is challenging to define what “sufficiency” is given scarce available research on service levels adequacy for SMDs and a dynamic demand landscape, literature and best practices on bike-share service levels suggest using a metric of SMDs per 1,000 residents^{xliii} as plotted in **Figure 7** below.

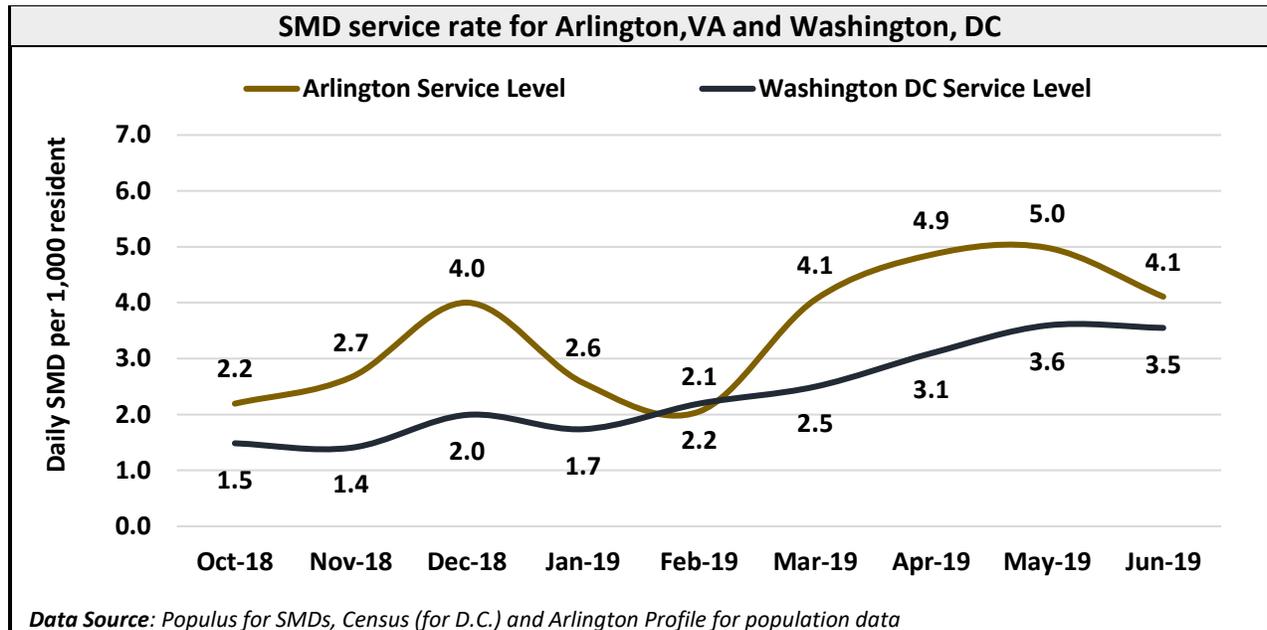


Figure 7 SMD service rate comparison between Arlington and Washington, DC

On average, operators deployed 3.5 SMDs per 1,000 residents in Arlington during the first nine month of the pilot compared to 2.4 for Washington DC during the same time period, making Arlington more highly serviced by SMDs than Washington, DC⁸. This comparison also holds when calculating a service measure of SMDs per 1,000 day-time population⁹ to account for the population who can use SMDs¹⁰. Service levels fluctuated during the pilot between an average of 2.9 and 4.5 SMDs/1,000 day-time persons. The variability in coverage can be explained by deployment fluctuations discussed previously.

Does this mean that Arlington’s level of service is adequate? The service level is still below the recommended 10-30 bikeshare bikes for every 1,000 residents by the Institute for Transport and Development Policy (ITDP)^{xliii}. However, those guidelines refer to station-based services, with dockless services potentially altering the norms. And in that sense, Arlington is more highly served by SMDs (average of 3.5 SMDs/1,000 people) than station-based bike sharing services (Capital Bikeshare = 3.1 SMDs/1,000 people^{xliv}). Moreover, taking a holistic view, the combined deployment of SMDs and station-based bike sharing services in Arlington, ranging between 6.6 and 8.1 SMDs per 1,000 residents, reflect active transportation coverage closer to the ITDP range. Nevertheless, this evaluation suggests that to

⁸ Note: unlike Arlington, Washington DC was not conducting a pilot during the comparison timeframe and the differences in terms of geography, population and intra-regional service variability across the city limit the conclusiveness of single-point comparison.

⁹ Refers to the number of people who are present in an area during normal business hours, including workers.

¹⁰ Average of 2.1 for Arlington versus 1.4 for Washington DC.

better answer this question, research should examine and develop adequacy measures pertinent to SMDs, which are likely to emerge as the technology matures and deployment patterns stabilize around a prospective long-term supply/demand equilibrium.

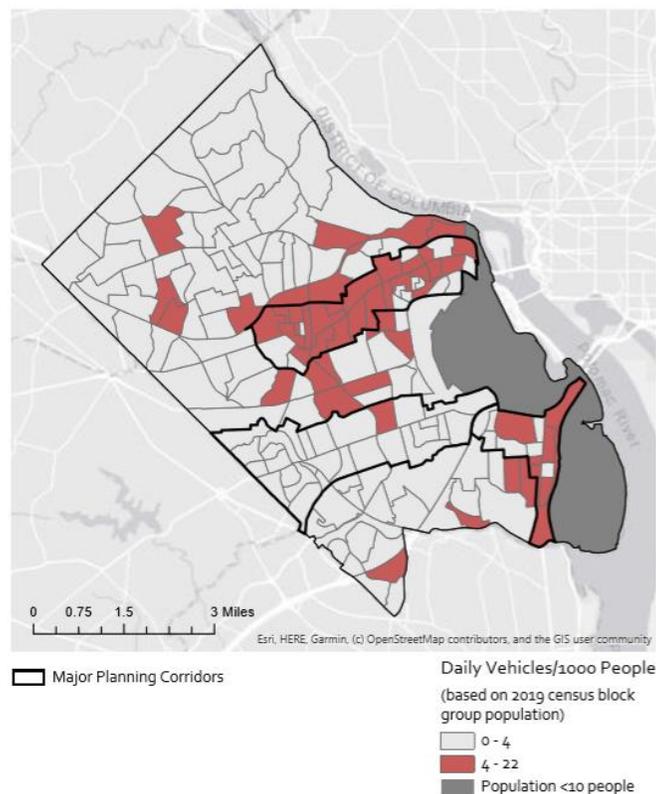
Spatial distribution of SMDs in Arlington

Key question: *Where are available SMDs clustered in Arlington? And how does it relate to land use and low- and high-income neighborhoods?*

After looking at the overall availability of SMDs in Arlington and examining the question of “adequacy” or “sufficiency” of service, this section turns to looking at the spatial distribution of available SMDs in Arlington County.

Overall distribution of SMDs in Arlington County

While the Arlington County agreement with operators is for deployment throughout the Arlington region, the **population of SMDs in operation over the first nine months of the pilot did cluster around two major corridors: Rosslyn-Ballston (R-B) and Route 1**, as seen in **Figure 8** below. This holds true both in terms of daily vehicles/1,000 people¹¹ (**Figure 8** below) and the absolute measure of average daily SMDs. The map shows a binary distribution of levels lower than average service in Arlington (0-4 SMDs/1,000 people) and above average service in Arlington (4-22 SMDs/1,000 people).



*Data source: Populus.ai.

¹¹ Four was chosen as a cutoff representing the average daily SMD for the County.

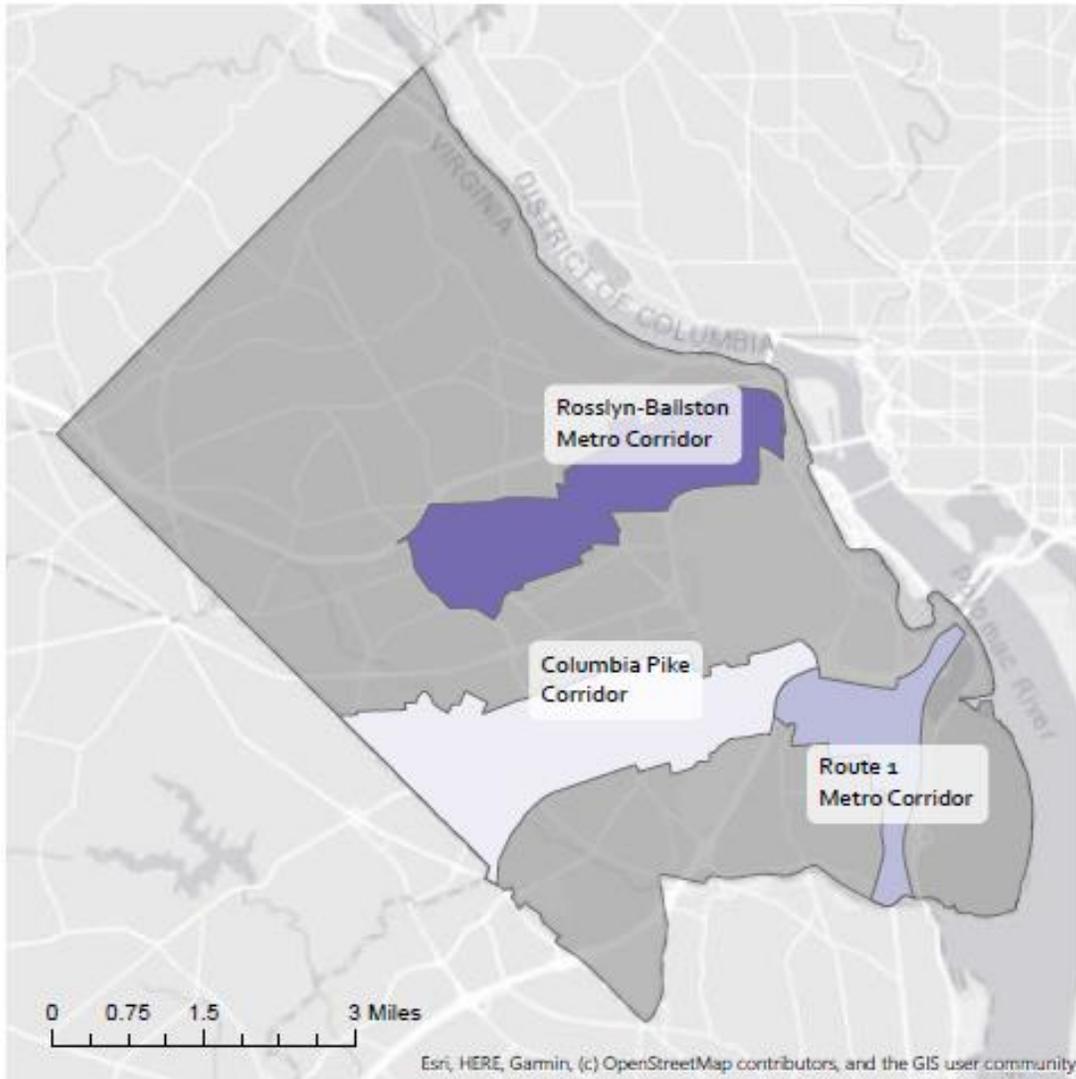
Figure 8 Spatial distribution of average daily SMDs in Arlington County (above and below ARL average service level of 4.0)

This distribution of SMD availability expectedly correlates with areas of high population or commuter density but also high transit accessibility. The characteristics of the major planning corridors (depicted in Figure 9 below) are as follows:

- The **R-B Metro corridor** represents an area of high-density, mixed-use development with high Metrorail supply. It is served by five closely spaced Metrorail stations providing access to the Blue, Orange, and Silver lines as well as local and regional bus routes^{xlv}. **The corridor was served on average by six SMDs/1,000 people and received 45% of total deployed SMDs.**
- **Route 1 (Richmond Highway) Metro corridor** includes key nodes in Pentagon City and Crystal City and is served by four Metrorail stations. Pentagon City is a dining and shopping destination and is home to an estimated 8,200 residents^{xlvi}. Crystal City is a neighborhood in transformation, close to both the Pentagon and Washington National Airport and potentially set to experience an influx of new residents and businesses as Amazon establishes its second headquarters in the area. The corridor was served on average by **four SMDs per 1,000 people and 10% of the total deployed SMDs in Arlington** over the first nine months of the pilot, equal to the average for Arlington.

By comparison, Arlington’s third planning corridor – **Columbia Pike**- is not as well-served. Despite a similar SMD count to Route 1 (10% of total SMDs deployed), higher population causes the coverage to drop to just two SMDs/1,000 people. It should be noted that this analysis only takes into consideration “residents”. However, traffic in these corridors might differ when accounting for daytime population. While daytime population data by corridor was not available for this analysis, data indicates that in 2019, the R-B corridor had 12 times more employed people than Columbia Pike and around twice as much as Route 1, not including employment rates at the Pentagon and National Airport¹². Therefore, normalized measures of service level based strictly on residents might be overestimating the disparity between the corridors.

¹² Data from Arlington Profile 2019: https://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/31/2019/05/Profile2019_5_10_19_FINAL.pdf; based on Arlington County’s CPHD estimates, there is an estimated 26,560 jobs in Pentagon and 7,750 jobs in National Airport.



Name	Average Daily SMDs/1,000 People	Percent Daily Average SMDs per Corridor
Columbia Pike Corridor	1.94	9.5%
Route 1 Metro Corridor	4.28	10.0%
Rosslyn-Ballston Metro Corridor	6.35	45.1%

*Data source: Populus.ai.

Figure 9 Average Daily SMD vehicles by major planning corridor¹³

Equity consideration of daily available SMDs

Key question: What does the distribution of SMDs say about operations and equity? For example, how does the service level of SMDs differ between lower- and higher-income neighborhoods in Arlington? and, how is South Arlington served as compared to North Arlington?

¹³ Jefferson Davis Metro Corridor is Route 1 corridor also to be renamed as Richmond Highway

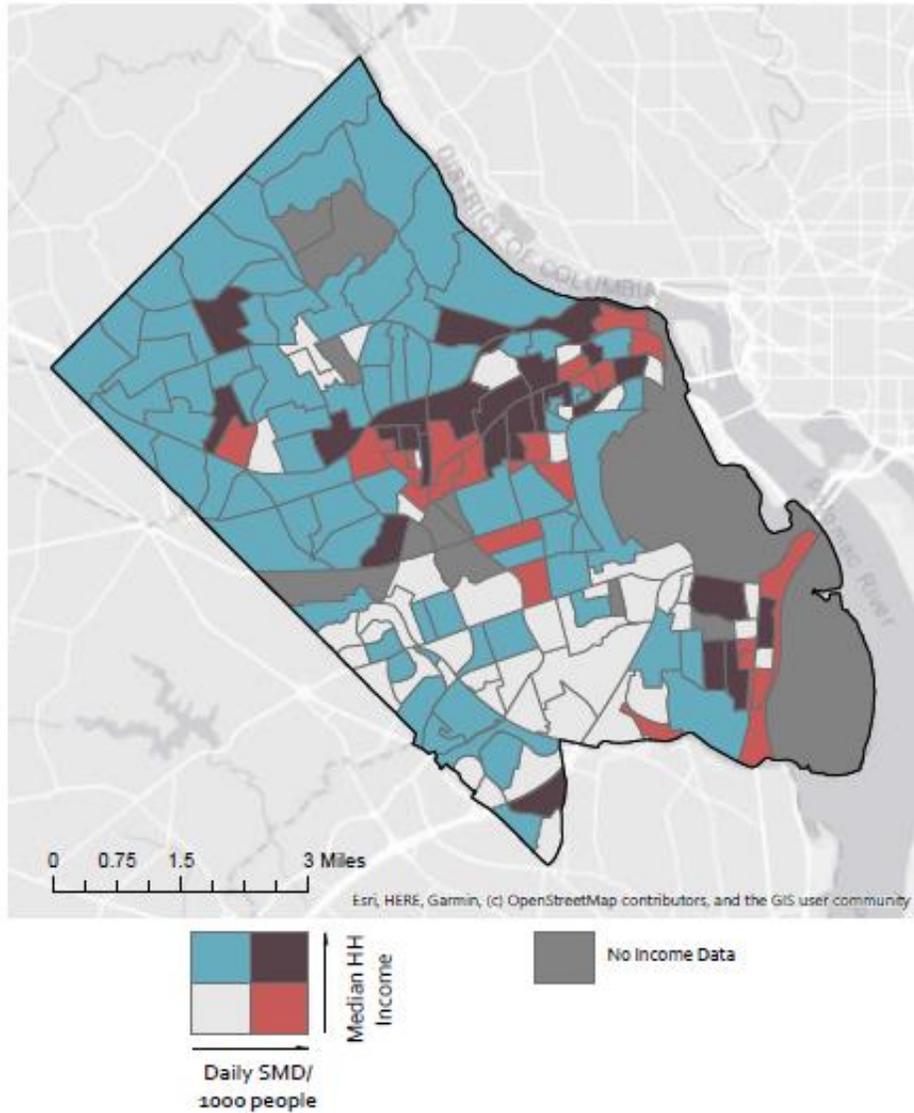
Lower than Arlington median income neighborhoods and SMD service levels

Overlaying **Figure 9** in the previous section (SMD distribution) with a map of income levels in Arlington, paints a picture of **the difference in services between lower than Arlington median household income and higher than Arlington median household income (See Figure 10 below)**. Arlington’s 2018 median household income of \$110,388^{xlvii}.

This measure, chosen primarily due to availability of data, quantifies differences between uneven regions in terms of income but does not entirely characterize “low income residents” or areas of “poverty” as defined by Arlington¹⁴.

The results reveal four key combinations: higher-income/higher service (black), higher-income/lower service (blue), lower income/higher service (red) and lower income/lower service (white), with areas having insufficient data colored in gray. This analysis shows that there are lower than ARL median income areas receiving high service levels as depicted in **Figure 10** below implying the potential for this mobility service to serve lower-income neighborhoods.

¹⁴ There is a data mismatch between deployment (at the block level) and poverty levels (available at the neighborhood level) as well as a lack of conversion from HH income to poverty level to be able to do an analysis of true “low income” areas



*Data source: Populus.ai.

Figure 10 Bivariate distribution of SMD service level and income in Arlington County

However, looking closer at the distribution of service level along the four quadrants/colors identified in **Figure 10** (See **Table 4** below) also reveals that there is room in improvement for better serving low-income neighborhoods as 29% of Arlington’s population falls in low-income areas with lower than average service level. To improve this situation, this analysis could be highlighting areas to start with.

Table 4 Population percentage in different income and service level combination areas

		Median Household Income	
		Below ARL median income	Above ARL median income
Service Level	Below four SMD/1k people	30% of ARL population	42% of ARL population
	Above four SMD/1k people	13% of ARL population	15% of ARL population

Daily average SMDs in South versus North Arlington

Available data through Populus also allows for an analysis of the difference in service between North and South Arlington, which they define as separated by U.S. Route 50 based on Arlington County’s definition. **Figure 11** below shows the difference between the service received between the two areas considering the respective resident population size of each area.

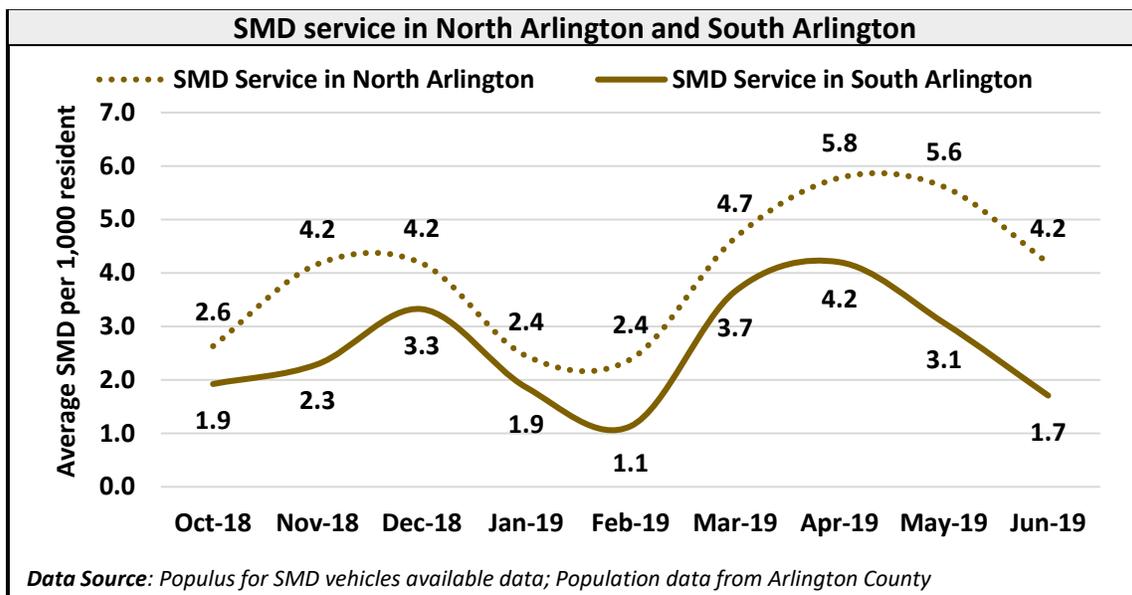


Figure 11 Comparison of SMD service level between North and South Arlington County

Normalized measures of service by residents shows that **North Arlington service levels exceeded South Arlington levels throughout the pilot period to date.** In fact, it received between and 1.3 times and 2.5 times more service, with the gap widening since April. However, in the absence of daytime population by subcounty level, this disparity might be overstated. Employment levels in 2015 show that North Arlington has 1.3 more employed people than South Arlington. North Arlington might also be getting more visitors than South Arlington. This remains an analysis for future research. In the absence of daytime population data, to promote equity, local policymakers could use this analysis to mandate for a more equitable distribution of service across North and South Arlington.

Operational challenges and compliance with the agreement

The evaluation of the pilot identified ten main operational challenges resulting from the presence of SMDs. Some of these challenges are breaches of the Memorandum of Agreement between operators and Arlington County. The challenges are enumerated below and described thereafter in **Table 5** below:

- 1. Inconsistent deployment of SMDs**
- 2. Inadequate deployment sites such as buses and sidewalks**
- 3. High operating speed**
- 4. Sidewalk riding**
- 5. Broken SMDs**
- 6. Thefts and vandalization of SMDs**
- 7. Idle SMDs for more than seven days**
- 8. Incorrectly parked SMDs**
- 9. Crashes and injuries**
- 10. Data**

Table 5 Summary of main operational challenges for the SMD pilot

	Operational Challenges	MOA Breach? And how it was addressed
Inconsistent deployment of SMDs	In March 2019, an operator formally suspended their e-bike service with bikes removed from service beginning in February 2019 when the operator decided to pull out due to differences in regulations between Arlington and Washington, D.C. Deploying too many e-scooters at any site.	No
Inadequate deployment sites	Deployment sites at bus stop zones and main footpath of sidewalks were obstructed by SMDs being deployed in these sites. Limiting service to certain neighborhoods, a breach of the MOA	Yes - the County required the operator remove device within two hours of a report. Yes - addressed by the operator upon the County's request.
High operating speed	Arlington County received complaints of speeding, which suggests that operators were not limiting speed to 10 MPH for e-scooters as agreed in the MOA.	Yes - County staff speed-tested the vehicles, however, no formal request was made to correct.
Sidewalk riding	263 emails (36% of emails) received by the Mobility Inbox discussed sidewalk riding.	No – customer-focused, rather than operator-focused.
Broken SMDs	Four out of the six active operators reported broken SMDs. Monthly variability ranges between two and five percent of SMDs were reported broken in the County. For November, December and January, when there was a possible distinction between scooters and e-bikes, broken SMDs mostly were scooters (88-98%). 17 emails out of 727 (2%) sent to the Mobility inbox referenced a broken SMD.	Maybe – the County enforced a suspension due to a fleet defect, however, not for broken devices.
Thefts and Vandalization	As a separate category, one operator reported one SMD being vandalized or stolen in February 2019 but 28 of 727 emails received (4%) to the mobility inbox discussed stolen or vandalized SMDs.	No
Idle SMDs for more than seven days	N/A Only one operator reported idle SMDs for December to February.	Yes – the County notified the operator to remove the handful of idle vehicles.
Incorrectly parked SMDs	The number of incorrectly parked SMDs per 1,000 trips increased from 12 incorrectly parked SMD per 1,000 trips in October to 37 incorrectly parked SMD per 1,000 trips in February and decreased thereafter monthly to 13 incorrectly parked SMDs per 1,000 trips in June. Arlington County has been closely monitoring this issue by recording the time the complaint was received and the time taken by operators to respond in order to determine compliance. It is estimated that operators have been compliant with guidelines roughly a third of instances, non-compliant a third of instances, with data insufficient to verify response time for the remaining third of instances.	Yes – the County notified the operator to remove the improperly parked vehicle within two hours. County staff and operators are working together to raise awareness on good parking practices including sending emails, promoting tips on County websites and participating in community events. The County has the authority to impound improperly parked devices but has not impounded any improperly parked devices; however, it notifies the operators upon receipt of a complaint of an improperly parked device. The ACPD has not issued any tickets for improperly parked devices since the demonstration began. To in part address some of the parking concerns and to facilitate SMDs connecting commuters to public transportation options, the County

		designed seven locations at six Metrorail stations on the Rosslyn-Ballston and Richmond Highway corridors for SMD parking “corrals”.
Crashes and injuries	<p>There were 69 crashes in total between October 2018 and June 2019. Those resulted in approximately 29 injuries. In terms of percentage of total trips, crashes increased from 1 SMD crash per 10,000 trips to 2.6 crashes per 10,000 trips in February 2019. This number fluctuated thereafter and was at 1.5 SMD/10,000 trips in June 2019. There were no reported fatalities. Crash statistics should be read in the context of a new technology for which studies have shown that a third of crashes occur on the first use, potentially skewing figures higher.</p> <p>Twenty-five percent of crashes pertain to single SMD crashes, followed by SMD collision with a moving vehicle (12%), then SMD with a pedestrian (9%), SMD with a moving vehicle and a damaged SMD (3%) and crashes involving a cyclist and SMD (1%).</p>	No
Data	Operators were not always compliant in the type of the data (e.g. operational data on broken SMDs) or quality of the data that was submitted and the timeframe requested for data submittal.	Yes - County staff created a data template for operators to help optimize how the County oversees the operation and the evaluation. In one instance, the County sent a Notice to Correct to an operator as its data submittal was weeks late.

A closer look at crashes and injuries

Arlington County collected e-scooter crash data from a variety of sources including operators, local law enforcement, health services, and news outlets to track the count and type of SMD crashes and injuries in Arlington County. A total of 69 crashes, 29 injuries and no fatalities were reported during the first nine months of the pilot.

To adequately characterize scooter safety performance based on crashes and injuries reported, it is necessary to **(1)** understand how it compares to other modes such as cars, and active transportation and **(2)** acknowledge the initial challenges with new technologies and the need to wait for technology to mature and for more people to be making regular (rather than first time) trips on scooters. In the case of the latter, this is because the first nine months of the pilot are expected to see higher incident and crash counts than that of which will characterize e-scooters in the long-term as familiarity increases. A study in Austin showed that a third of incidents happen on the first use and that sixty-three percent of people interviewed said they had ridden a scooter less than nine times when they were injured^{xlviii}. Along those lines, the comparison with other modes is not entirely fair as other modes have matured and have more experienced riders. This should be kept in mind when interpreting the graph in **Figure 12** below.

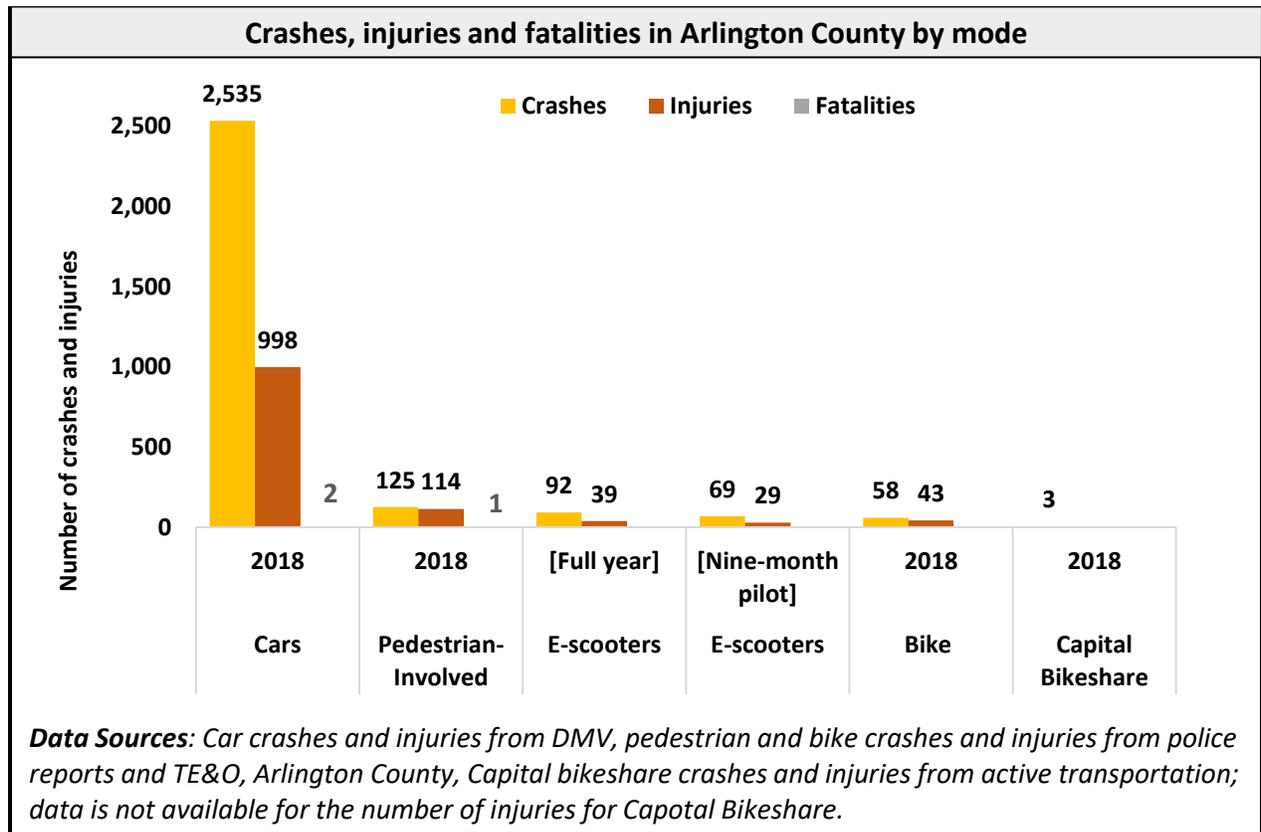


Figure 12 Crashes and injuries across modes in Arlington County¹⁵

The results in **Figure 12** above suggest that e-scooter crashes and injuries are closer in magnitude to pedestrian and bike crashes and injuries, with average crashes between pedestrians and bikes. Moreover,

¹⁵ We did not have data on the number of injuries for Capital Bikeshare.

e-scooters in the pilot did not record any fatalities, while there were two car fatalities and one pedestrian-involved fatality in 2018.

However, when comparing to other modes, it is important to look at normalized measures of crashes that reflect the difference in exposure between the modes given the variation in speed, distance traveled and trip counts. These could be measures of (1) crashes per 1,000 miles, (2) crashes per 1,000 trips, and (3) crashes per 1,000 people.

Given available data including approximations of the number of bike and pedestrian trips in Arlington, an imperfect conversion rate for bike and pedestrian from trips to mileage and the absence of an accurate number of car trips, the research team found **qualitatively** that normalized measures of e-scooter crashes are lower than pedestrian but higher than bike crashes.

In comparison, looking at other major pilot program evaluation reports, the City of Baltimore was the only one that compared crashes and incidents across modes and found similar results of more crashes than bikes but less than pedestrians and categorized scooters as safer than cars based on the measure of crashes per 1,000 people.

In summary, the following should be kept in mind in terms of examining the safety performance of e-scooters:

- **Comparing new technologies with well-established modes:** Comparing e-scooter crashes to the rest of the modes could skew results given that a third of the crashes usually happen on the first ride, reflecting in part the unfamiliarity of first-time riders (and/or inadequate initial operator instructions) rather than an inherent risk of SMD devices themselves. Sixty-three percent of people interviewed in the Austin study said they had ridden a scooter less than nine times when they were injured^{xlix}.
- **Data for e-scooters and the rest of the modes are imperfect, limiting the ability to compare.** E-scooter data has limitations in terms of under-reporting in hospitals (i.e. not having a separate category for e-scooters). On the other hand, Arlington County does not have a perfect measure of the total number of miles and trips for pedestrians and bike. The counts used in the analysis in **Figure 12** were taken from two counters around the County and are likely to be an underestimation of the total volume, thereby biasing the pedestrian and bike crash rate upwards.
- **It is likely that crashes or incidents are underreported.** SMD mode specific data on crashes is not currently available from local hospitals, and it has been impossible to get state-level data from the Virginia Department of Transportation (VDOT) as their crash reporting forms do not track shared e-scooter and e-bike crashes.

Finally, it should still be noted that scooters (as the rest of the evaluation will show) are expected to remove cars off the road, which could result in fewer crashes on a net basis.

Many operational challenges cited in the previous section can be limited by adequate communication with the community to raise awareness on the rules, regulations and good practices of SMD riding and parking. In the following section, the quality of the communication with the community is measured and assessed.

Information Supply: communication with the community during the pilot program regarding operations

Key questions: *Where do people in Arlington get their information on SMDs from? Are they aware of the rules and regulations? How efficient were operators in communicating the necessary information?*

The communication of information on the SMD pilot to the Arlington community was facilitated through multiple sources such as:

- (1) **Arlington County's website**¹⁶, containing information on the pilot, a link to the complaint email and external resources (such as Arlington Transportation Partners¹) on rules and regulations
- (2) **Arlington Outreach events** where Arlington communication staff attends major community events to increase awareness of the program and gauge reactions on the pilot
- (3) **Operator's messaging** when a rider signs up for the service and before they unlock their SMD device

Arlington County's online feedback form (described in the Research Approach section of this report) helped answer questions regarding the importance and efficacy of these communication platforms¹⁷.

➤ **Where do people in Arlington get their information from?**

The results of the feedback form present several interesting conclusions with regards to the provenance of key information. The key elements are discussed below and provided in **Figure 13**.

The first is that **the main source(s) of information for SMD riders are the operators' apps or websites**, stressing the importance of continuously monitoring and pushing information through this outlet to make sure that riders are getting a comprehensive and accurate set of information in the appropriate language as the County deems necessary to differentiate guidance from legal requirements (e.g. "you should not ride on sidewalks" vs. "it is illegal to ride on sidewalks in Arlington").

The second important observation is that **there is ample room for increasing awareness** whereby 20-22% of SMD riders do not know what the "laws" are and 43% of non-riders (but potential future riders) are also unaware. The high percentage of non-SMD riders who do not know the laws is also critical because it could be biasing community opinions of scooters and scooter behavior in Arlington. For instance, if they think that SMD riders should be wearing helmets, they might consider riding without a helmet as erratic behavior and bias their opinion of the performance of this mobility service and of the pilot program more generally.

Third, **around 10% of riders and 20% of non-riders get their information from Arlington County's website** which suggests that this platform should be leveraged to raise awareness.

Similar results were found in Virginia Tech's SMD survey for Rosslyn.

¹⁶ <https://transportation.arlingtonva.us/scooters-and-dockless-bikeshare/>.

¹⁷ For feedback form length limitations, these questions were not included in the in-person feedback forms.

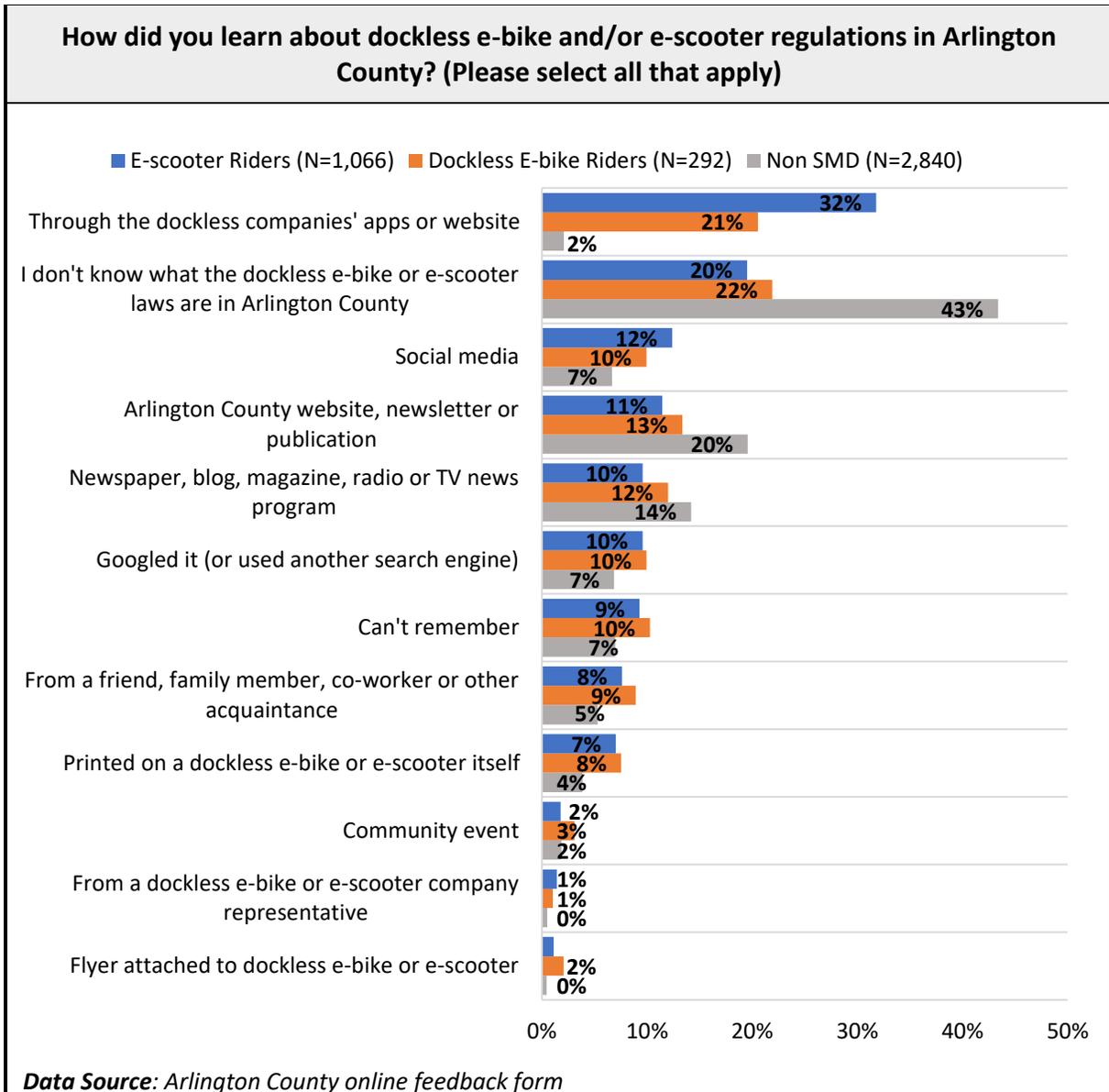


Figure 13 Source of information on e-scooter regulations according to the online feedback form

➤ **Are people in the Arlington Community aware of SMD rules and regulations in general?**

After examining where respondents got their information from, their level of awareness of different rules and regulations in Arlington County was measured next. Respondents were prompted to determine which of a set of SMD riding options are “allowed” to do in Arlington¹⁸, with results presented in **Figure 14** below. For comparison purposes, the correct set of rules and regulations are marked with a check mark in **Figure 14** and what they are not allowed are marked with an **X**.

¹⁸ For “rules” tested in this question, refer to [Arlington Transportation Partners \(2019\)](#).

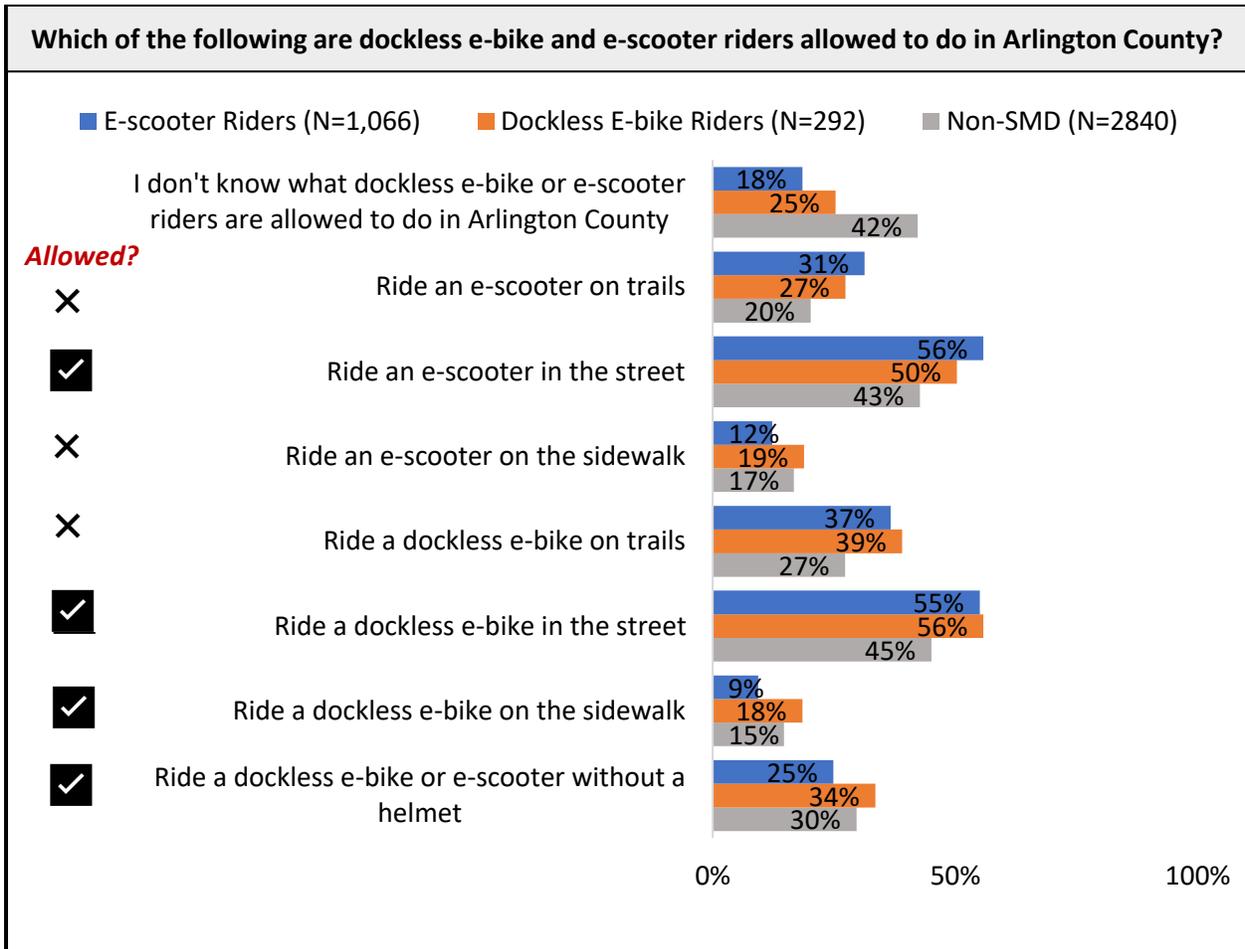


Figure 14 Awareness of SMD rules and regulations in Arlington County according to the online feedback form

The results of this assessment are more striking, with a significant degree of variability in the relative familiarity of both riders and non-riders with the rules and regulations of SMD ridership. For instance, **more than 80% of e-bike riders were unaware that they could ride on the sidewalk.** While some rules, such as scooter ridership on sidewalks, appeared to be more broadly understood, albeit still below desired levels (12% of e-scooter riders thought they were allowed to), there remains ample room for improvement as results clearly indicate that a significant share of riders and non-riders are generally unfamiliar with rules and regulations.

Several other observations from this question are worth highlighting. A first observation is that the percentage of SMD riders who think they can ride on trails is relatively high (31% for e-scooter and 39% for e-bikes). In the case of e-bike riders, some confusion could be due to the fact that e-bikes are allowed on the W&OD trail only. The second observation is that the percentage of riders of either scooters or e-bikes who chose the correct laws corresponding to their used mode remains relatively low. For instance, only 18% of e-bike riders and 15% of non-SMD riders know that dockless e-bikes could be ridden on the sidewalk.

The main conclusion from this question is that there is room for improvement in raising awareness as to what riders can do. Uniform laws across neighboring jurisdictions (while complicated in practice) could

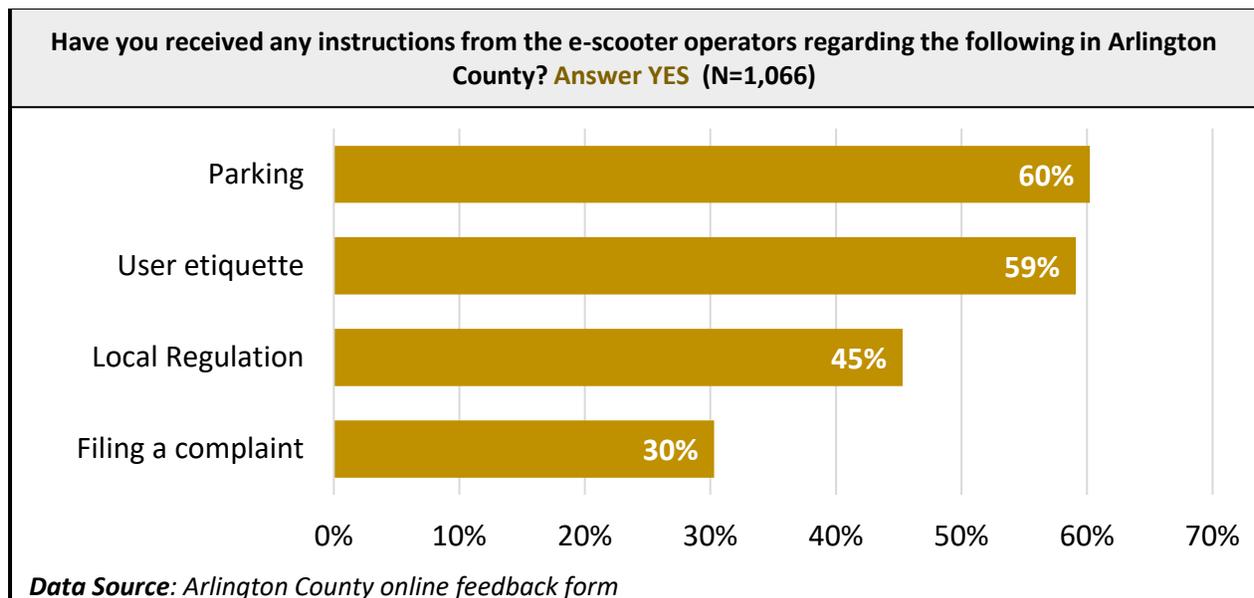
also help more clearly define a common set of parameters for riders to be familiar with. Also, while keeping in mind the importance of keeping the riders’ experience seamless (given that convenience is likely one of the main drivers of using SMDs), innovative pathways could be required to make sure riders are aware of rules and regulations. An example is a quick 30- to 60- second test before each new account unlocks an SMD type (scooter or dockless e-bike) for the first time with the options highlighted in our questions above, requiring successful completion of the questionnaire before unlocking the device.

➤ **Are operators pushing SMD rules, regulations, messages and best practices adequately?**

Operators provide pop-up messages to riders regarding correct parking procedure when riders first rent a device through an operators’ app and periodically thereafter. They also provide informational emails and ad campaigns to the general public, demonstrations at community events, and they have the ability to assess penalties to riders who park incorrectly.

Similarly, operators were also receptive to County requests to instruct their riders on proper operational etiquette promoting safe and responsible behavior. This included introductory and periodic instructional reminders when using the respective operator’s app to rent scooters; promotional campaigns such as Lime’s “Respect the Ride” campaign reminding riders to obey all traffic signs and signals; dispatching brand ambassadors into the County to educate those riding on the sidewalk; etc.

To test the efficacy of such communication, respondents were asked what information they got from operators and the results were summarized in **Figure 15** below.



**"user" etiquette was used in the feedback form and included here for accuracy. "users" are referred to as "riders" throughout this report. Note: axis not set to 100%.*

Figure 15 Efficacy of operator messaging according to the feedback form respondents

Most respondents reported having received instructions from the e-scooter operators on parking (60%), and user/rider etiquette (44%). User/rider etiquette was intentionally left broad given the variability in the focus of different operators in this regard. As an example, user/rider etiquette could be acts of courtesy such as showing pedestrians you’re sharing the sidewalk that you are aware of their presence by making eye contact or smiling. **Less than half of respondents (45%) indicated that they had received**

information from operators on local regulations and less than a third (30%) indicated that they received information on filing a complaint.

This implies that there is room for improvement in terms of having companies push more and improve messaging on local regulations and on the ability to file a complaint. This would help cities better manage these services by (1) making sure riders know about the rules and regulations, and (2) by being able to track the performance of these services and address or hold operators accountable once they have access to the complaints. This is all the more important in the context of responses to the previous section where companies were the main source of information for riders of SMDs.

Below, the analysis turns to assessing the pilot from the rider's standpoint in terms of trips taken and rider characteristics.

SECTION 2 - SHARED MOBILITY DEVICES (SMD) UTILIZATION

In this section, the analysis turns to the demand side of the SMD pilot to look at ridership data and riders' characteristics. This section uses a combination of data sources, complementing operator data with feedback received through the online and in-person feedback forms.

Number of trips taken on SMDs in Arlington County

Key questions: How many trips were taken in Arlington during the pilot?

In line with patterns uncovered in the availability of SMDs in Arlington County, SMD utilization fluctuated over the course of the pilot (See **Figure 16 and 17** below). The first month of the pilot saw ridership of around 60,000 monthly trips in October 2018 before decreasing significantly over the winter months, to lows around 23,000 trips per month in January and February 2019. Ridership increased gradually thereafter to a high of around 80,000 in May. The first phase of the pilot ended in June with around 60,000 trips, with the dip possibly in part reflecting the contraction in available SMDs in circulation, discussed previously. The fluctuation broadly mirrors some of the trends in availability of SMDs, with weather and lower winter deployment likely determinants in the seasonal decline in ridership.

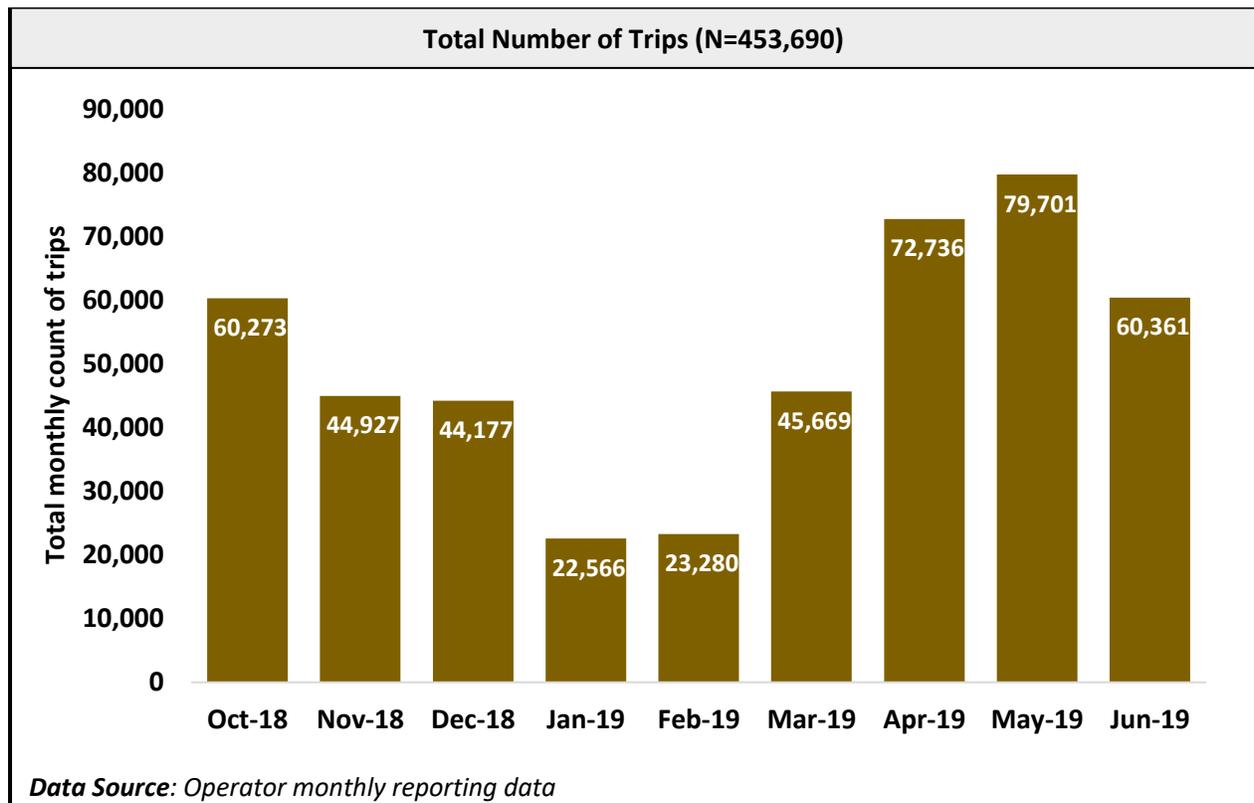


Figure 16 Total number of trips taken on SMDs in Arlington County by month between October 2018 and June 2019

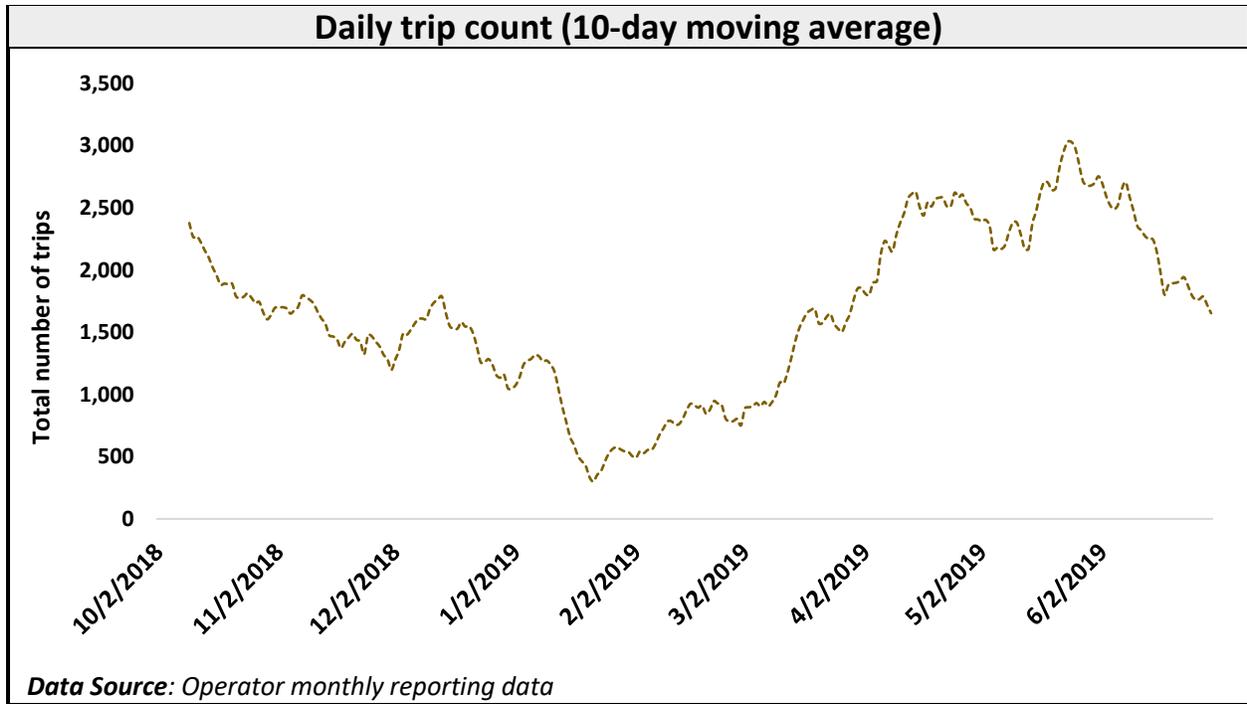
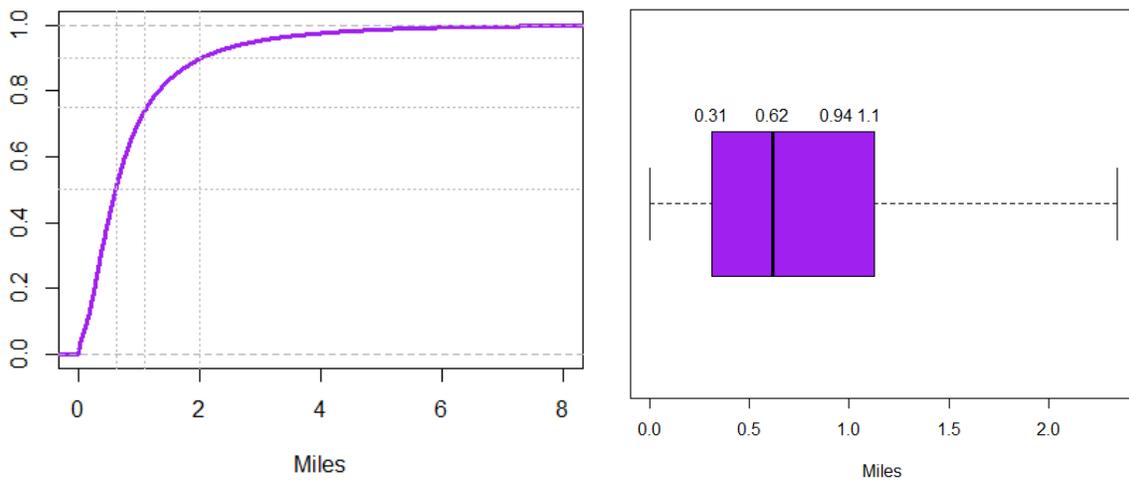


Figure 17 Ten-day moving average of the SMD daily trip count

Trip Characteristics

Key questions: what do we know about the characteristics of these trips? In terms of distance, time and distribution over the day?

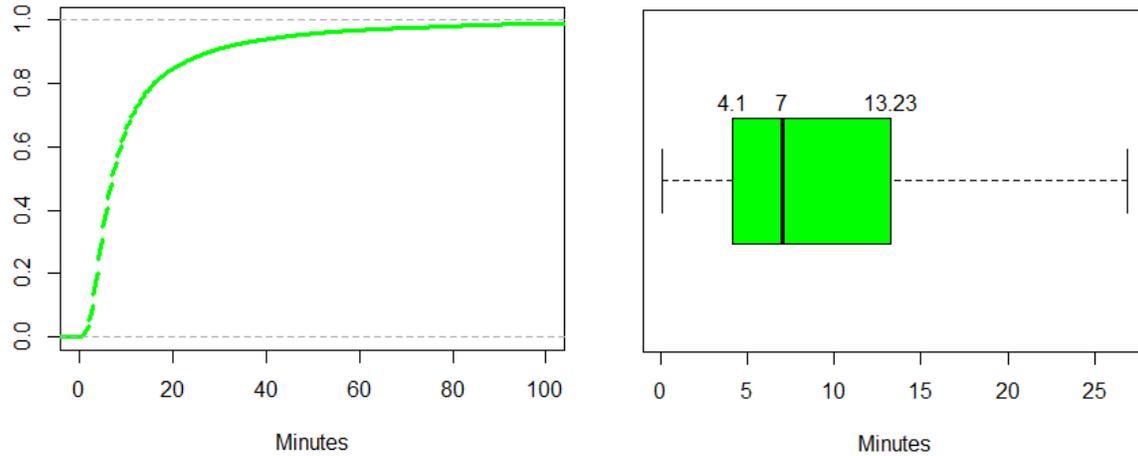
Short trips dominated the SMD trips landscape in Arlington over the first nine months of the pilot with an average distance of 0.94 miles per trip. **Figure 18** below represents the cumulative distribution of SMD trips in Arlington, showing that half of the trips were below 0.62 miles, 75% of the trips are below 1.1 miles and 90% are below two miles, which is the average trip distance for the Capital Bike Share system^{li}.



*Data Source: Operator Monthly reporting data

Figure 18 Distribution of distances traveled by SMDs between October and June

Figure 19 below represents the distribution of SMD trips by duration (in minutes). The average trip time is of 14 minutes, with half of the trips completed under seven minutes and 75% of the trip under 13 minutes in duration. While this is not surprising given that most SMD trips are under a mile in terms of distance, it remains an important indication that the extent of the interaction between SMD riders and their devices is relatively limited.



*Data Source: Operator Monthly reporting data

Figure 19 Distribution of SMD travel time between October 2018 and June 2019 in Arlington County

Key questions: how are these trips distributed in time?

Figures 20 and 21 below depicts the number of trips by time of the day for weekdays and weekends separately. Results show that on weekdays, 42% of trips occurred during rush hours with 24% of the trips taking place during the morning rush hour and another 18% of the trips (approximately 58,500 trips) occurring during the afternoon rush hour. This points to an important role of SMDs in commute patterns. The Portland evaluation also found that 19% of their trips occurred during the afternoon rush hour.

Furthermore, according to ridership data, 70% of trips took place during weekdays while 30% of trips took place on weekends, although Saturday ridership was the highest day in terms of ridership over the 9-month period. This usage distribution, at least in terms of rush hour peaks and weekend vs. weekday ridership, is similar to what was found in the Washington, DC SMD evaluation report.

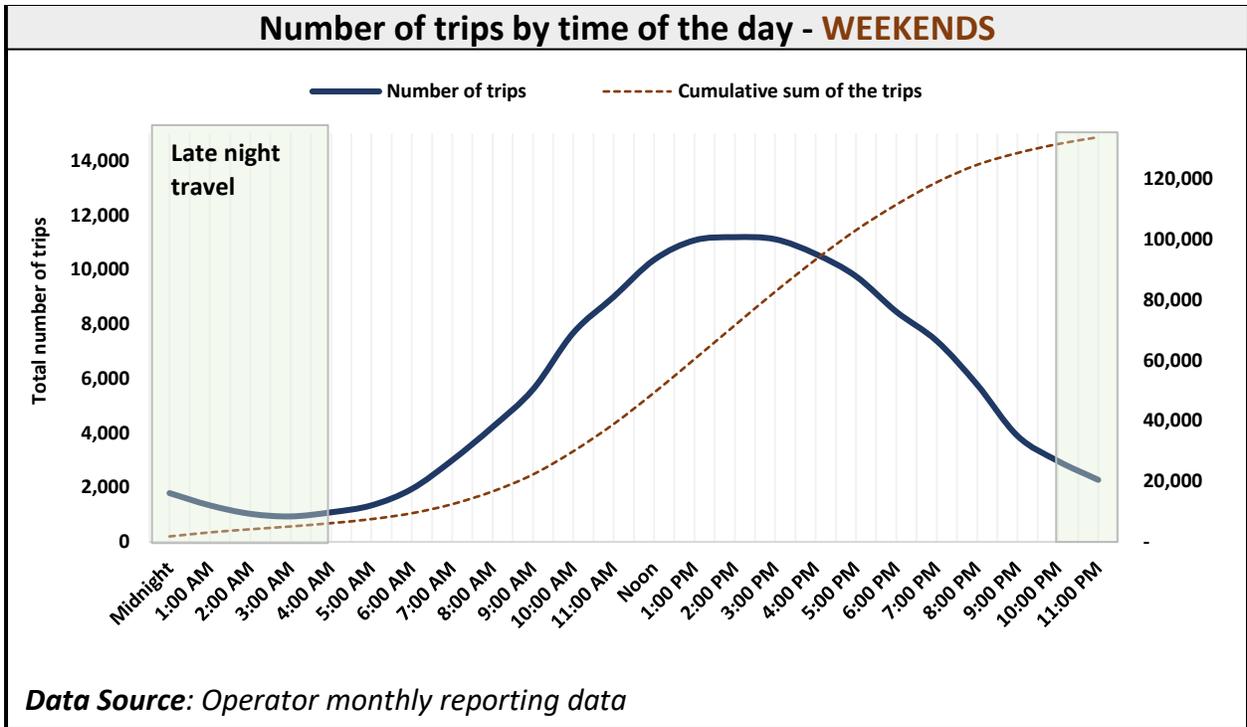


Figure 20 Distribution of SMD trips by time of the day on weekends

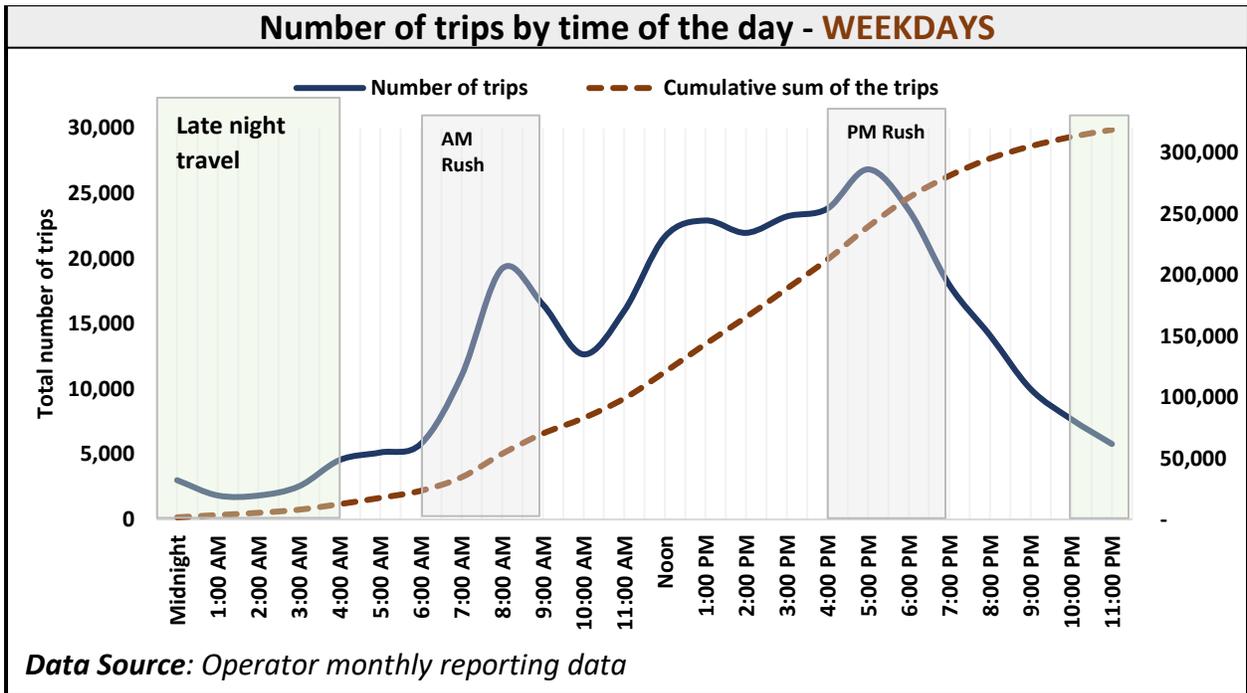


Figure 21 Distribution of SMD trips by time of the day on weekdays

Spatial distribution of trips taken on SMDs in Arlington County

Key question: Where are people in Arlington using SMDs to go to? (i.e. how are the trips discussed previously spatially distributed in Arlington County?)

Thanks to detailed trip origin and destination data (latitude and longitude) provided by operators, the research team was able to map out the entirety of the SMD pilot program, uncovering insights into travel patterns.

As expected, given the distribution of trip distances (with the majority of SMD trips under one mile), most riders remain within the bounds of the County, with 89% of the trips starting and ending in Arlington County. Eight percent of trips started in Arlington and ended outside of Arlington and 2% start outside of Arlington and ended in Arlington¹⁹.

The color-coded map of trip origins by destination colors in **Figure 22** below also shows visually that **SMD riders are staying within their neighborhoods²⁰**. The dots on the map represent trips beginning at the location of the dot. The color of the dots represents the destination, color-coded according to the legend provided in **Figure 22**.

For instance, the cluster of orange dots in the Georgetown neighborhood of Washington DC (the waterfront area connected to Rosslyn, VA by the Key Bridge) reflects trips that originated in Washington, DC (location of the dots) but ended in Rosslyn (the color of the dots). The similarity between the map and the legend (top and bottom of **Figure 22**) where dots are of the same color as their respective neighborhoods indicate that most often, riders are using SMDs within in their own neighborhoods, with any cross-over most often occurring near neighborhood boundaries. This is a conclusion that Washington DC policymakers also reached when assessing SMD travel patterns in their own pilot program.

¹⁹ 1% of the trips did not start or end in Arlington according to the classification used in this analysis due to the difference in boundary definitions used by operators and the one found on Arlington County's website.

²⁰ The neighborhoods were defined by the researchers based on the need to divide the region into no more than nine regions for feasibility of plotting the data.

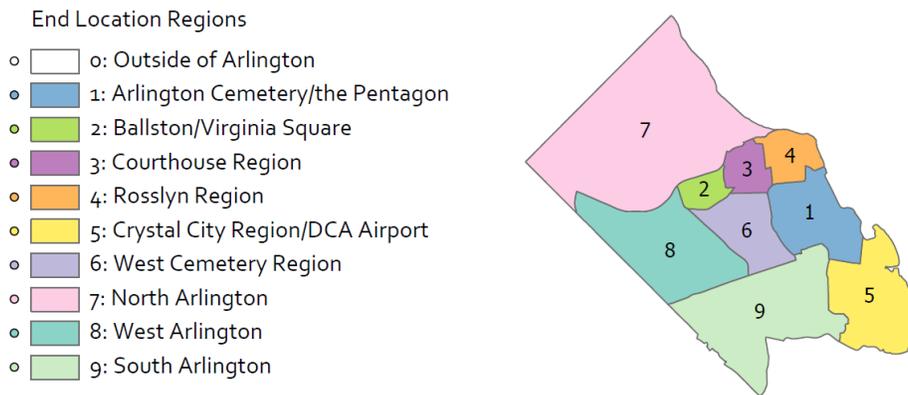
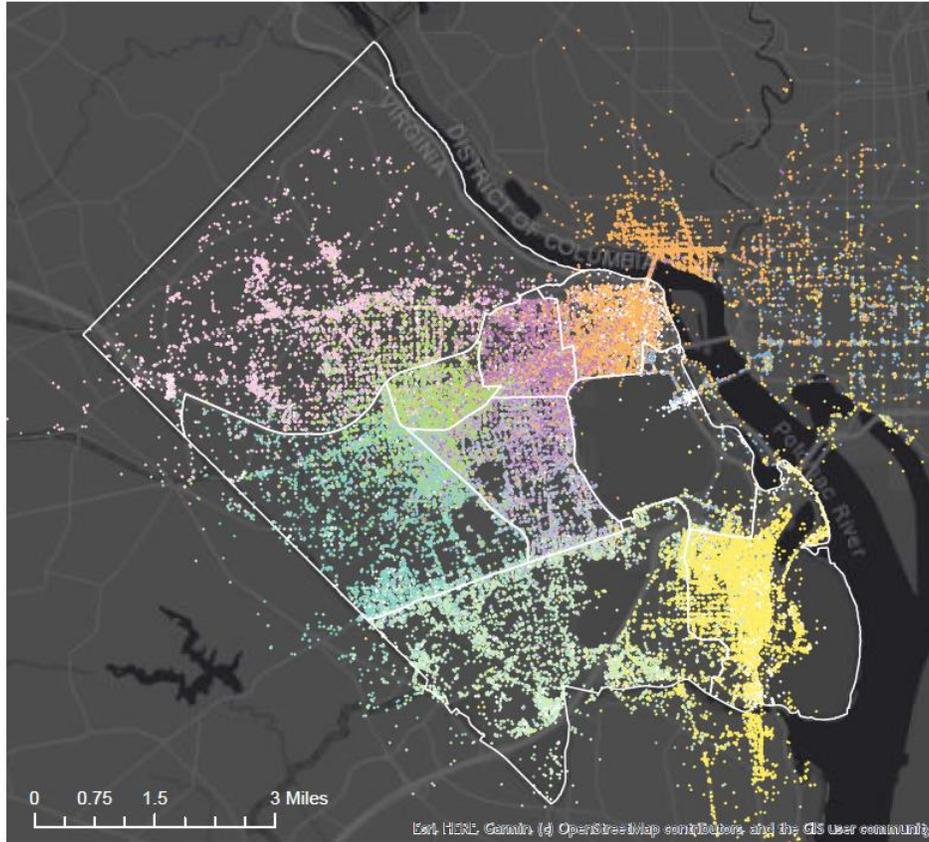
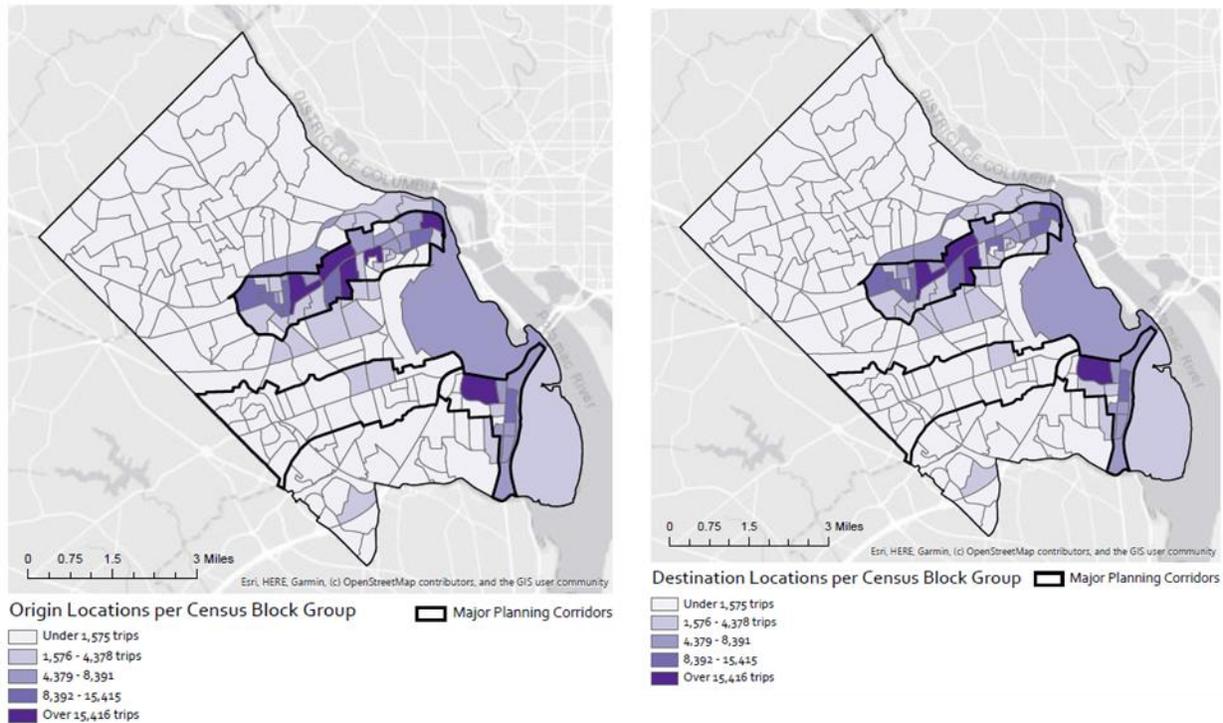


Figure 22 Trip destinations distribution for all trip origins in Arlington

In terms of specific corridors, ridership mirrors the distribution of SMDs available discussed previously in this report (section on “pilot operations”), with most of the trips clustered around the two main commercial and Metrorail corridors – the R-B corridor and Route 1 corridor (shaded in darker purple in **Figure 23** below). The R-B corridor includes 60% of the trip origins and 55% of the trip destinations, Route 1 corridor includes 17% of the trip origins and 35% of the trip destinations. The Columbia Pike corridor receives fewer trips with 4% of the trip origins and 5% of the trip destinations for the trips between October 2018 and June 2019.

It is difficult to say whether the lack of ridership along the Columbia Pike corridor is supply- or demand-driven as many factors play a role (land use, infrastructure, demographics, culture and preferences, etc...). Nevertheless, the combination of low utilization of SMDs in areas of lower deployment in Arlington County warrants further exploration. Increasing deployment in that corridor and assessing the corresponding change in utilization could help clarify the relative importance of deployment in driving ridership.

The trips are clustered in these corridors even when the population of the corridors is accounted for. Even when examining these patterns after normalizing for population, the distribution continues to show a similar concentration of trips (on a per rider basis) along the two key corridors.



*Data Source: Operator monthly reporting data

Figure 23 Spatial distribution of SMD trip origins and destinations in Arlington County

Infrastructure utilization

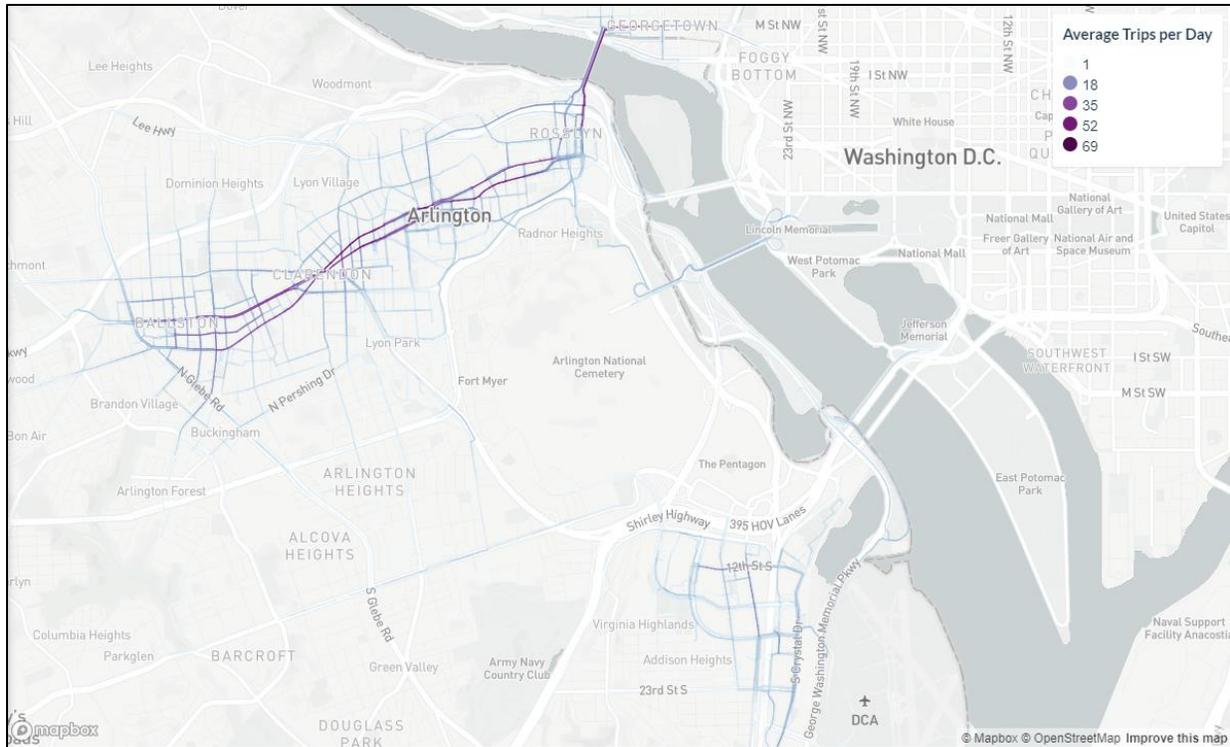
Key question: How do SMDs use Arlington infrastructure?

This sub-section looks at the main routes utilized by SMD riders, the modes used to access SMDs, the current and preferred infrastructure for riding SMDs and finally the utilization of SMD parking or corrals.

Infrastructure utilization - main routes used in the County

Based on detailed trip data including origins and destinations, the map in **Figure 24** below reflects the density of trips along key routes (87% of trips undertaken during that time) between January 1st and June 30, 2019²¹ as provided by Populus.

²¹ The Populus feature for routes was not available prior to January 1st, 2019.



*image source: Populus.ai – modified from original scale.

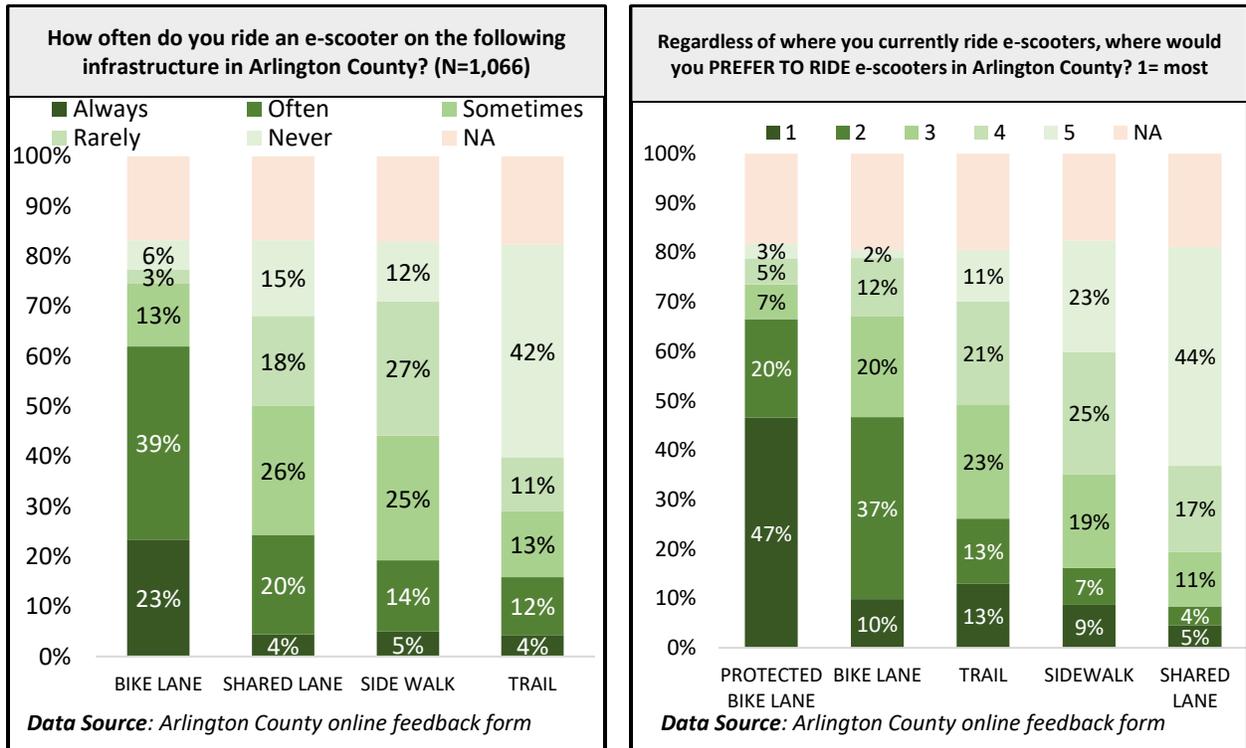
Figure 24 Distribution of SMD trips on routes in Arlington County

Mirroring the overall deployment and trip patterns, the main routes used are found in the two corridors of high use, the R-B corridor and Route 1 corridor. Within the R-B corridor, key e-scooter arterials include the Key Bridge (in and out of Washington, DC), N Lynn Street, Wilson Boulevard, Clarendon Boulevard, and 9th street in between Clarendon and Wilson boulevard is also used. For the Route 1 corridor, 12th St S, S Eads St, and S Crystal Dr are routes of high use.

Highlighting these areas is important in helping inform the allocation of infrastructure capital given funding restrictions in order to ensure infrastructure investments yield the most optimal impact. High-use routes point planners towards areas they could prioritize in terms of SMD infrastructure such as protected bike lanes, corrals, bike racks or other active transportation infrastructure.

Infrastructure utilization - from macro to micro: where do SMD riders ride?

Based on responses to the feedback form, (in Figure 25 below) bike lanes are most commonly used with 62% of e-scooter riders always-to-often using bike lanes, followed by shared lanes (24%). The percentage drops to 19% for sidewalk and 16% for trails, although such rates remain relatively elevated given that under the Arlington pilot e-scooter riders were not allowed under the Arlington pilot to use sidewalks or trails.



*NA refers to respondents who chose to skip this question or give less than 5 rankings.

Figure 25 Current and preferred use of the infrastructure according to the online feedback form

Comparing this result to where riders prefer to ride shows that riders overwhelmingly prefer to ride on protected bike lanes (67% of respondents chose it as a top or second choice) followed by bike lanes (a bit under half of respondents chose it as either a first or second choice). Shared lanes were the least favorite with only 9% choosing it as their top two choices. An important distinction can be found in examining responses regarding street ridership (protected bike lanes, bike lanes and shared lanes), with the skew in preferences reflecting the relative importance of safety for SMD riders. Interestingly, despite the broad polemic surrounding sidewalk ridership of SMDs in Arlington and other areas of the U.S., SMD riders surveyed in Arlington appeared by and large to favor street ridership than utilizing sidewalks, with only 16% of respondents pegging sidewalks as a top two choice of where to ride SMDs.

These results suggest that for the County to support this community of riders, protected bike lanes should be more widely implemented.

Infrastructure utilization - the use of corrals

With SMD parking emerging as a key issue for the community given the rise in deployment and in order to facilitate SMD connectivity to public transportation options, Arlington County staff designated seven

locations to serve as SMD parking “corrals”, or on-street locations for parking SMDs. The seven corrals, located near six Metrorail stations on the Rosslyn-Ballston and Route 1 corridors, are as follows:

- N. Lynn St. & Fairfax Dr.
- N. Lynn St. & 19th St. N.
- Clarendon Blvd. & N. Uhle St.
- N. Monroe & 9th St. N.
- N. Stuart St. & 9th St. N.
- S. Hayes St. & 12th St. S.
- 18th St. S. & S. Bell St.

Using temporary materials and spray paint, County contractors were able to install the corrals over the course of two afternoons in December 2018, with some examples pictured in **Figure 26** below, and worked with operators to include the parking areas in their respective apps.

Populus²² collected and provided visualization for data at five corrals around Arlington County as shown in the table below in **Table 6**. Two more corrals were added subsequently to their analysis at Ballston and Virginia Square.



*Images Source: [DES](#) and [Greater greater Washington](#)

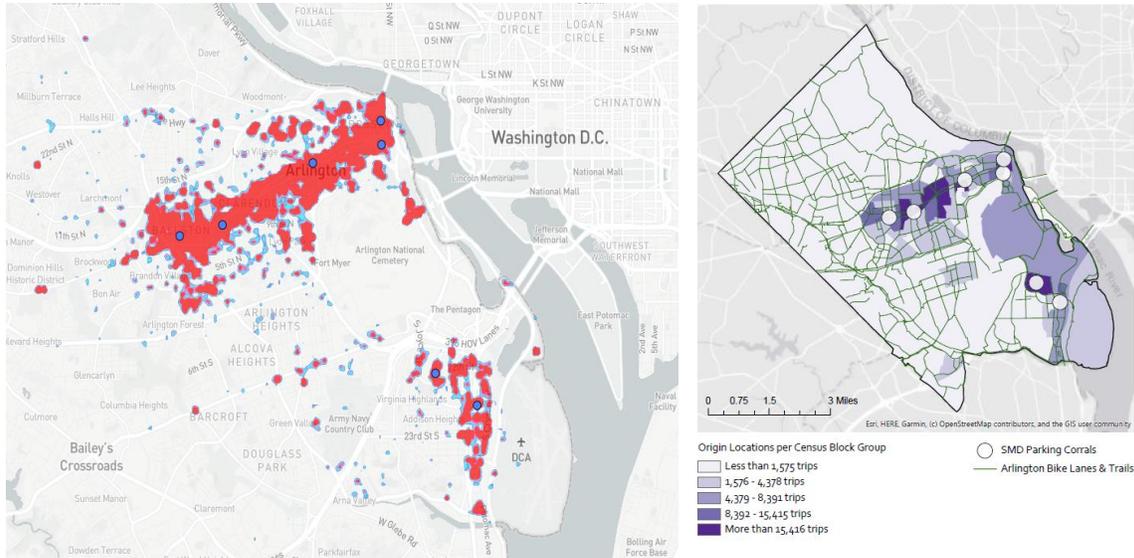
Figure 26 Images of SMD corrals around Arlington County

Table 6 Arlington County SMD corral location

Crystal City Corral	18 th St. S&S Bell St. across from Metrorail
Pentagon City Corral	S Hayes St. & 12 th S, near Capital Bikeshare
Courthouse Corral	Clarendon Blvd & N Uhle St.
Rosslyn: Lynn & Fairfax Corral	N Lynn St. & Fairfax Dr, near Capital Bikeshare
Rosslyn: Lynn & 19th Corral	N Lyn St. & 19 th St. N, near Capital Bikeshare

As illustrated in **Figure 27** below, the corrals were installed in areas of high trip utilization.

²² Populus started tracking utilization on 01/10/2019.



*image source: Populus for image on the right and Mobility Lab for image on the left

Figure 27 Corral location (a) with corral utilization, (b) with origin trip heatmap and bike lane and trails infrastructure

Analyzing ridership data in and around corrals reflects both the reasoning behind choosing such locations and the increase in parking utilization at corrals. Examining areas within 500 meters (0.31 miles) of a bike corral, the three corrals with most trips and parking events around them are in the Rosslyn-Ballston corridor: **Ballston corral, Lynn & Fairfax corral, and Virginia Square corral**. Ballston’s corral has the highest number of SMD parking events, trips origins, trips destinations, and deployment within 500 meters (0.31 miles) of the corral.

On a relative basis, bike corrals located in the Route 1 corridor (i.e., Crystal City corral and Pentagon city corral) had the lowest number of parking events, trip origins/destinations, and deployment among the six corrals identified. This can be explained in part by the relatively higher ridership along the R-B corridor.

Nevertheless, the elevated event counts in all key corral locations confirms the rationale behind staff selecting them as areas of key SMD density.

Focusing on the utilization of corrals specifically requires narrowing the scope of the analysis to these limited areas. Looking at a smaller area of **five meters** within the emplacement of a bike corral, the magnitude of activities expectedly drops from the wider area discussed above but reflects a noticeable number of parking events. The number of SMD parking events, number of SMD deployed, and trips originating and ending at five meters from a bike corral indicate that these areas are witnessing significant activity. The Virginia Square corral had the highest number of parking events within five meters from a bike corral, with around 2,800 parking events, followed by Pentagon City and Lynn & 19th St. at around 1,800 parking events a piece. Virginia Square corral has the highest number of trips originating and ending at the bike corral as well as highest deployment metrics. Using longitudinal data, there could be an opportunity to examine changes in deployment and parking trends following corral installation.

Trip Purpose

Key Questions: where are SMD riders taking trips to?

Insights from the online feedback form

According to responses from the feedback form, 18% of e-scooter riders and 8% of dockless e-bike riders indicated connecting to/from Metrorail as the primary purpose of using SMDs in Arlington County, as reflected in **Figure 28** below. This response rate validates the positive suggestions that this mobility service could act as a viable complement to transit, prospectively helping lower car ridership and/or SOVs, although more research would likely be required to further examine the potential and limitations of SMDs in this regard specifically.

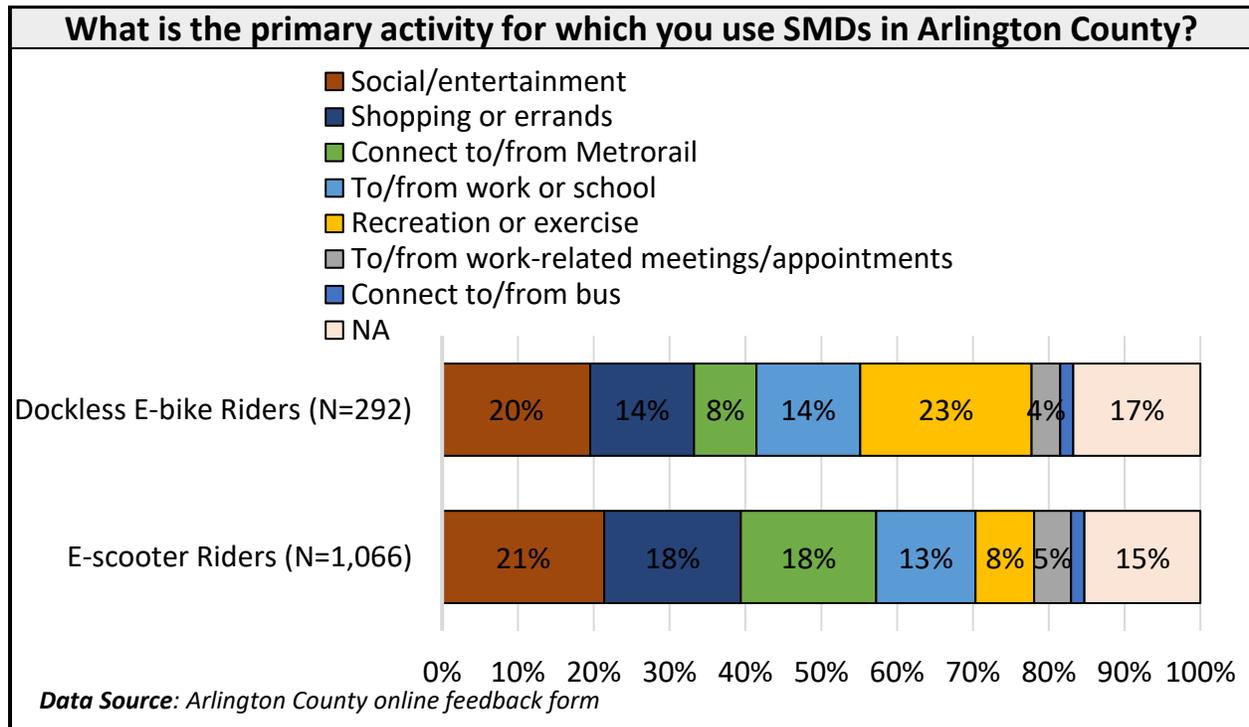


Figure 28 Primary trip purpose for SMD use in Arlington according to the online feedback form

In terms of activities driving SMD use more broadly, the feedback form pointed to social and/or entertainment as the category most cited as a primary purpose for using e-scooters in Arlington followed by connecting to Metrorail and shopping or errands. Washington DC's pilot also showed that running errands and social travel were the most common uses for dockless vehicles.

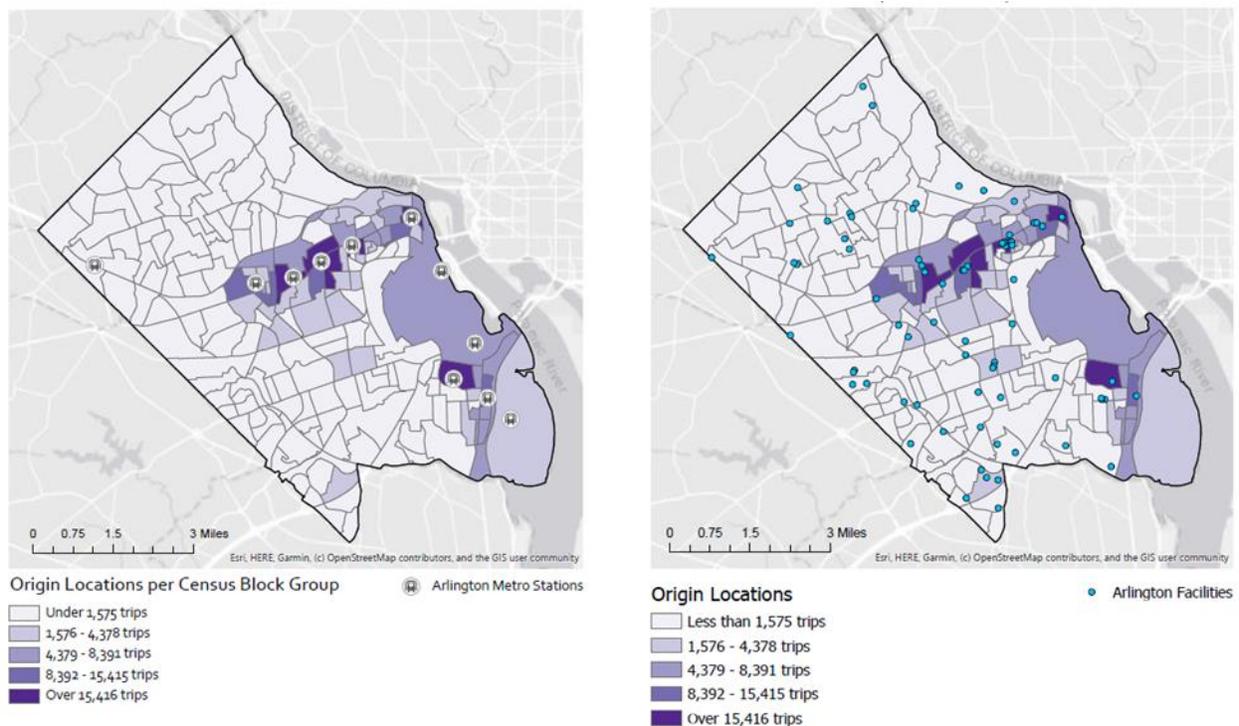
For dockless e-bikes, recreation or exercise was the activity that was most chosen as a primary activity. Both options were bundled to mirror previous surveys and allow for comparisons, but the large share may warrant unbundling recreation from exercise in future surveys in order to add granularity to the analysis. Social and entertainment was also an important category where 20% chose it as their primary activity when using dockless e-bikes in Arlington, broadly in line with e-scooter ridership.

Importantly, while there does appear to be a significant share of discretionary ridership (for social or recreational purposes), activity distribution data also point to SMDs being used to facilitate necessary

activities such as commuting to/from work or school, running errands and connecting to transit. This distribution highlights that SMDs should not be thought of strictly as a recreational convenience, but rather as part of the County's transportation ecosystem in all its facets.

The analysis below examines whether usage data from operators uncover similar trends. While examining trip data around Metrorail stations does not conclusively establish that people are using them to access Metrorail as these are also high commercial and residential areas, it nevertheless provides insight into travel patterns in and around transit stations which could indicate that riders are using SMDs to access transit.

Usage data plotted in **Figure 29 below**, illustrates that trips happen in areas of high transit supply suggesting a potential use of these SMD services as a complement or first and last mile modes for transit. The feedback form indicated this was the case from self-report perspective.



***Data source: Operator monthly reporting data**

Figure 29 Location of Metrorail stops and facilities²³ on trip origin heat maps

Transit: On average, scooter trips originated 0.38 miles away from transit and ended 0.48 miles away from transit²⁴. This short distance confirms previous discussions on trips occurring in high transit corridors and suggests the potential for scooter trips to complement transit. The analysis showed that late night trips originated and ended closer to transit stops (0.32 and 0.43 miles respectively) than overall trips indicating

²³ Facilities include: Hospitals, Fire Stations, County Offices, Nature Centers Community Centers, Recycling Centers, Pools, Post Offices as found in [Arlington County's shape files](#) (schools and Metrorail stations were filtered out).

²⁴ The average distance is computed in GIS as a straight line and should be considered as an underestimation of the actual distance.

the importance of e-scooters complementing transit when it is unavailable during late night travel. The heat maps of late night travel show a comparable spatial distribution of trips to overall travel.

The research team had data available from Populus on trips around the following Metrorail Stations: *Rosslyn Metrorail, Courthouse Metrorail, Clarendon Metrorail, Ballston Metrorail, Virginia Square Metrorail, East Falls Church Metrorail, Arlington Cemetery Metrorail, Pentagon Metrorail, Pentagon City Metrorail, Crystal City Metrorail, National Airport Metrorail.*

When counting the larger area of 500 meters (0.31 miles) from a major Metrorail stops, **the three major Metrorail stops with the most trips happening at their vicinity are Ballston Metrorail (78,000 parking events), Clarendon Metrorail (70,000 parking events), and Courthouse Metrorail (63,000 parking events)** – all of which are located in the Rosslyn-Ballston Corridor.

Ballston Metrorail is the most likely to be connected to by SMDs, in terms of the highest number of parking events²⁵, number of SMD deployment²⁶, and trips starting and ending in the selected area. **The least utilized major Metrorail stops in term of SMDs events (origins, destinations, origins or deployment) were East Falls Church Metrorail (866 parking events), and Pentagon Metrorail (1,729 parking events).**

While elevated trip counts within 500 meters (0.31 miles) of transit stops directionally suggest the potential for multimodal ridership, more research is required to confirm this trend because Metrorail station areas are also areas of high commercial and residential density activity. Nevertheless, trip origin data does suggest Metrorail stations can be thought of as important nodes in the SMD network. For example, 64,000 trips on average originated within 500 meters (0.31 miles) of each of the five key Metrorail stops in the Rosslyn-Ballston corridor (Rosslyn, Courthouse, Clarendon, Virginia Square, Ballston) during the pilot, respectively, or almost 25% of all trips originating in the corridor.

However, direct integration with transit is difficult to ascertain given data available. In terms of “perfect” integration with transit, defined as SMD departures or arrivals exactly at Metrorail stops (within zero meters of a Metrorail stop), the number of SMD-related events (as logged by available data) diminishes dramatically. The number of SMD parking events, SMDs deployed, and trips originating and ending at zero meters from a major transit stop are much lower compared to activities recorded within the larger area of 500 meters (0.31 miles) from a major transit stop. The drop in the number of trips between 500 meters and trips within 0 meters might support the argument that not all trips near transit are taken by people using transit. However, due to data limitations, this result should not be stressed.

Frequency of ridership: insights from the online feedback form

With operator data limited in terms of identifying rider-specific usage patterns, **the feedback form provided valuable insight into the SMD ridership landscape in terms of frequency of use.**

When asked about the frequency of use of SMDs in Arlington County in the feedback form, **more than half of dockless e-bike riders (57%) indicated not using dockless e-bikes often in Arlington by reporting to have ridden it only once or twice in Arlington. Only five percent of dockless e-bike respondents use the service four or more times a week.** This could owe in part to the limited availability of dockless e-bikes in Arlington.

²⁵ Parking events are events in between the vehicle is available for rent and the time it gets rented out.

²⁶ Deployments are counts of initial deployment and rebalancing.

Conversely, **36% of e-scooter riders reported using scooters more than once a week**, with 19% having only ridden once or twice in Arlington and 30% having ridden more than once or twice but less than once a week. The relative utilization patterns of e-bike and e-scooters are provided in **Figure 30** below. In comparison, the Baltimore City evaluation found that 5% of e-scooter riders use it every day, 32% use it a few times a week, 14% once a week, 31% few times a month and 19% used it only once or twice.

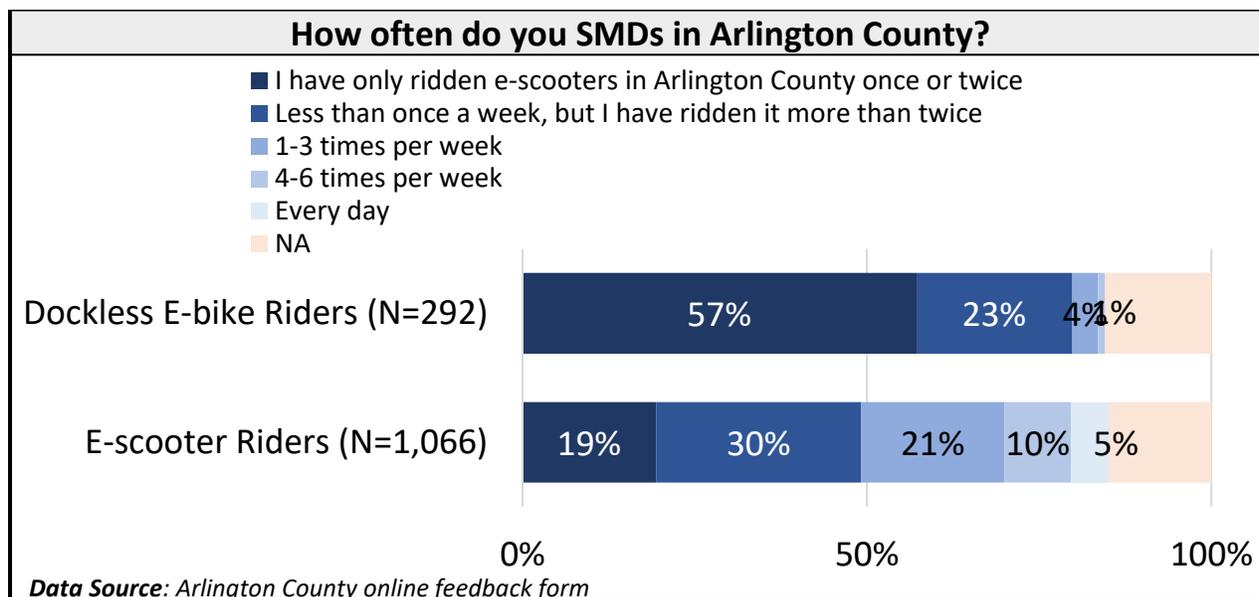


Figure 30 Frequency of SMD ridership according to the online feedback form

SMD rider characteristics

Key question: Who is using SMDs in Arlington County?

Summary: Result from the feedback form provide some preliminary insights into SMD rider profiles. In particular, statistics reflect a larger proportion of male riders than female, with a relatively lower average age of riders versus non-riders. In terms of occupation and education, the largest proportion of riders was made up of full-time employees and with lower rate of advanced degrees than non-riders yet still educated. This mirrors findings in Santa Monica, San Francisco and Portland Pilots. These findings and other takeaways on rider characteristics are examined in further detail throughout this section.

Gender: Results from the collected sample indicate that 46% of Arlington e-scooter riders identified as **male**, well above the 25% share for women. This finding mirror trends in other SMD pilot programs, although the skew towards male ridership was significantly more pronounced in pilot programs such as Santa Monica, Portland and San Francisco (See **Table 7**). Notably, roughly 20% of respondents to the feedback form (and more than 25% of e-scooter respondents) declined to disclose gender, thus skewing Arlington data lower in absolute than other programs. If limiting this analysis to respondents having disclosed their gender, then 63% of riders were male and 34% were female compared to 57% of female and 37% of male for non-SMD riders.

Table 7 Review of key results from pilot evaluations across the U.S. regarding gender

Arlington	Santa Monica	Portland	San Francisco
-----------	--------------	----------	---------------

	Scooter riders	Non-SMD riders	Scooter riders	Scooters riders	Scooters riders
Male	63% (46%*)	57%	68.9% ^{lii}	64% ^{liii}	81% ^{liv}
Female	34% (25%*)	37%	30.8%	34%	17%

**percentages calculated including NA in the total number of responses (i.e. non-response).*

Age: E-scooter riders in Arlington were also relatively **younger than non-riders**, with 47% of respondents using e-scooter aged 39 or less in 2019 (born after 1980). Interestingly, a relatively sizeable share of dockless bike-share riders that responded to the survey, around 30%, were born between 1965 and 1980 (~40-54 years of age), indicating some attractiveness of active SMD services to older generations as well, despite physical requirements. Once again, the lack of responses to demographic questions skews aggregate measures lower, and for example excluding those responses from the analysis would point to more than 63% of e-scooter riders born after 1980 (compared to 22% for non-SMD riders). Comparing these statistics to those of other pilot programs such as Portland and San Francisco reflect many directional similarities. In San Francisco, half of all survey respondents were between the ages of 25 and 34, while more than 50% of e-scooter riders in Portland were under 34 years of age.

Education: Comparing SMD riders to non-riders in the feedback form, a lower percentage of riders had advanced degrees, although it should be noted that the elevated proportion of advanced degrees (51%) for non-riders skews this comparison. This stands in contrast to the Portland pilot program for instance, which found a larger percentage of e-scooter riders having 4-year degrees than Portland residents, not supporting this conclusion.

Ethnicity: While there were limited differences between riders and non-riders to suggest a material skew in SMD ridership that would cause concerns in terms of equity and access, e-scooter riders in the feedback form had a higher proportion of Hispanic and black or African-American than non-SMD riders.

Life stage: E-scooter riders in the feedback form were more likely than non-riders to be undergoing a life transition, defined as experiencing a major life event altering their daily routine, with 38% of riders report a change of address or move in the past three years for example. Life events are important to transportation choices as they could make their travel less habitual and create conditions to break out of the inertia and open to new mobility solutions.

All these riders' characteristics and others are provided in the charts below (**Figure 31**).

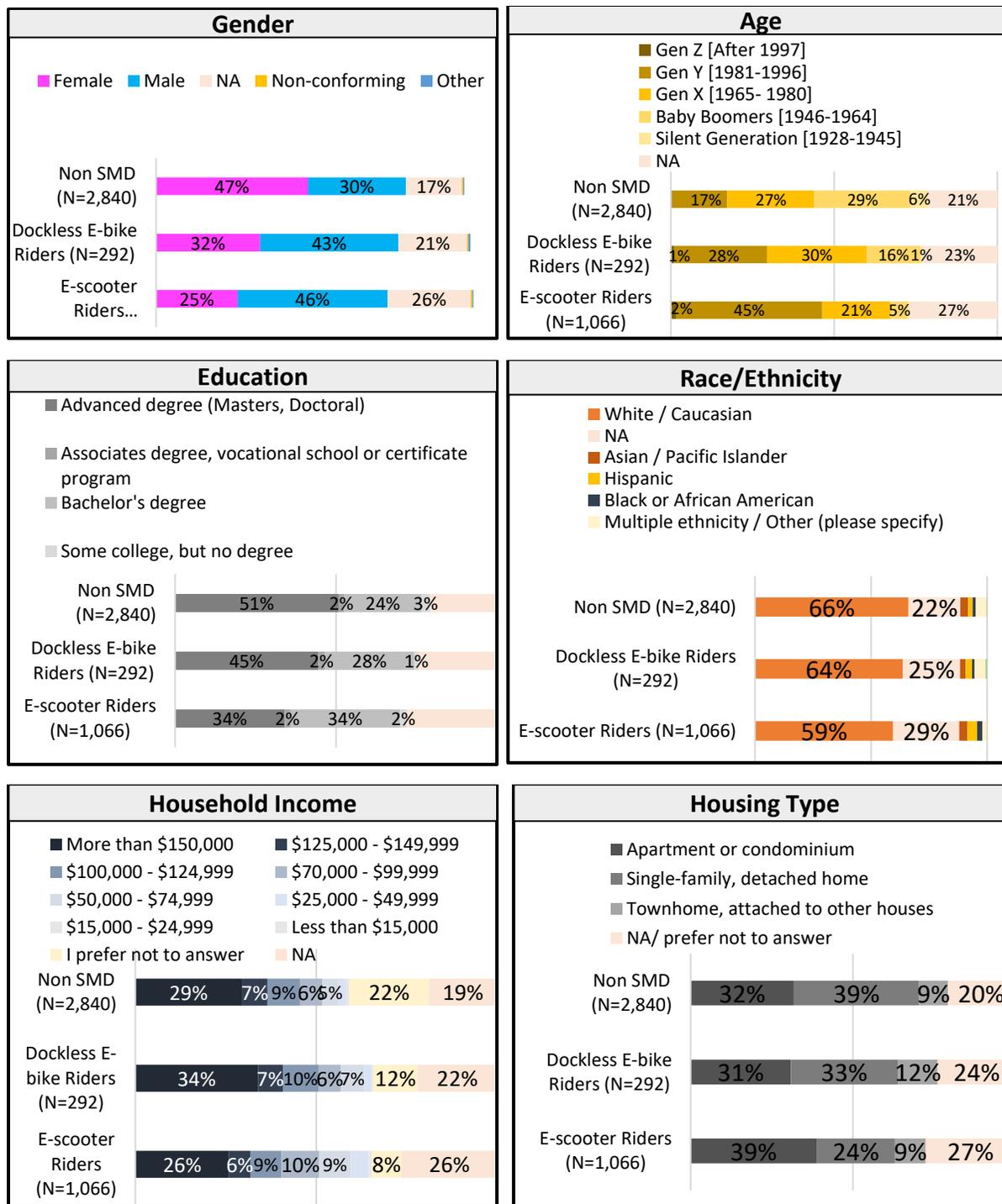


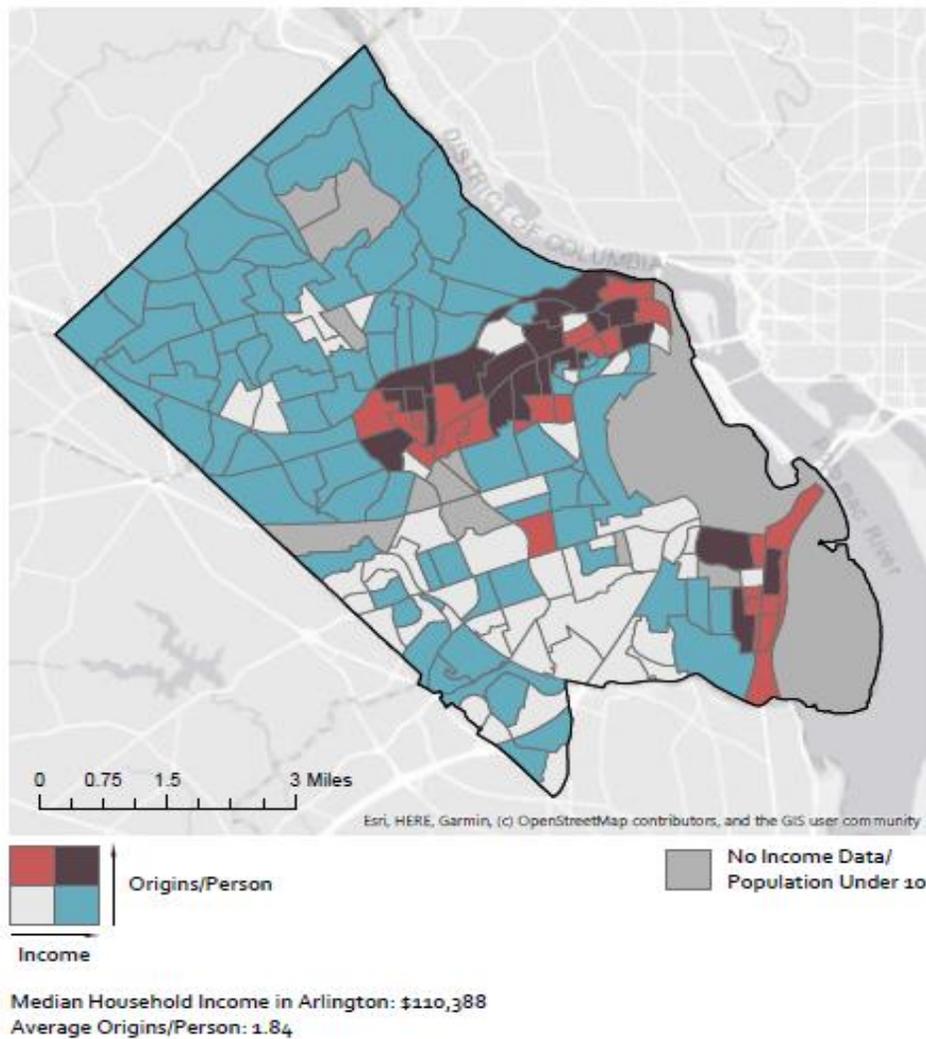
Figure 31 Trip maker demographics according to the online feedback form

Equity considerations of SMD utilization

Key question: Are lower than Arlington median income neighborhood residents using SMDs?

Looking at a bivariate map of trips and income levels, a map overlaying the count of trip origins and income distribution, shows that some neighborhoods with incomes below the Arlington County Median Household Income have a high trip generation number (colored in red in **Figure 32** below) suggesting that SMDs could be appealing to lower-income residents and promoting equity. It should be noted as a caveat that due to lack of individual rider income data available, data in this chart reflect average income levels of the corresponding neighborhoods rather than those of riders themselves.

Conversely, areas colored in white in the chart below reflect neighborhoods with average incomes below the median household income that displayed a relatively low rate of SMD trip origination, particularly in South Arlington, mirroring the relatively lower rate of deployment of SMDs discussed in the Pilot Operations. While more research is likely required to examine the full extent of equity considerations, the bivariate map below does reflect some variability in ridership by income levels, with both positives and areas warranting further investigation.



*Data source: Operator monthly reporting data

Figure 32 Bivariate map of trip origins and income levels in Arlington County

The feedback form included questions on federal assistance and awareness of operator's equity programs but there were not enough responses to analyze the data. Only three e-scooter respondents indicated being eligible for federal assistance, and three riders indicated being aware and using Bird's equity program, one respondent being aware of and using Lime's equity program and one person having used Lyft's equity program.

Sustainability considerations of SMD utilization - mode replacement

While difficult to measure through trip data, one of the aims of the feedback form was to measure the extent to which SMD penetration had led to mode replacement. To do so, the feedback form asked SMD riders how they would have made a trip in the absence of an SMDs and the change in use of other modes after starting to use SMDs.

Alternative modes

There are several important takeaways from the responses to this question as summarized in **Figure 33 below**. When asked about the mode they would have used to make the trip, the largest proportion of SMD-using respondents (37% of e-scooter riders and 22% of dockless e-bike riders) indicated walking as the alternative to their SMD trips. This is not surprising given the limited distances traveled on average by SMDs, as discussed in the Trip Characteristics section of this report.

The second most chosen alternative mode was ride-hailing (such as Uber, Lyft or Via). **Roughly one in five SMD riders suggested they would have used ride-hailing if not for SMDs**, indicating the potential for this mobility service to replace car trips. Understanding the competitive dynamics of SMDs vs. ride hailing is important in maximizing this trend, with convenience and flexibility of origins and destination at lower costs (especially for short trips, given ride-hailing fare minimums) likely one of the benefits leading to this substitution. This substitution in particular could result in congestion and air quality improvement as ride hailing is shown to increase traffic^{lvvi}.

The third most common alternative mode substituted by e-scooters (13%) and dockless e-bikes (14%) were other motorized trips such as driving a personal car, also suggesting some sustainability and SOV mitigation potential. For the Portland pilot, they found that 19% would have driven a personal car, and 15% would have hailed a taxi, uber or Lyft. Interestingly, only 5% of e-scooter riders and 7% of e-bike riders referenced transit (bus or Metrorail) as the mode being substituted by SMDs, despite extensive transit service along both critical Arlington corridors.

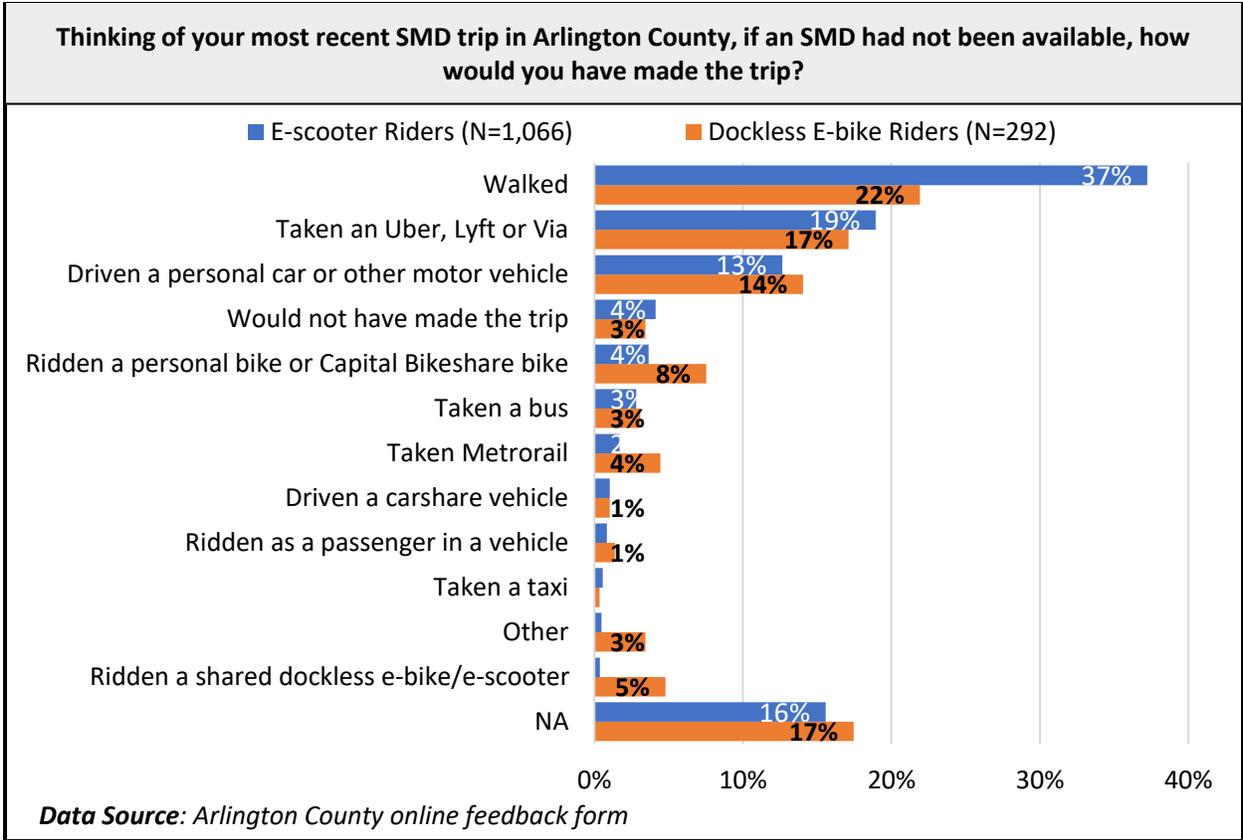


Figure 33 SMD mode replacement according to the online feedback form

When asked about their change of other modes after starting to use e-scooters in Arlington County, 38% of SMD riders indicated using services such as Uber less and 31% using their personal cars less. In terms of impact on walking, 17% of respondents said they walked less often which is not surprising, although another 11% of respondents also said they walked more, ostensibly to pick up SMDs from nearby locations. Eleven percent of respondents are also using Metrorail less, with some 10% increasing their use of transit (Metrorail or bus) suggesting a potential increase in first and last-mile access to transit.

Section three below turns to looking at the reaction of the community to the deployment described in section one and the utilization detailed in section two.

SECTION 3 - THE COMMUNITY'S REACTION TO THE PILOT

After examining the state of pilot deployment and trends in utilization, this section seeks to assess the Arlington community's reaction to the SMD pilot. The approach consists first of evaluating riders' experience and level of satisfaction with the service before examining the broader community's (i.e. including non-SMD riders) reaction to the pilot and ending with a closer look at the unstructured complaints and compliments received by Arlington County.

SMD rider experience and satisfaction

Key questions: *What were the main motivations behind using SMDs? Are riders satisfied with their experience in terms of access, safety, adequacy of infrastructure and appropriateness of rules and regulations? What were the main attitudes that were shaped during the pilot?*

To evaluate the SMD rider experience, we focus primarily on responses from the online feedback form.

Motivation to use SMDs

When prompted to select their most significant driver for using SMDs (see **Figure 34** below), the largest share of e-scooter riders (55%) selected *"to get around faster"* as one of their top three choices, making it the most selected answer of the option set. This was followed by *"convenient"* (44% of e-scooter respondents) and *"fun to ride"* (36% of e-scooter respondents). All three of the most popular answers mirror some of the key takeaways from utilization patterns, including short trips and relatively elevated rate of recreational riding. While e-bike responses were broadly similar, the main divergence in responses between e-scooter riders and dockless e-bike riders had to do with health benefits, with the *"it's healthier"* response receiving 23% of responses for e-bike riders but almost nothing from e-scooters. *"Avoid parking"* is also among the top reasons (18% for e-scooter riders and 14% for dockless e-bike riders) which is noteworthy in that riders are acknowledging a competitive advantage for SMDs relative to cars. Similar to Arlington, 63% of survey respondents in the Portland e-scooter pilot survey^{lvii} chose *"get around more easily, faster"* as an answer to *"why did you try e-scooters for the first time, either in Portland or another city?"*.

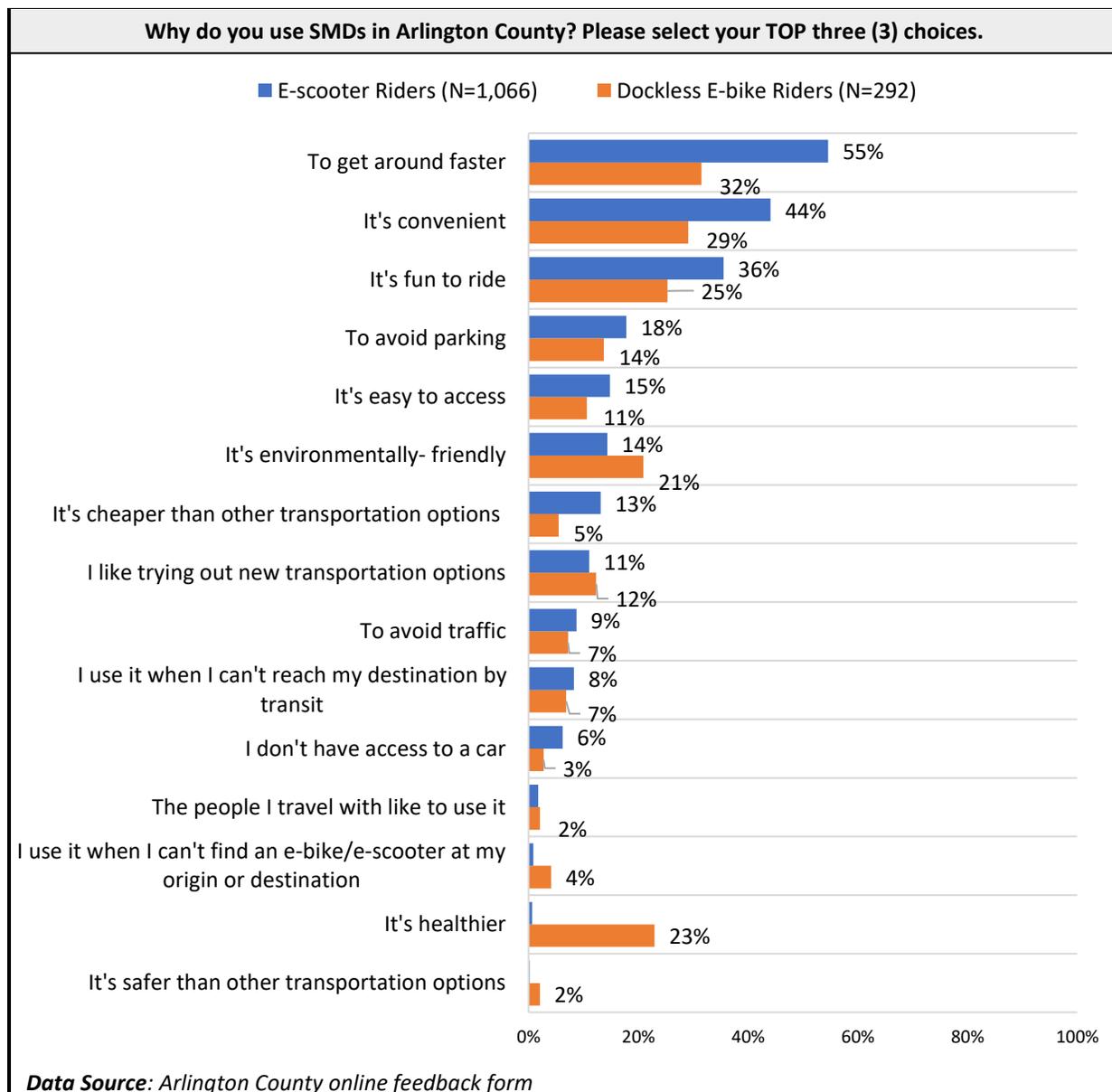


Figure 34 Key determinants of SMD use in Arlington County according to the online feedback form

Problem Experience

Another explicit goal of the feedback form was to assess how often SMD riders faced problems and what types of problems they encountered. Results from the feedback form related to the problem experience (provided in **Figure 35** below) show that there is still room for improvement in terms of making the SMD experience more seamless. When asked which type of problem they encountered, only 36% of e-scooter rider respondents chose “none of the above”. Of the remaining 64%, the majority (60%) encountered either mechanical issues with their e-scooters or issues unlocking/locking e-scooters via the mobile app. Given the relative novelty of the e-scooter technology, some issues were to be expected, however, in the absence of comparable data with Capital Bikeshare or other pilots, there is no benchmark on what a “high” or “low” rate of problem experience is. More serious incidents were relatively scarce, with three percent

of respondents having experienced a crash. Conversely, fewer respondents had problems with dockless e-bikes, with 59% not having experienced any of the given problems.

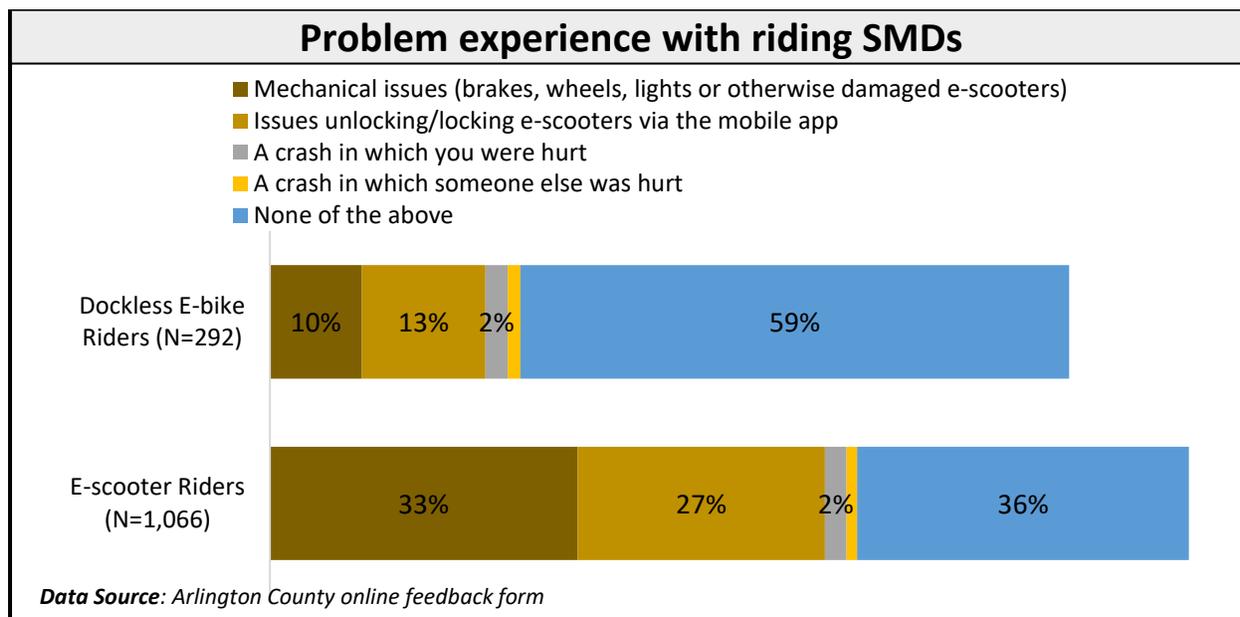


Figure 35 Problem experience with SMDs in Arlington according to the online feedback form

Satisfaction with the pilot and main attitudes shaped

Another important dimension the evaluation sought to explore was the attitude of riders towards the pilot, and first-hand recommendations from riders on how to improve the roll-out of SMDs in Arlington County. The full set of answers is provided in **Figure 36**, with the key takeaways as follows:

Positive attitudes: Overall the results suggest that e-scooter riders shared broadly positive attitudes towards e-scooters with 74% agreeing that e-scooters are convenient to ride and 74% agreeing that they enjoy riding, which sends a positive signal regarding rider satisfaction and future ridership. Also, 57% of respondents found that e-scooters are kept in good working condition. Finally, 58% of respondents agreed that they could find SMDs easily available near their office/school and 60% in their neighborhoods.

Expanding transportation options: Around 64% of respondents agreed that e-scooters have increased their ability to access destinations and 52% agreed e-scooter has increased their access to public transit and 57% agreed that e-scooters decrease their need for parking. This is a positive signal in terms of the potential for this new mobility service to expand transportation options, increase accessibility to destinations and decrease reliance on cars.

Room for improvement: A third e-scooter respondents (34%) agreed that the maximum speed of 10 MPH was adequate, and less than half (48%) felt safe riding e-scooters, both of which are key items for policymakers as they pertain to regulations and infrastructure, respectively. The percentage of people feeling safe riding an e-scooter can be expected to increase as people become more familiar with the technology (see section below on perceptions of safety).

Finally, a good share of respondents (40%) agreed that they prefer to use e-scooters over other transportation modes whenever possible providing encouraging signs in terms of long-term adoption rates.

E-scooter Attitudes Developed During Arlington's SMD Pilot (N=1,066)

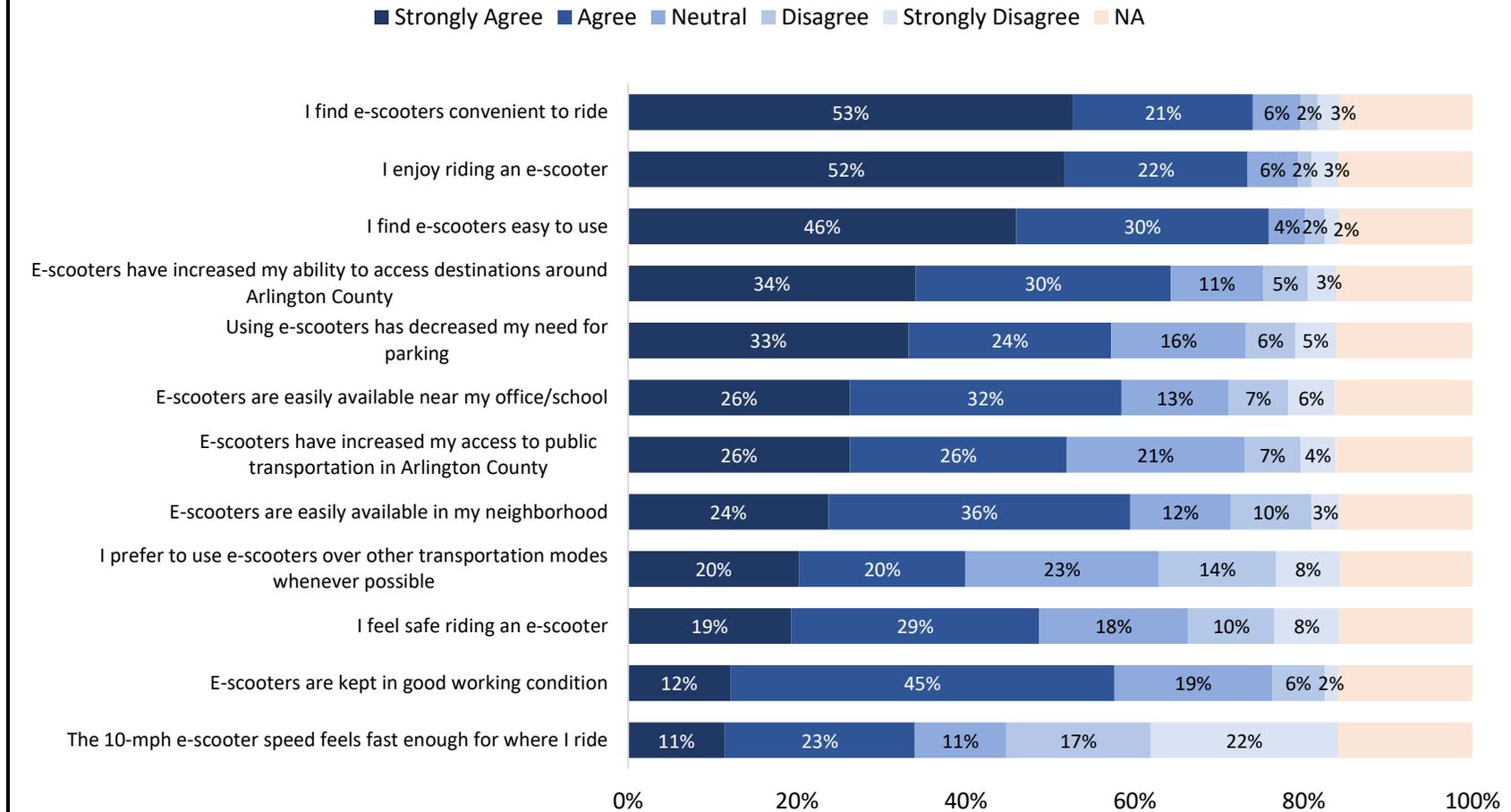


Figure 36 Rider's attitudes with respect to SMDs according to the online feedback form

Broader community experience with SMDs

Expanding the analysis to non-riders of SMDs provides interesting insights into how the pilot was perceived and the impact it has had on the community more broadly and on the transportation ecosystem in Arlington County. For this analysis we also rely on the findings of the feedback form.

Perceptions of safety

When asked about how safe respondents felt as pedestrians around different modes in Arlington, e-scooters stand out as a key source of concern for the community. More than half (57%) of respondents reported feeling unsafe to very unsafe around e-scooters compared to 26% for dockless e-bikes, 14% for capital bike share and 13% for regular bikes (as shown in **Figure 37a** below).

However, untangling the responses to this question with regards to e-scooters specifically by separating respondent groups (split between e-scooter riders, dockless e-bike riders and non-SMD riders), uncovers significant variance in perceptions. Results display a significant skew towards safety concerns by non-SMD respondents with 73% of non-SMD responding not feeling safe as opposed to 41% of dockless e-bike riders, and just 15% of e-scooter riders. Lack of familiarity with the service, rules and regulations pertaining to ridership and the rapid emergence of SMDs could all have contributed to this negative sentiment, with time, habit and experience (trying SMDs) potentially mitigating such concerns to some extent in the medium to long term.

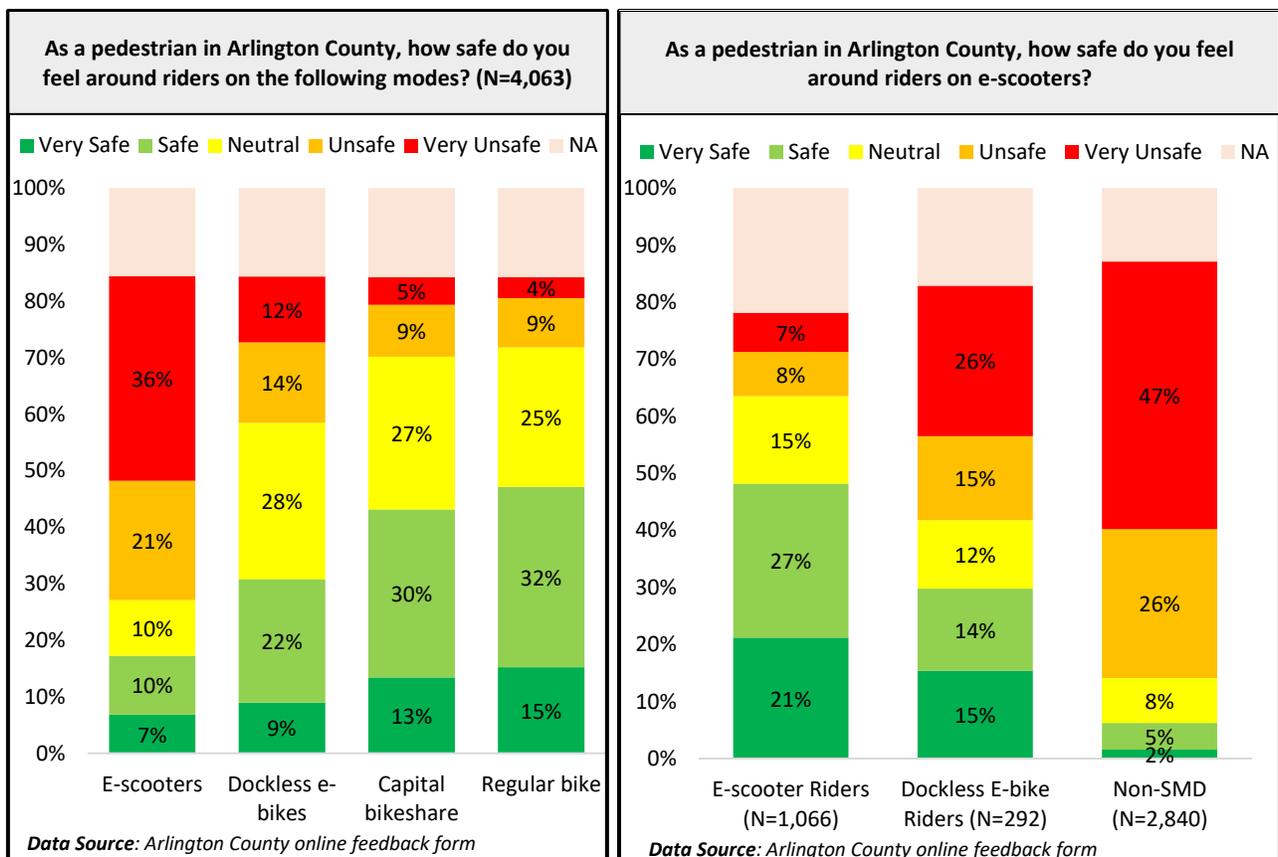


Figure 37 Pedestrian's perception of safety (a) around all modes (b) around e-scooters

Perceptions of comfort

The perceptions highlighted in the previous section towards e-scooters permeates throughout the feedback form including blocked sidewalks for pedestrians and safety concern for drivers. These results are provided for reference in **Figures 38 through 41** below.

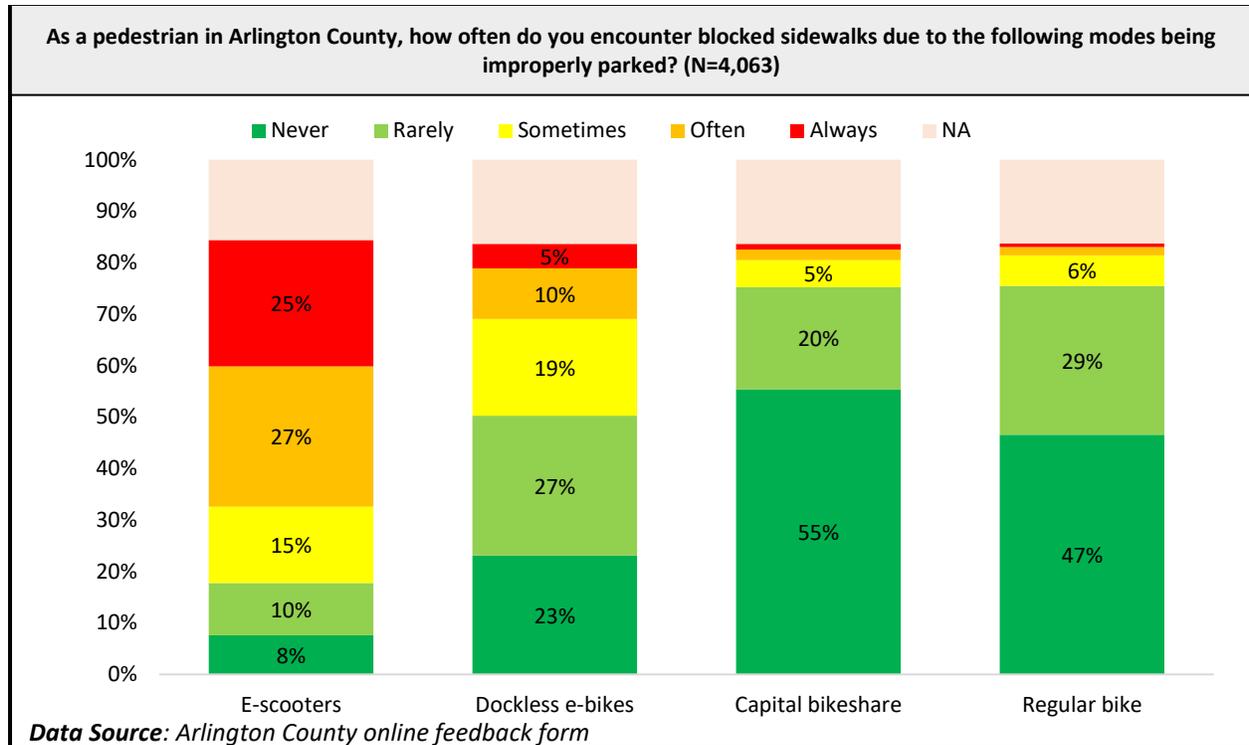


Figure 38 Pedestrian's frequency of encountering blocked sidewalks due to transportation modes

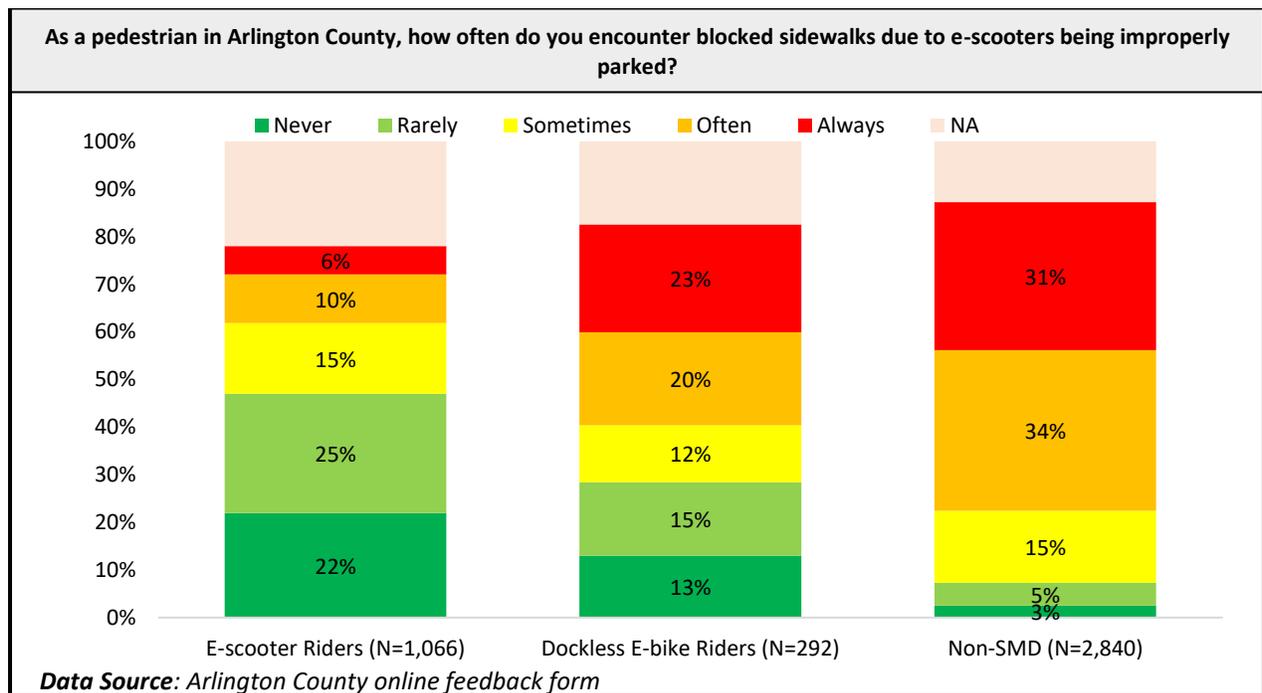


Figure 39 Pedestrian's frequency of encountering blocked sidewalks due to e-scooters by rider type

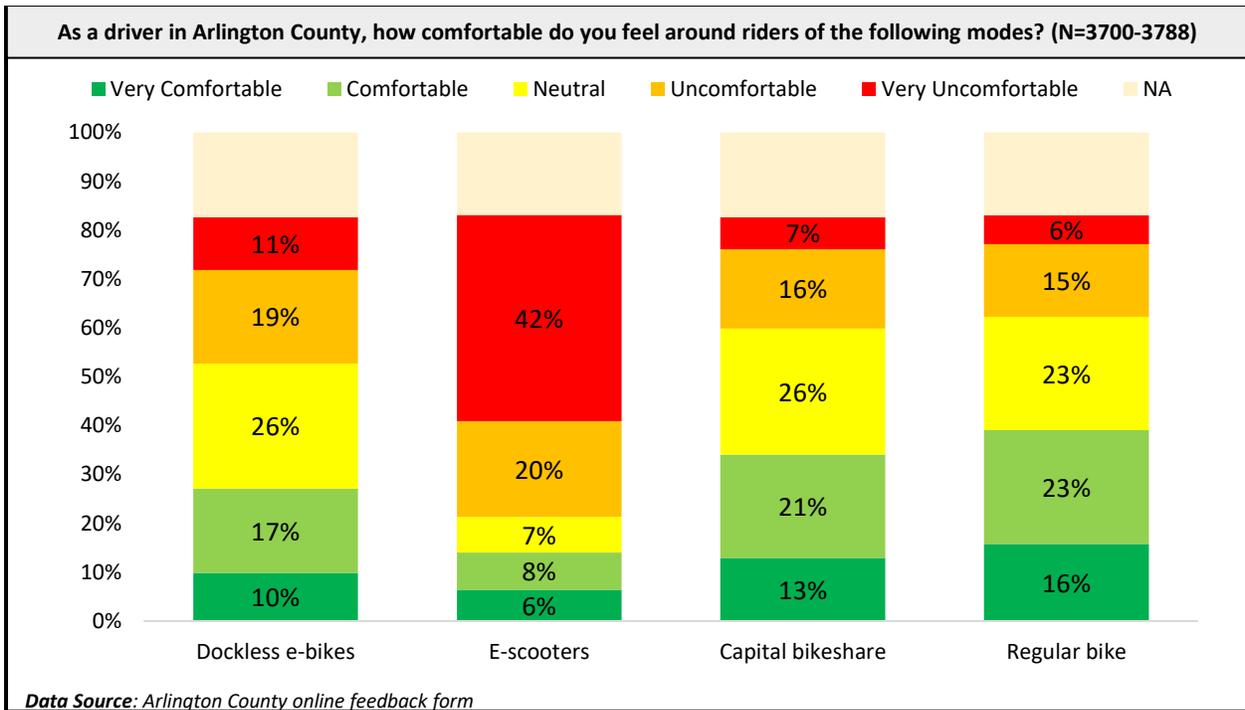


Figure 40 Driver's comfort around transportation modes

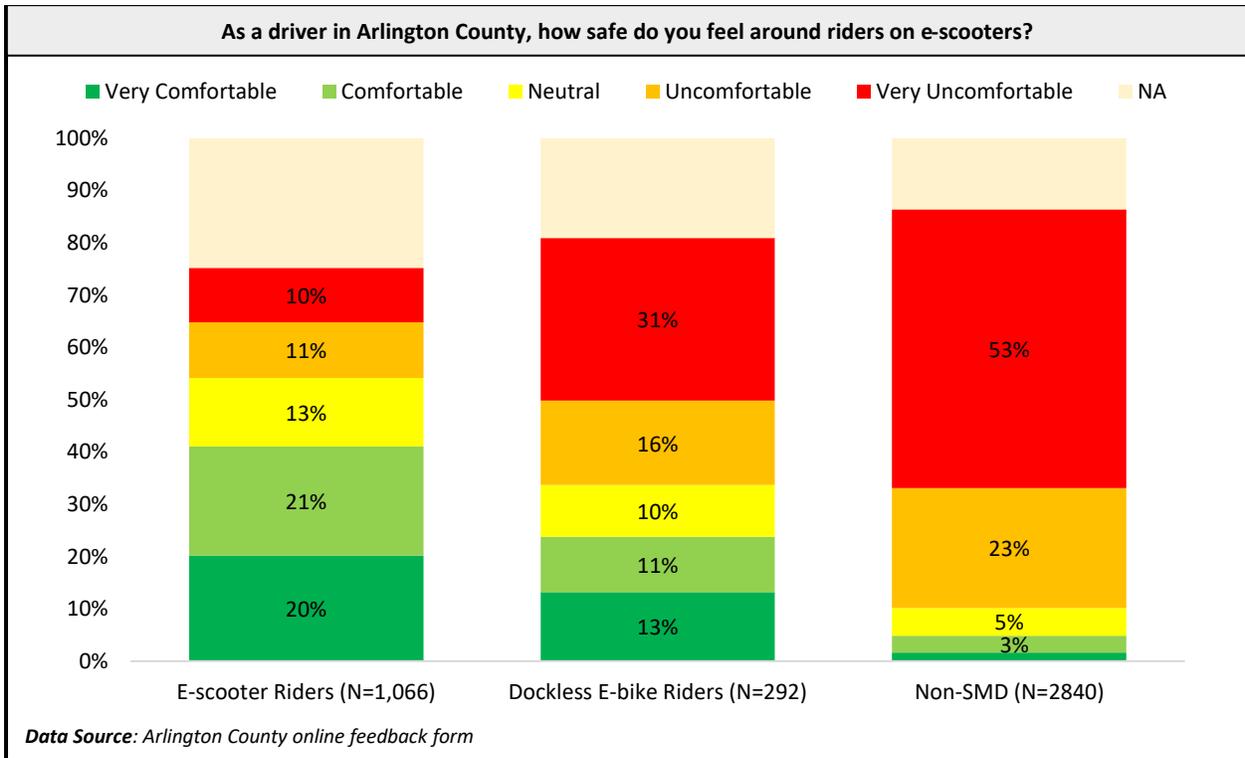


Figure 41 Driver's comfort around e-scooters by rider type

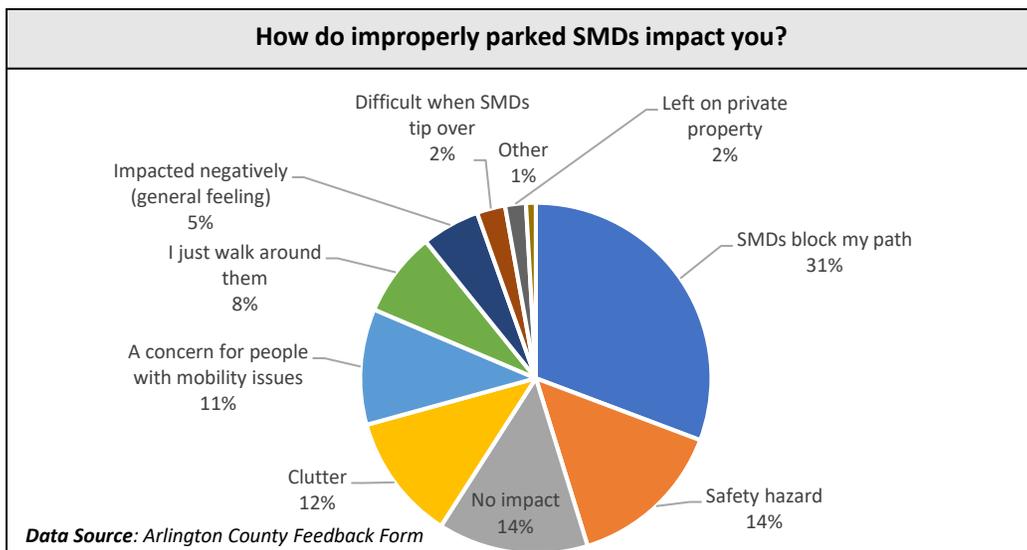
The online feedback form also had an open-ended question about “how do improperly parked dockless e-bikes and e-scooters impact you”. Because this was an open-ended question, responses varied in length and topic. In this analysis, the responses were categorized based on common topics that arose while the survey responses were being reviewed (See **Figure 42** below). Keywords were used to help group responses into common categories, such as “safe”, “walk around”, “wheelchair”, “property”, and “block”. For example, the keyword “block” was used to review responses about how incorrectly parked SMDs blocked the path of pedestrians in Arlington County.

There was a total of 2,876 responses for the open-ended feedback question about improper parking. This does not include the 1,187 who did not provide any additional feedback.

Most of the feedback (884 responses, or 31% of total feedback received) was about how improperly parked SMDs blocked the path of pedestrians in sidewalks, driveways, and other common-use areas in Arlington County. The second most frequent feedback is how these improperly parked SMDs pose a safety hazard to pedestrians, who can possibly trip on improperly parked SMDs (417 responses, or 14% of total feedback received). The size of the share of people who stated a safety concern is the same as those who reported minimal to no negative impact from improperly parked SMDs (398 responses, or 14% of total feedback received).

Other feedback categories that received high responses were from people who thought improperly parked SMDs clutter Arlington County (335 responses, or 12% of total feedback received), those who were concerned about how improperly parked SMDs may negatively affect people with mobility issues (307 responses, or 11% of total feedback received), and those who resorted to just walking around improperly parked SMD²⁷s (225 responses, or 8% of total feedback received).

Other categories of feedback received were general feelings of negative impact from parked SMDs (154 responses, or 5% of total feedback received), and more precise complaints such as finding it difficult to deal with SMDs that tip over (75 responses, or 3% of total feedback received), or improperly parked SMDs abandoned on private property (55 responses, or 2% of total feedback received).



²⁷ This is not the same as “I just walk around them” which is closer to “no impact”.

Figure 42 Open-ended responses on the impact of parked SMDs on the community in Arlington according to the online feedback form

The open-ended responses differed between riders and non-riders. Out of the people who reported “no impact”, 66% used either type of SMD and 34% were non-riders.

Barrier to using SMDs and ways to address it going forward

The feedback form also sought to assess the barriers for use, targeting specifically non-riders. When asked about why **they haven’t used** e-scooters in Arlington in a close-ended form, the first popular choice was “I don’t think e-scooters are safe” selected by 58% of non-SMD riders and 32% of dockless e-bike riders and the third most popular choice was “I feel unsafe riding in the street” selected by 36% of non-SMD riders and 21% of dockless e-bike riders (see **Figure 43** below). This suggests that the main barrier to using e-scooters in Arlington pertain to the adequacy of the infrastructure or a safe place to ride. This suggests that there is potential for further penetration of SMDs if safety concerns are addressed, be it through infrastructure or better maintained or designed devices. The second most popular deterrent was lack of interest in using SMDs, with 56% of non-SMD riders selecting this option.

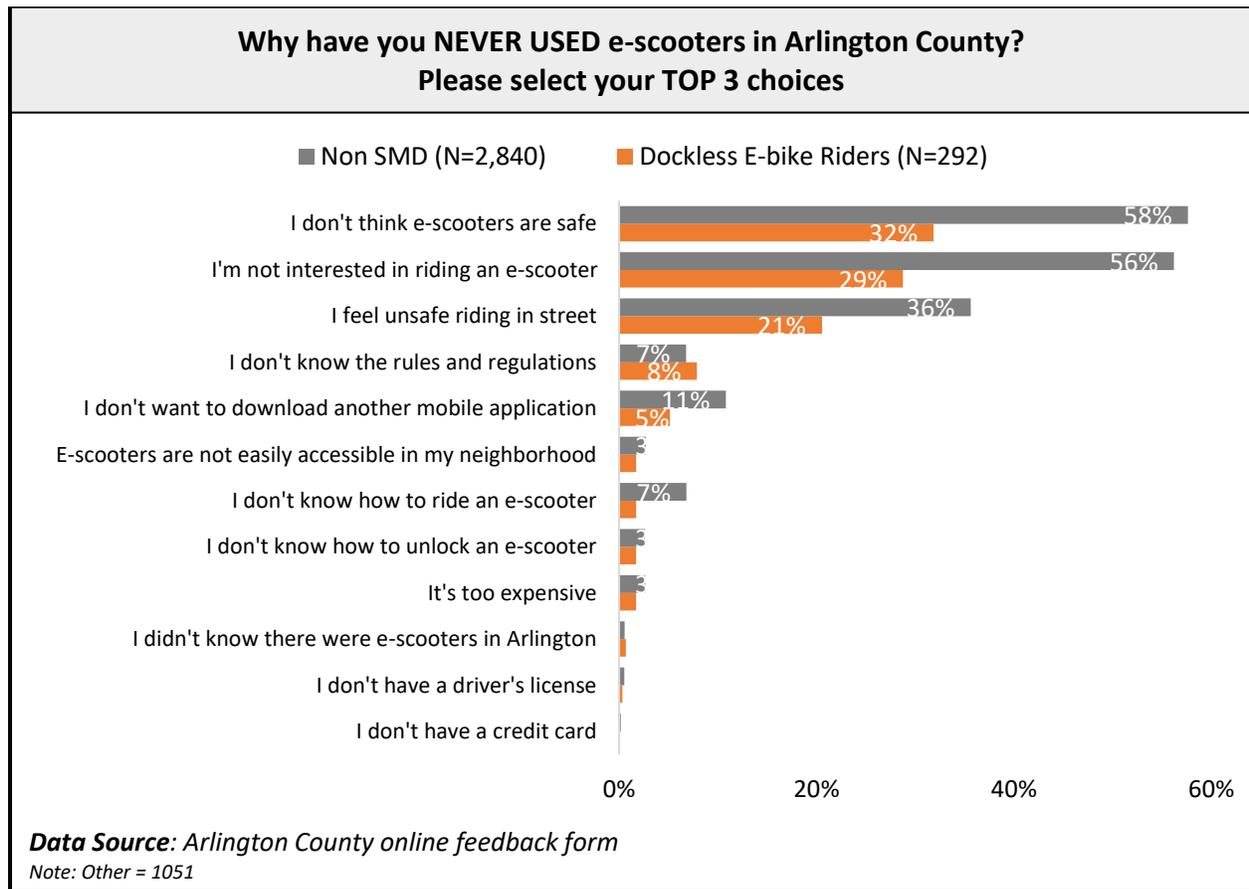


Figure 43 Barriers to using e-scooters in Arlington County

When asked about specific measures that could lead them to start using or increase use of SMDs, the most popular responses across riders were “safer places to ride”, “more e-scooters available in Arlington” and “lower cost of e-scooters”. Detailed results are provided in **Figure 44**. A large number of non-SMD respondents (68% of respondents) reported that none of the options provided could make them ride

SMDs, illustrating some level of pre-conceived aversion to such devices. As the section on attitude comparison between types of riders show, this perception or response could change once non-SMD riders try the service or it becomes more familiar with fewer negative experiences.

From the in-person feedback form during the outreach events, 37% indicated nothing could make them ride more, 27% chose more SMDs in Arlington, 22% lower cost, 16% safer places to ride and 3% more SMDs in surrounding jurisdictions.

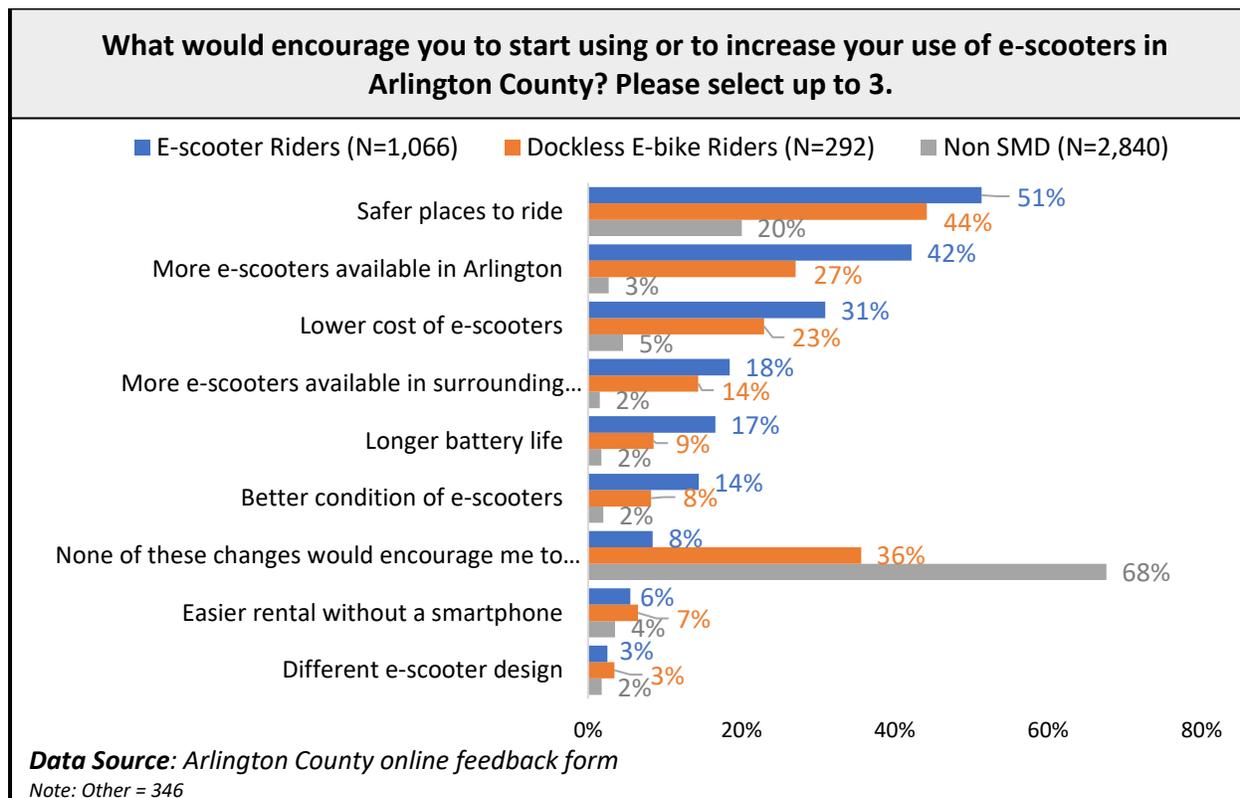


Figure 44 Factors that would encourage the community to use SMDs more

When asked what infrastructure would make them feel safer (**Figure 45** below), most SMD riders (e-scooter riders and dockless e-bike riders) wanted bike lanes separated from motor vehicles traffic with a physical barrier while most non-SMD riders wanted designated e-scooter parking. From the in-person responses during the outreach events, 66% wanted bike lanes separated from traffic with a physical barrier, 36% wanted smoother pavement, 36% wanted designated parking and 22% wanted wider bike lanes.

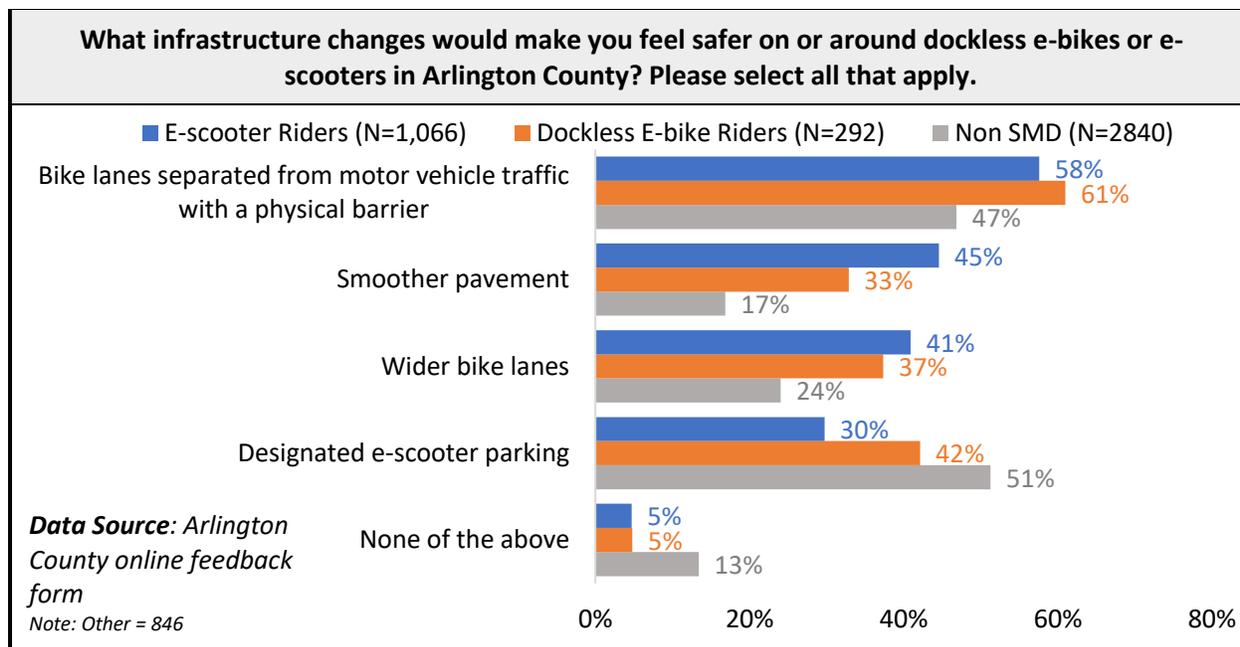


Figure 45 Factors that would make the community feel safer on or around SMDs

Unstructured feedback

Key questions: *What are the dimensions they care most about? What is working and what is not working?*

This section discusses feedback outside of the guided framework of the feedback form. This analysis provides valuable insights into the issues that the community genuinely cares about, unprompted and unguided by researchers or survey, complementing the rest of the analysis. The evaluation of unstructured feedback shows how the community is thinking about SMDs, both in terms of complaints and compliments.

A closer look at voluntary complaints and compliments: the Mobility Inbox (mobility@arlingtonva.us)

Evaluating self-initiated voluntary submissions helps uncover: (1) themes that community members feel strongly about, and (2) within the themes, the dimensions they associate with SMDs.

The total number of emails received, disregarding duplicates and irrelevant inquiries (as noted in the Methodology section), is 727 emails. The total number of emails decreased considerably from October (226 e-mails) to February (24 e-mails) (see **Figure 46** below). In absolute terms, counts increased again between February and May but accounting for the number of trips (i.e. exposure), complaints have decreased consistently from 3.7 inbounds per 1,000 trips in October 2018 to just 0.6 e-mails per 1,000 trips in June. Increasing familiarity with SMD service maybe a contributor to this decrease, as may be rider familiarity with rules and parking etiquette.

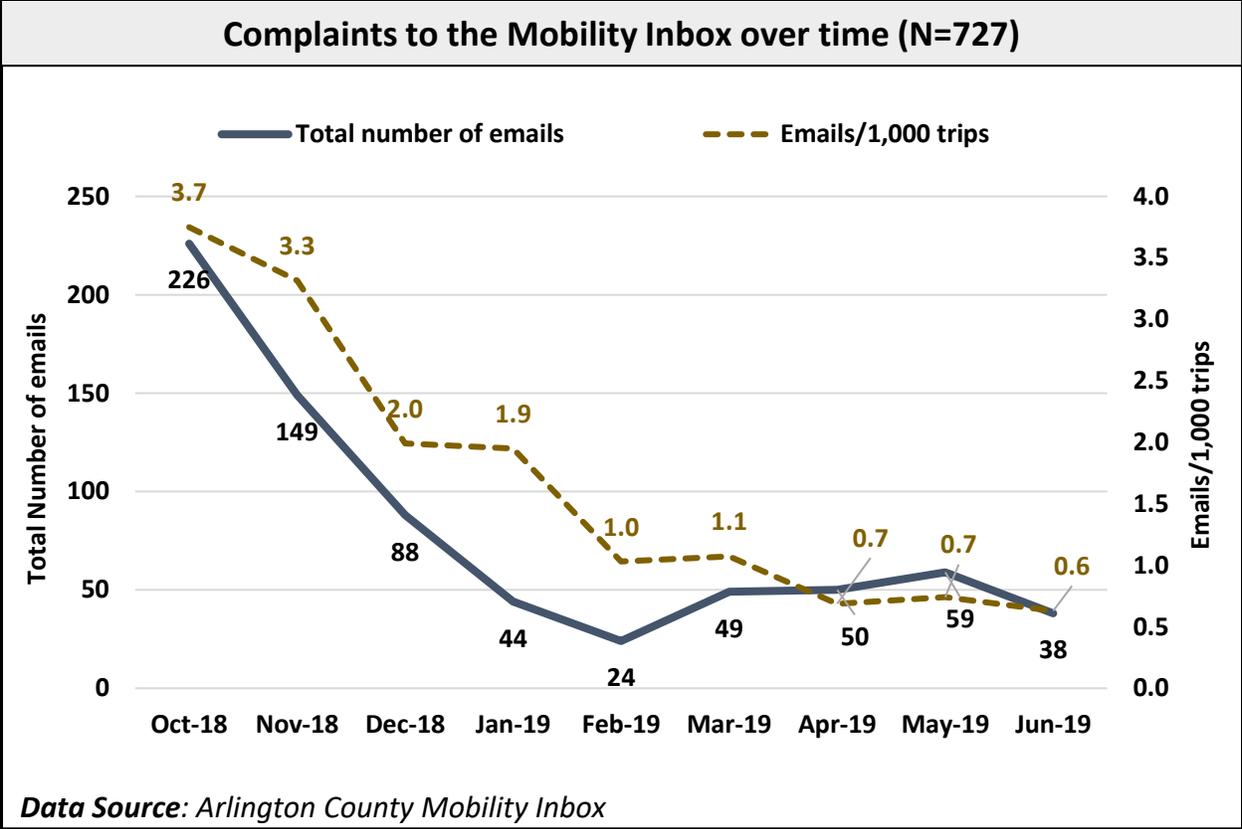


Figure 46 Inbound inquiries received to the Mobility Inbox over time

Examining the key topics flagged in e-mails sent to the Mobility Inbox (See **Figure 47** below), “parking” received the highest number of complaints, followed by sidewalk riding, safety, rider behavior and underage riding.

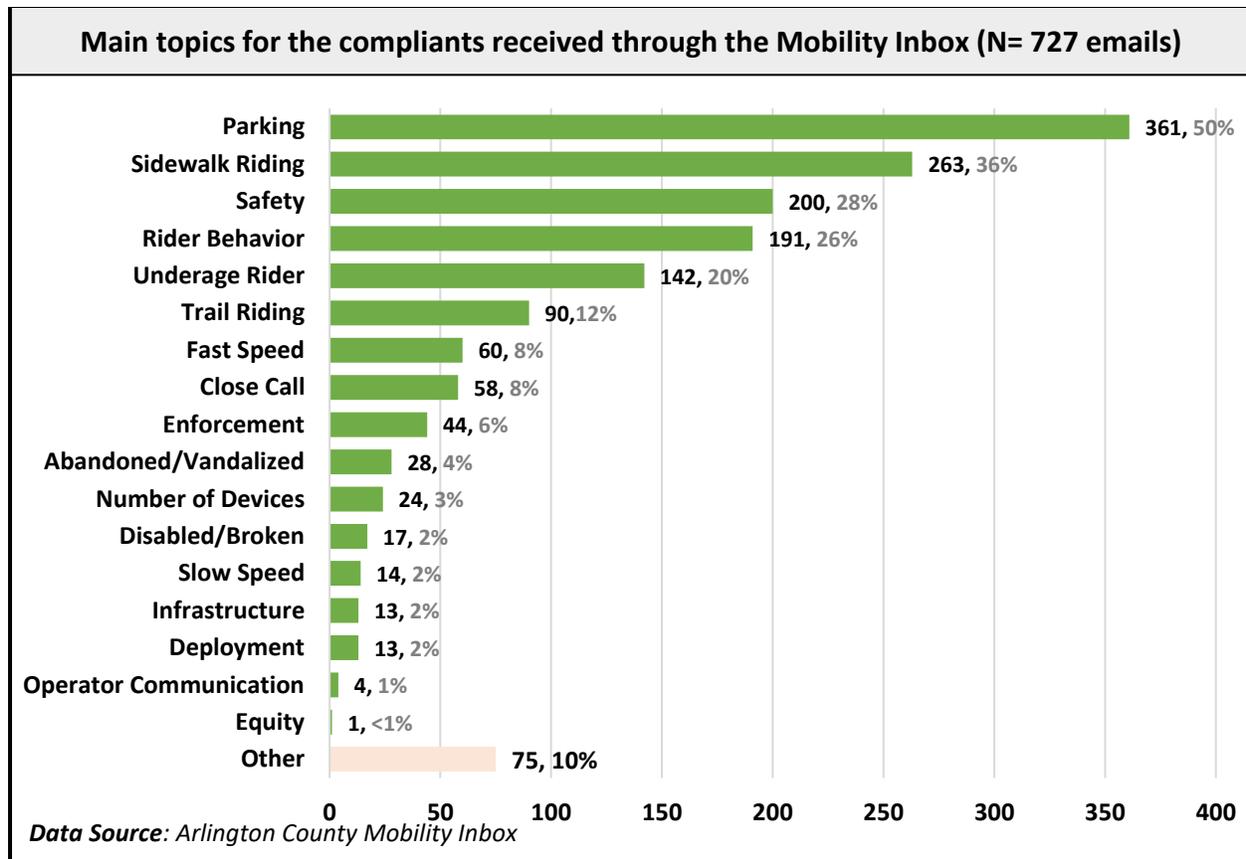


Figure 47 Key topics identified in the Mobility Inbox

This is also illustrated in the word cloud in **Figure 48** below depicting the relative frequency of the topics discussed in **Figure 47**. Overall, concerns relating to sidewalks are the most frequent source of complaints, whether it is about riding on the sidewalk or parking on the sidewalk.

A closer look at the qualitative complaints raises several important observations. First, within SMDs, scooters received much more attention than dockless e-bikes. This is expected given the small number of e-bikes in circulation during a shorter period of time compared to e-scooters.

In terms of how the community is thinking around SMDs, some dimensions stand out:

- **The infrastructure**
- **Parking and riding**
- **Transportation modes**
- **Land use**
- **Rules and regulations**
- **Safety**
- **Speed**
- **Demographics**
- **Specific operators**
- **The human factor**

*"I am writing to let you know of my displeasure with the preponderance of Scooters in our neighborhood. They are **parked** all over the place (driveways, lawns, in the middle of sidewalks) and are an eyesore - I also believe that they can be a safety hazard if the operator is not paying attention."*

*"Many riders are **riding** too fast, **scooting** around cars and **barreling** down the sidewalk where pedestrians can turn or step one direction and get slammed (as almost happened to me on a couple of occasions in the Ballston area) because you don't hear them **coming** and don't expect them **flying** down the sidewalks."*

The human factor. The community is also thinking about the human element which show up in the word cloud as **"people", "community", "residents", "public"**.

*"It would be preferable that these so-called "dockless scooters" would not be parked in places that **inconvenience other people in the neighborhood**. It is also unsightly to see them parked here and there. If parked on grass they could impede lawn mowing; if parked on sidewalks they could impede walkers; if parked in bike lanes, they could impede bikers. You need a better solution. What happens when it snows and people can't shovel their sidewalks?"*

Transportation modes. The word cloud also shows that people are thinking in terms of other modes and riders. **Pedestrians** for instance show up with a high frequency. **Although to a lesser extent, words such as drivers/driving, cars, the buses, metro, walking, traffic and "transportation"**, also show up in the list of complaints. This means that it is important that the County both examines the impact of SMDs on other modes but also educate the community on the findings through outreach and community events.

*"As a **car-free** working adult, I personally love the electric scooters. While I love them, I also have come across some issues that we need to work out. I use **Capital Bike share** but find the locations not always convenient (and usually mean additional walking sometimes adding quite a bit of time) and not always available. I appreciate the electric scooters as they provide another option to get me to location, usually within a mile, where bike share may not be the best option (sweat), conveniently located, or even available. The cost for using the scooters is right. For example, I had to run an errand a mile away along the **metro** line. The simple and fastest way for me to get there was to use a scooter. **Metro** would have added 30-60 minutes to go one stop (walking, weekend hours, train ride, walking). **Bus** also would have been longer. **Lyft** would have cost 5 times as much. To fit the trip in and spend money locally instead of ordering my item on Amazon, I only got this errand done because of the scooter."*



Land use. People complaining about or complimenting SMDs often reflect on the land use. Words such as “neighborhoods”, “schools”, “property”, “areas” as well as specific areas such as “Clarendon”, “Wilson”, “Ballston”, “Washington” or “Glebe” all show up in inbound comments.

*“I’m also curious as to how much the companies that own said scooters will be paying for the inevitable use of sidewalks and other **public spaces / county property** that ‘brick & mortar’ stores utilize and pay for through their taxes. From what I’ve read, one of the major advantages of ‘dockless’ technology is to get around having to pay a county or business for areas in which to place and maintain docks, instead just letting people leave them wherever, which means they skip out on some **taxes** related to **land-use** and **property ownership** while still using up **public or private property & space.**”*



Rules and regulations. Key words: “Rules”, “regulations”, “laws”, “enforcement”, “police”, “allowed”.

*“I understand that the **regulations** in place are meant to make the use of these safe for riders, drivers, and other pedestrians. But most riders don’t follow them and enforcing those **regulations** would be a herculean task and a waste of our police officers’ time. Any policy that relies on the good faith and sound judgement of a self-selecting group of individuals (with no real qualifications for use) is doomed to fail.”*

Safety. Key words: “Dangerous”, “helmets” “safety” “hit”

*“I think the new scooters are great as a way for people to get a little further a little faster than walking while being much cheaper and greener than having more cars. However, I notice on your website that ‘Dockless e-scooters and e-bikes are considered motorized vehicles and are subject to the same rules and regulations as a motor vehicle.’ I cannot think of a single time that I have seen a scooter rider obeying the rules of the road and not cutting across an intersection diagonally, riding against traffic, crossing streets in the middle of blocks, and generally behaving dangerously. I would encourage the County to launch an aggressive **safety** education campaign, because I don’t want to see an **accident or injury.**”*

Speed. Key words: “Mph” and “fast speeds”

*“Hi, I have a complaint regarding Arlington’s 2019 regulation of electric scooters. The new regulation mandates that all e-scooters should be limited to **10mph**. Having ridden the scooters now that the new rule is in place in 2019, I can say with certainty that they have been rendered useless. At **10mph**, they are a danger to the rider when ridden in the street, which is the only place the county allows people to ride them. At such **slow speeds**, they are inefficient, cost more to riders because the trips are longer, are very unsafe because no traffic on any street in the county goes only 10mph, and will cause traffic jams galore. Also, the scooters are supposed to solve the “last-mile” transit option, and if they can only go **10mph**, they cannot be used for commuting of any kind because they are not much faster than a walking **speed**. With this **speed** reduction, people will have no incentive to take public transit because they won’t have an efficient ride home from the station and will opt instead to drive more.”*

Information and communication. Key words: “information”

Aside from the Mobility Inbox analyzed in this section, Arlington County’s outreach events were an important source of qualitative unstructured feedback. These comments were obtained by intercepting

people at events who likely have not had access to the feedback form about SMDs. The analysis below describes the main findings from these events.

A closer look at the results from Arlington Community Outreach

As introduced in the research approach chapter of this report, Arlington County communication and outreach staff conducted a series of 10 outreach events. This section summarized the main insights gained from these sessions.

The main conclusion from the outreach is that most attendees acknowledged that the current program has challenges, with a majority expressing an interest in resolving issues rather than an end to the program.

"My opinion isn't strong enough for a dot, but I support trying something." - Non-rider
"I don't dislike them, but it's just hard. It's a new technology and everyone's figuring it out." - Non-rider

The main comments received addressed: accessibility, parking, adequacy of the infrastructure, appropriateness of the rules and regulations and equity. These are summarized below.

Accessibility

- *"I take two buses to get to work, and the scooter helps me make my first bus so I don't have to hustle while walking or drive the whole way." - Multimodal commuter*
- *"I like the scooters-- Arlington should continue to be a leader in transportation. We should strive to be innovators." - Non-rider*
- *"I used to take this trip to the grocery store for a few things with a car, now I can just do it with this" - Scooter rider*
- *"They feel more approachable, like less athleticism is required than the bikes." - Rider, young woman*

Parking

- *"I'm going to go with incentives, because all these things (corrals, racks, lock-to) don't mean anything without a way to get people to use them" - Non-rider*
- *"Better parking options are good ideas-- but need to make it convenient and intuitive, or people won't use them. Maybe with incentives?" - Non-rider*
- *"Concern for parking behavior presents special challenges in neighborhoods with narrow or no sidewalks. Some of the parking solutions proposed don't make as much sense outside of the corridors".*

Adequacy of infrastructure

- *"As a biker, I totally get the need to sometimes be on the sidewalk when the road doesn't feel safe, but behavior needs to be better."*
- *"The street isn't a good place to ride sometimes. In those places, there need to sidewalks wide enough for everyone." – Walker*
- *"These new devices with smaller wheels mean than potholes in the street are an even bigger risk than to bikers and cars. I didn't want to ride on the sidewalk, so I rode on the street and broke my collarbone hitting a pothole." - Former scooter rider*
- *"If there isn't a bike lane, where should I ride? The street where cars are going fast or the sidewalk where I need to slow down for other people there?"*

Appropriateness of rules and regulations

Trails

- *"We need to be able to use trails-- so much of how you can get places safely is trails in Arlington" - E-scooter commuter*
- *A recurring concern from trail-riders of all types is the number of devices left along trails. They seem to stay longer than other devices and would be harder for operators to get access to pick up.*

Speed limits

- *"I understand the interest in having a speed limit, but the way e-scooters currently limit speeds don't let us power up hills; it seems limited by power output rather than actual speed. If I have to kick up a hill, it limits the effectiveness of it as a transportation option. Small adults can go faster than large adults; makes it odd to ride with friends." – Frequent scooter rider*

Jurisdictional differences

- *"It feels like each place you can ride them has different rules. It makes it confusing." - Occasional rider*

Age limits

- *"I mean, I can drive a car. Why is a scooter different?" - High school student*
- *"If the companies are genuine about not targeting young riders, then they shouldn't drop them off near Swanson, Gunston." - Parent*

Equity

- *"I heard that some companies are limiting use to the major neighborhoods. That doesn't seem right-- if they're here, they should be available everywhere." - Occasional rider*
- *"I don't have a smartphone. You look at the scooter, and even if I wanted to ride it, I can't. There's nothing that tells me how."*



Figure 49 Pictures from Arlington County outreach events

When asked about solutions they found most attractive (see **Table 8** below), bike lanes were most popular (chosen 32% of the time across the events) followed by racks (chosen 22% of the time across the events) then corrals (chosen 16% of the time across the events), education (chosen 42 times), incentives (chosen 32 times), lock-to technology (chosen 18 times) and GPS fencing (chosen 17 times). Some people suggested other new ideas such as: one app for all scooters, scooter docks charging batteries, more stable scooters with better lights, and smoother pavement.

Table 8 Results from the mitigation board at Arlington County outreach events

Existing Ideas	B2W Rosslyn (N=58)	Quarter fest (N=91)	MU & Westover Farmers Markets (N=47)	Fridays at Fountain/Courthouse & Rosslyn Farmers Market (N=56)	Columbia Pike Blues Festival (N=157)	Total (N=409)
Bike Lanes	21%	33%	36%	30%	34%	32%
Racks	14%	12%	19%	30%	30%	22%
Corrals	16%	23%	11%	16%	15%	16%
Education	12%	9%	21%	9%	8%	10%
Incentives	9%	9%	6%	11%	6%	8%
Lock-To	19%	3%	2%	0%	2%	4%
GPS Fencing	10%	4%	2%	2%	3%	4%
Ambassadors	0%	7%	2%	2%	2%	3%

*Percentages of 30 and larger are in red, percentages between 15% and 29% are in green.

A closer look at open-ended feedback from the online feedback form

This section discusses the additional feedback gathered from the SMD online feedback form. Participants were asked for any additional feedback they may have about the SMD Pilot Evaluation and Arlington County. Because this was an open-ended question, responses varied in length and topic (See **Figure 50** below).

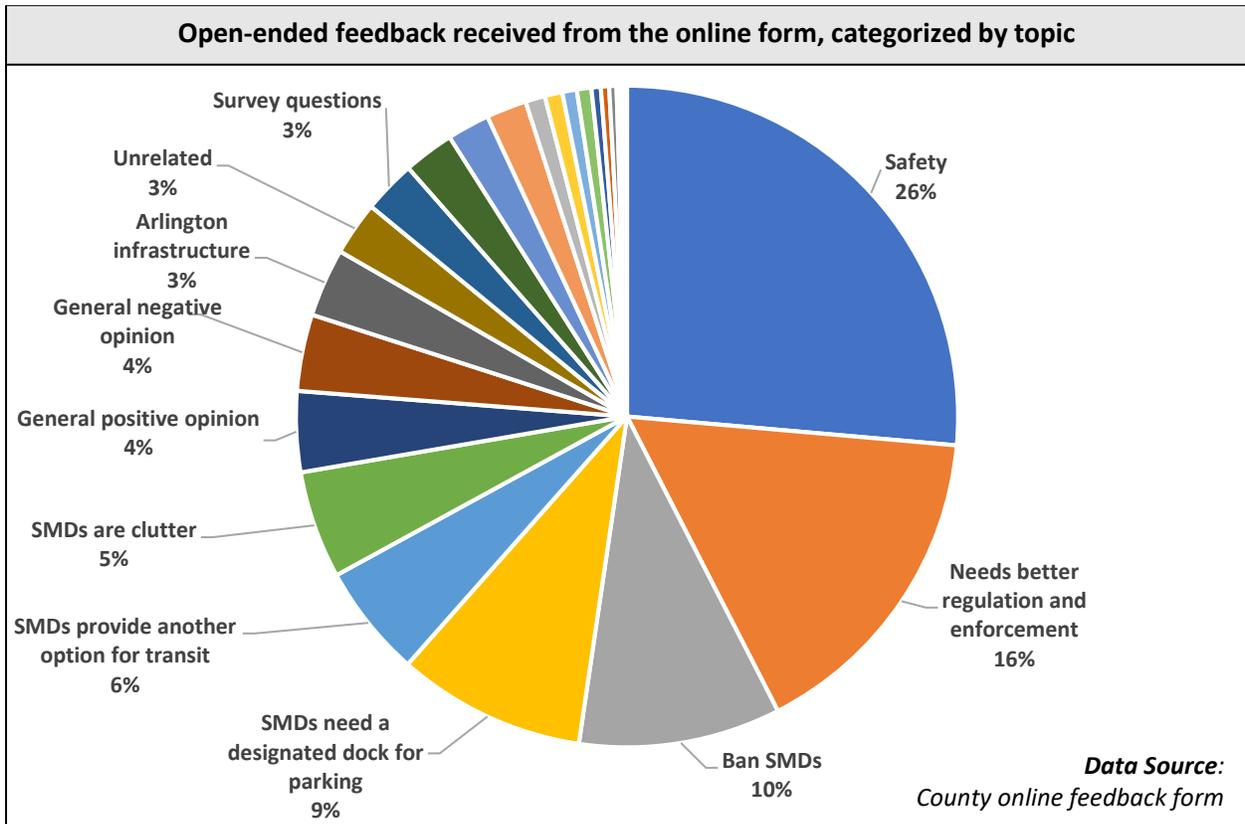
In this analysis, the responses were categorized based on common topics that arose while the feedback form responses were being reviewed. Keywords were used to help group responses into common categories, such as “safe”, “dangerous”, “sidewalk”, “speed”, and “park”. For example, the keyword “park” was used to review responses about SMDs wrongly parked in private property and on sidewalks, as well as feedback about providing designated docks for SMDs.

There was a total of 1,978 responses for the “additional feedback” portion of the feedback form. This does not include the 2,085 who did not provide any additional feedback.

There was no plurality of open-ended feedback. The most frequent open-ended feedback was only 522 responses, or 26% of total open-ended feedback received and that was about safety concerns for pedestrians and SMD riders. The second most frequent open-ended feedback’s theme was about how SMDs need better regulation and enforcement (318 responses, or 16% of total open-ended feedback received). The third most frequent open-ended feedback’s theme was to ban SMDs (195 responses, or 10% of total open-ended feedback received).

The other feedback categories that appeared frequently in open-ended responses were about designated docks for SMDs (182 responses, or 9% of total open-ended feedback received), how SMDs provide another transit option in Arlington County (109 responses, or 6% of total open-ended feedback received), and complaints about how SMDs clutter Arlington Count (104 responses, or 5% of total open-ended feedback received).

One positive feedback received was how SMDs provide another option to get around Arlington County (109 responses, or 6% of total feedback received). Other general positive feedback about SMDs (i.e., “I like scooters!”) comprised of 78 responses or 4% of total feedback received. There were a few calls to deploy more SMDs in more areas around Arlington (19 responses, or 1% of total feedback received).



Note 1: Chart only shows feedback categories that received 50 or more responses

Figure 50: Open-ended feedback received, categorized by topic

CHAPTER 5: CONCLUSION – LESSONS LEARNED & RECOMMENDATIONS

This report presents a detailed analysis of Arlington County’s shared mobility devices (SMD) pilot as it pertains to its service operations, service utilization and the community’s initial reactions to the service. While more comprehensive in nature, the ultimate objective was to understand how these services performed. Performance was measured against the County’s transportation goals as defined in its Master Transportation Plan (MTP^{lviii}) mainly with respect to mobility, safety, equity and sustainability.

Coming to a single conclusion on SMD performance is challenging. The mobility service is new, the infrastructure is evolving with the increase in adoption (e.g. addition of SMD parking corrals), and changes in the technology. Moreover, data is scarce, and research and benchmarking measures are almost non-existent. Acknowledging these constraints, the main takeaways from this evaluation is that three levels of performance were identified:

(Good SMD performance) SMDs can provide a viable complement to the County’s transportation ecosystem that increases mobility options and advances sustainability. Results of the pilot confirm that shared mobility devices are popular, with high number of trips and adoption, they are positively perceived by those who use them and could provide sustainability and equity benefits as it increases active transportation and access

(Mixed SMD performance) Certain aspects of the pilot have shown more mixed results, with inconclusive results as to a clear success or failure in terms of performance. This includes the focus on equity concerns (with a disparity in normalized deployment between North and South Arlington), and the clear communication of rules and regulations to the Arlington community.

(Weaker SMD performance) There remain some challenges with the integration of SMDs in Arlington that will need to be addressed. This includes clear safety concerns from the standpoint of riders, pedestrians and drivers in Arlington pointing to the need for more adequate infrastructure (e.g. protected bike lanes), and community concerns over parking and clutter resulting from the program. Safety concerns are also expected to dampen with time as more people use SMDs and become familiar with such services. Results have shown considerable differences in perceptions between SMD riders and non-SMD riders. This suggests that perceptions should improve as more trips become repeat trips and not first trips.

The summary evaluation table below provide an overview of how the results of this pilot were used to evaluate performance with respect to advancing Arlington County’s transportation goals.

SUMMARY EVALUATION TABLES

KEY QUESTIONS	GOAL 1: PROVIDE HIGH-QUALITY TRANSPORTATION SERVICES		
	PILOT OPERATIONS	UTILIZATION	COMMUNITY'S REACTION
HAS THE LEVEL OF SMD SERVICE IN ARLINGTON DURING THE PILOT BEEN ADEQUATE GIVEN RIDER DEMAND	YES, RELATIVELY - Arlington gets more SMDs per 1,000 resident (4.0) than Washington DC (2.4) and more vehicles than Capital Bikeshare in Arlington (3.1 SMDs per 1,000 resident).	N/A	NO – Too many - Several respondents in the open ended (5%) and feedback form (12%) referred to improperly-parked SMDs as “clutter”. <i>Not enough (at key locations)</i> – More than 30% of respondents disagreed that e-scooters were available in their neighborhood or near their office/school.
IS THE PUBLIC RECEIVING ENOUGH INFORMATION ON HOW TO INTERACT WITH THESE “NEW” SERVICES?	NO - Relatively low awareness of rules and regulations as well as acknowledgment of receipt of information on complaints and local regulations from operators. 20-22% of SMD riders and 43% of non-riders do not know what the laws are. Less than half of respondents (45%) indicated that they had received information from operators on local regulations and less than a third (30%) indicated that they received information on filing a complaint.	N/A	NO - Comments to the Mobility Inbox and open-ended questions to the feedback form showed recurrent lack of knowledge on rules, regulations and how to ride SMDs, indicating that riders should be educated regarding (1) sidewalk riding, (2) speed, and (3) parking. YES – Comments and complaints reflecting a lack of understanding of SMDs and rules/regulations decreased significantly over the course of the pilot, suggesting familiarity and experience could be having an impact.
IS THE ARLINGTON INFRASTRUCTURE ADEQUATE TO SUPPORT A SMOOTH OPERATION OF THESE SERVICES?	N/A	YES – Implementing corrals in areas of high ridership with signs of elevated utilization; NO - limited availability of protected bike lanes that would make riders feel safer. 67% of respondents of the feedback form prefer to ride on protected bike lanes.	NO - 58% of e-scooter riders would feel safer if there were bike lanes separated from motor vehicle traffic with a physical barrier.
ARE THESE SERVICES INCREASING RESIDENTS’, WORKERS’ AND VISITORS’ ACCESS TO ACTIVITIES?	N/A	YES - Riders use SMDs for transportation trips, only 8% of e-scooter riders and 23% of dockless e-bike riders use it for recreation or exercise purposes, pointing to a high use of SMDs to get to destinations and activities.	YES - SMD riders like the new mobility service. 74% from the online feedback form find it convenient to ride, 74% enjoy riding it, 76% find it easy to use. 4% of respondents said they would not have made their most recent trip if not for SMDs.
IS THE RATE OF BROKEN SMDS ADEQUATE?	<i>Monthly variability ranges between 2% and 8% of SMDs reported broken over the pilot</i> YES – From an operational standpoint, broken SMDs have had a limited effect on overall deployment with the exception of one operator.	N/A	NO - 33% of e-scooter riders reported having experienced a mechanical issue and 27% reported having experienced issues unlocking/locking e-scooters via the mobile app in Arlington County.

GOALS 2 & 6: MOVE MORE PEOPLE WITHOUT TRAFFIC & ADVANCE ENVIRONMENTAL SUSTAINABILITY

KEY QUESTIONS	PILOT OPERATIONS	UTILIZATION	COMMUNITY'S REACTION
<p align="center">ARE SMDS SUBSTITUTING FOR CAR TRIPS?</p>	<p align="center">N/A</p>	<p>YES – 19% of e-scooter riders would have used Uber or Lyft and 13% would have driven a personal car or other motor vehicles to make their most SMD-based recent trip.</p>	<p align="center">N/A</p>
<p align="center">ARE SMDS PROVIDING A DIFFERENTIATED AND USEFUL COMPLEMENT TO ARLINGTON'S MULTIMODAL TRANSPORTATION SYSTEM IN SUCH A WAY THAT IT WOULD ALLOW RIDERS TO REQUIRE LESS CARS OR SOV USES?</p>	<p>YES – Deployment is concentrated around areas of high transit accessibility and along key transit corridors.</p>	<p>YES – 18% of e-scooter riders and 8% of dockless e-bike riders reported using SMDs to connect to/from Metrorail; 11% reported increasing their use of bus and 10% reported increasing their use of Metrorail after starting to use e-scooters in Arlington County Elevated count of trips originating or arriving at transit stops. Limited signs of significant direct substitution of transit trips by SMDs (7% reported less Metrorail and 3% less buses).</p>	<p>YES - 14% of e-scooter riders chose "it's environmentally" friendly in their top three choices of why they use SMDs in Arlington.</p> <p>When prompted to select their most significant driver for using SMDs, "to get around faster" and "convenient" were the most popular answers, supporting the perceptions of SMDs as a useful complement to the Arlington transportation landscape</p>

GOAL 3: PROMOTE SAFETY			
KEY QUESTIONS	PILOT OPERATIONS	UTILIZATION	COMMUNITY'S REACTION
DO CRASH RATES CONFIRM THAT SMDS ARE RELATIVELY SAFE?	<p><i>There were 69 crashes in total between October 2018 and June 2019 (~20 crash/100k miles)</i></p> <p>YES – Crash statistics indicate that SMDs are relatively safer than cars</p> <p>NO – Crash rates exceed average bike crash rates</p>	N/A	N/A
DO RIDERS AND NON-RIDERS FEEL SAFE ON OR AROUND SMDS?	N/A	N/A	<p>NO –</p> <p>As <u>riders</u>, less than 50% of respondents felt safe riding SMDs in Arlington, with lack of infrastructure flagged as a key reason.</p> <p>As <u>pedestrians</u>, more than half of respondents reported feeling unsafe to very unsafe around e-scooters – skewed higher by non-SMD riders. 26% of open-ended questions discussed concerns about safety, which included helmet use. From the online feedback form, 58% of non SMD riders don't think e-scooters are safe.</p> <p>Safety is the main barrier for not using SMDs according to the online feedback form and third most important source of complaints to the Mobility Inbox.</p>

GOAL 4: ESTABLISH EQUITY

KEY QUESTIONS	PILOT OPERATIONS	UTILIZATION	COMMUNITY'S REACTION
<p>ARE LOWER-INCOME RESIDENTS ADEQUATELY SERVED BY SMDS COMPARED TO HIGH-INCOME RESIDENTS?</p> <p>DO SMDS HELP ARLINGTON COUNTY CATER TO THE NEEDS OF DISADVANTAGED SEGMENTS OF THE POPULATION AND PROMOTE EQUITY?</p>	<p>YES - While the analysis showed that North Arlington received between and 1.3x and 2.5x more service than South Arlington, the analysis also showed that some lower than median income areas received higher than average service.</p> <p>NO – Certain neighborhoods with incomes below the median had low deployment measures.</p> <p>N/A</p>	<p>YES - The analysis showed that trips are generated from and are ending in areas of lower than median household income.</p> <p>NO – Certain neighborhoods with incomes below the median had low ridership measures.</p> <p>YES - There are areas with lower median incomes and high ridership rates. Late night travel provides opportunities for people to return back from home if need be when transit is not accessible during that time.</p>	<p>YES – Very few comments had to do with lack of accessibility to SMDs or underserved neighborhoods.</p> <p>No – Comments did refer to the dependence of SMDs on smartphone, with accessibility limited without one.</p>
<p>ARE SMDS NEGATIVELY AFFECTING ACCESSIBILITY AND COMFORT FOR PEOPLE WITH DISABILITY? (E.G. SCOOTERS PARKING ON SIDEWALKS AND RAMPS)</p>	<p>MIXED - The pilot recorded a number of incorrectly parked SMDs potentially impacting people with disability using the sidewalk. The number of incorrectly parked SMDs per 1,000 trips increased from 12 incorrectly parked SMD/1,000 trips in October to 37 incorrectly parked SMD/1,000 trips in February and decreased thereafter monthly to 13 incorrectly parked SMDs/1,000 trips in June.</p>	<p>N/A</p>	<p>YES - Sidewalk riding and parking had the highest number of complaints which could be affecting people with disabilities, including blocking sidewalk ramps.</p>

GOAL 5: MANAGE EFFECTIVELY AND EFFICIENTLY

KEY QUESTIONS	PILOT OPERATIONS	UTILIZATION	COMMUNITY'S REACTION
<p>HAVE OPERATORS BEEN COMPLIANT WITH THE MEMORANDUM OF AGREEMENT (MOA) FRAMING THEIR PARTICIPATION IN THE ARLINGTON COUNTY SMD PILOT PROJECT?</p>	<p>MIXED. The evaluation identified five breaches of the MOA in terms of (1) inadequate deployment sites, (2) high operational speeds, (3) idle SMDs for more than seven days, (4) incorrectly parked SMDs and (5) data.</p>	<p>N/A</p>	<p>N/A</p>
<p>ARE THE CURRENT RULES AND REGULATIONS GOVERNING THE USE OF SMDS IN ARLINGTON ADEQUATE GIVEN WHAT HAS BEEN LEARNED FROM THE PILOT PROJECT?</p>	<p>YES - The rules and regulation in place were broadly adequate to enable a successful pilot program</p> <p>NO - The absence of rules regarding equitable distribution of SMDs affected deployment and lack of clear guidelines to riders on rules and regulations limited user compliance</p>	<p>NO - More people indicated wanting to ride on protected lanes (67%) or sidewalks (16%) than in shared lanes (9%), which was the least popular option</p>	<p>MIXED - 16% of the comments on the open-ended section of the feedback form discusses the need for better regulation and enforcement; less than half of e-scooter riders agreed with the statement "the 10 mph e-scooter speed feels fast enough for where I ride".</p> <p>Several complaints pertain to enforcement rather than regulations themselves, with age limits, speed limits and sidewalk riding limits all acknowledged but not enforced.</p>

<p>ARE COMMUNITY'S EXPECTATIONS BEING MANAGED WELL FOR BOTH RIDERS AND NON-RIDERS?</p>	<p>N/A</p>	<p>N/A</p>	<p>YES - Decrease in complaints and successful outreach events, more to be done.</p>
<p>ARE ADEQUATE RESOURCES BEING DEVOTED TO THE MANAGEMENT OF SMD DEPLOYMENT & OPERATIONS?</p>	<p>YES - Arlington County Staff worked on addressing all operational challenges and 20% of non-riders get their information from Arlington County's website</p>	<p>YES - Analysis shows that SMD corrals were deployed in areas of high utilization with positive results</p>	<p>YES - Complaints have decreased significantly over time NO - Community feedback reflects some lack of awareness or understanding of SMDs that could be remedied by more active County outreach.</p>

Based on these results, the research team developed the following eight recommendations for Arlington County:

I. Accelerate infrastructure investments to address rider and community safety and comfort concerns; focus on available route detail data

- Evaluate the possibility of increasing the share of protected bike lanes in key SMD corridors with the Rosslyn-Ballston corridor as a high priority given high ridership and elevated vehicle and pedestrian traffic.

II. Continue working on innovative ways to address parking

- Communicate more stringent parking restrictions for operators – if addressable through technology – such as systematic restrictions by operators from parking at or near an intersection, outside residential or commercial entrances, in the middle of a sidewalk or near handicap parking space.
- Provide operators with map of desired deployment areas in each neighborhood and conversely of no-parking areas.
- Monitor and enforce operator response time in addressing parking complaints, where applicable.
- Examine further potential for SMD-specific parking infrastructure such as corrals or lock-to devices.

III. Create, monitor, and refine equity expectations, go beyond geography

- Monitor and enforce as required proportional deployment in specific target areas.
- Perform more detailed equity and access analysis to ensure SMDs are being deployed in lower-income areas.
- Aim to assess equity from three standpoints (1) accessibility (in terms of location and the need for a smartphone to unlock the mobility service), (2) existence of equity programs, and (3) payment methods (e.g. needing a credit card).

IV. Focus on and invest in communicating the rules and regulations to the public, including riders and non-riders

- Establish clear guidelines and messaging that is consistent across county resources and operator information platforms (websites, apps, and devices).
- Monitor operators' messaging to ensure rules, regulations and rider resources are clearly communicated.
- Suggest or mandate creative ways in which operators can better communicate rules and regulations including, more innovative methods such as quizzes²⁸.
- Clearly state when rules are different from neighboring jurisdictions such as Washington, DC.

²⁸ Any such initiative should be done while balancing the importance of the convenience to riders so as not to negatively impact demand and the overall rider experience.

- Continue to conduct community outreach events, soliciting feedback and communicating how the county is addressing key community concerns flagged in this evaluation.

V. Continue monitoring operations and requiring complete and robust data from operators

SMDs are growing significantly while still at an early stage in terms of technology, best practices, and operational guidelines, making close monitoring a critical requirement for their continued operation.

- Require operators to comply with the data template and to submit additional operational data that they have not submitted yet (e.g. idle time, thefts and vandalism, broken SMDs, vehicle-specific trip and incident-level data).
- Require unified data (in terms of variables provided and format) from operators, allowing easier processing and cleaning of the data, which would leave more room for research and analysis.
- Monitor the difference between Washington DC and Arlington in terms of the service level (SMDs per 1,000 people).
- Monitor the difference between SMDs and Capital Bikeshare bikes in terms of the service level (SMDs per 1,000 people).
- Monitor incident rates such as broken SMDs and crashes with a specific focus on systematic or operator-specific patterns pointing to structural challenges.

VI. Share results and county initiatives with the public, make the integration of SMDs into Arlington an inclusive and interactive conversation

- Share key SMD-related studies with the public including how the County is thinking about sidewalks, the rationale behind opening them up to SMD ridership and how it envisions the coexistence between SMDs, pedestrians and bikers.
- Inform the public on how the County is dealing with speed limitations without compromising on safety, including how speed limits, if applicable, are monitored and how operators are held accountable.
- Address perceptions of lack of safety, a key challenge to SMD popularity or even acknowledgment. This could include undertaking a specific study on SMD safety, exploring alternatives available (e.g. helmets, bike lanes) and misconceptions, and share findings with the public.
- With assistance from Arlington law enforcement, provide insight into the SMD enforcement process and potential deterrents for infractions.
- Share the results of this pilot evaluation as well as experiences from pilots in other cities to provide comparison and benchmarking, which are critical with early-stage technologies.

VII. Collect or compile more robust data within and outside the SMD program and mandate periodic evaluation of SMD trends

A broader array of data sources could enable more accurate analysis of SMDs in Arlington. This could include:

- Daytime population for Arlington using more granular measures than county-wide can help with a better comparison of (1) who actually is demanding SMDs at any point and (2) between areas that receive higher levels of commuters/workers (e.g. North vs. South Arlington).
- More detailed income data than above or below median household incomes could help examine equity concerns more accurately.
- Request crash data from law enforcement and health services to start differentiating between scooters and other modes when dealing with incidents to improve tracking.
- Repeat SMD evaluations to assess SMD trends and truly characterize the service and its long-term evolution (e.g. crashes).

VIII. Undertake additional research or studies including more detailed analysis of specific issues of interest flagged in the pilot evaluation

This evaluation provides a valuable starting point in terms of flagging the most critical issues but has foregone detailed focus on specific issues in the interest of a holistic assessment of the SMD pilot. Several more detailed analyses could be undertaken with available data and separate longer-term studies and/or surveys incorporating learnings from this evaluation could help improve SMD system performance, rider experience and community responses, including:

Short term studies with available data

- Examining key results (e.g. perceptions) by sample segment including perception and experience by gender, primary mode, and frequency of use.
- Examining trip characteristic differences by corridor.
- Looking at trip characteristics by time of the day and weekends versus weekdays.
- Examining geographic distribution of operational problems – are incidents concentrated in one or more areas in Arlington? Do they correlate with elements of the infrastructure or land use?
- Taking a closer look at “late night travel”, potentially complemented with an intercept survey to characterize such trips and their link to accessibility.
- Examining the community’s reaction to the pilot before and after the installation of corrals - did complaints, operational challenges and trip change after the installation of corrals?
- Performing more sophisticated modeling of SMD behavior using attitudinal and demographic variables in order to understand the determinants of satisfaction, frequency, trip purpose etc.
- Conducting more sophisticated analysis of the Mobility inbox data.

- Conducting more sophisticated correlation analysis based on bivariate maps obtained and discussed in this report.

Long-term studies with additional data

- Studying the impact of e-scooters on accessibility and comfort for people with disability.
- Collaborating with other pilot programs and leveraging findings from Arlington utilization rates to estimate an “adequate” level of service that planners should aim for in designing SMD programs. This would be a similar effort to the ITDP bike share planning.
- Evaluating acceptable levels of broken SMDs for new technologies or a new mobility service.
- Evaluating communication techniques for best retention rates within apps (tests, games etc.).
- Examining travel behavior from the perspective of mode substitution between cars/TNCs and SMDs.
- Developing a scoring system/service standard for performance measures to rank and evaluate operators, mandating a minimum service level for continued operation in Arlington County.

The results and the recommendations of this report should be read within the context of Arlington County and the data collected during the pilot. The limited time SMDs have been in operation and the corresponding limited data and research means that the characterization of SMDs and how cities manage them will continue to evolve. This makes it important for local policymakers to continue monitoring and collecting data in order to derive structural and systemic trends, accurately characterize these services and ensure their integration into the Arlington County transportation landscape yields desired benefits while mitigating negative externalities.

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