Safer Charging, Safer Deliveries

Lessons from NYC DOT's Public E-Bike Charging Pilot

Eric Adams
Mayor

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Dear Fellow New Yorker:

Electric bicycles have dramatically expanded in number along New York City streets over the last decade, providing a sustainable and convenient travel option for delivery workers and everyday New Yorkers. When New York State legalized e-bikes in 2020, delivery workers—the bikes' most frequent users—had been properly deemed "essential workers," as they brought food to our homes during a once-in-a-century pandemic. As the public has come to rely even more on quick deliveries, these cyclists, largely recent immigrants, are benefiting from new technology that could increase productivity and new laws that allowed them to earn a living.

However, as the number of e-bicycles grew, so did safety concerns—as intense demand fueled growth that did **not** prioritize safety. Many of the electric bicycles favored by delivery workers are equipped with rechargeable lithium-ion batteries that do not meet industry safety standards. These batteries have contributed to a dramatic growth in deadly fires—the New York City Fire Department (FDNY) estimates that 33 New Yorkers have died in battery-related blazes in just the last five years.

To prevent the epidemic of deadly fires, the Adams administration has focused on a range of solutions across agencies that will save lives – including stronger enforcement against the sale of dangerous batteries. At New York City Department of Transportation (NYC DOT), we launched a ground-breaking battery charging pilot program earlier this year.

This report, **Safer Charging, Safer Deliveries: Lessons from NYC DOT's Public E-Bike Charging Pilot**, will provide an overview of the successes, challenges, and lessons learned from this pilot. With thanks to dozens of delivery cyclists willing to volunteer for the pilot as well as companies willing to give their products a test-run in our unique and challenging market, we now have encouraging results:

- The pilot showed that battery-swap cabinets can safely meet the needs of delivery workers, who completed over 12,000 battery swaps over six months
- The pilot reduced dangerous at-home charging sessions by more than a third, and for many participants, eliminated the practice entirely

Equally alarming as fire deaths, we have also seen traffic fatalities among e-bike riders far outpace other cyclists. At the NYC DOT, teams have been laser-focused on developing other solutions that can increase safety for e-bikes. On the design front, we are building wider protected lanes or widening established lanes to allow faster e-bikes to safely share space with slower cyclists and e-scooters. We have also begun an extensive multi-language public education and marketing campaign to highlight the safe usage of e-bikes.

The revolution in micro-mobility in urban areas—across the United States and around the world—is upon us and has opened our collective eyes to newer travel modes that are more convenient, affordable and sustainable. But safety is always our top priority, which is why the decline in battery fire deaths so far this year has been heartening evidence that our collective strategy may be having positive effects.

We look forward to applying the lessons from this pilot and continuing that progress.

Ydanis Rodriguez

Executive Summary

In February 2024, the New York City Department of Transportation (DOT) announced the E-bike Battery Charging Pilot Program to explore the feasibility of outdoor charging solutions for electric bicycles (e-bikes). As part of Mayor Adams's **Charge Safe, Ride Safe Action Plan**, the six-month pilot program deployed battery-swapping cabinets from PopWheels and Swobbee, along with e-bike charging docks from Swiftmile, at five locations. The program recruited 118 test users—predominantly food delivery workers with Arrow Model 9 and Model 10 e-bikes, the industry's most popular models. Participants received unlimited free charging services. The pilot ran from March 7 to September 7, 2024, with battery-swapping services extended through February 2025. The program's core goals were to enhance fire safety, incentivize e-bike use, and assess the adoption of new battery charging technologies among commercial cyclists.

User Profile

All test users were app-based delivery workers, and all but one resided in New York City. Participants primarily served Manhattan neighborhoods and regularly commuted via e-bike. The majority of participants were male, and over half identified as Latin American, with West Africans comprising the second-largest demographic group. Prior to the pilot, most users (81%) charged their e-bike batteries at home, with 41% returning home between shifts to recharge.

Key Findings

- The two battery swapping services were heavily used, with a total of 12,100 battery swaps over the course of the pilot
- The charging docks were moderately used, with 1,300 charging dock sessions over the course of the pilot
- The program reduced at-home charging among participants, with a 35% reduction in participants charging batteries at-home, and there were no fire incidents during the pilot

- Late afternoon was the most popular time to charge. Demand for charging peaked at key periods before popular food delivery times: at 11 a.m., between 4 and 5 p.m., and around 9 p.m.
- Pilot locations near high demand restaurant areas were more popular. Cooper Square, located in the heart of the East Village, accounted for 59% of all transactions, while Brooklyn Army Terminal, located in an industrial area in Brooklyn, had just two percent of all transactions
- PopWheels and Swobbee demonstrated strong user retention, while 62% of registered Swiftmile users discontinued using the docks by the end of the program
- The program decreased reliance on spare batteries, with survey data showing a 50% decrease in the use of spare batteries while conducting deliveries
- Strong relationships between users and service providers fostered a sense of community stewardship over the battery-swapping network
- Program participants expressed a strong willingness to pay for a monthly, unlimited subscription to maintain access to the services after the pilot program ends

The findings of this pilot demonstrate that an outdoor battery charging network could help support the adoption of electric micromobility, while reducing fire risk.


Swobbee
E-Bike Battery Charging Pilot Program
Welcome to one of NYC's first electric bicycle charging stations. This location is one of five sites in a pilot program run by the NYC Department of Transportation (NYCDOT) to test safe battery charging technologies for electric bicycles used by delivery workers. During the 6-month pilot program, only pre-registered test users can use the available charging technology.
If you are a delivery worker interested in testing these charging technologies, please scan the QR code below to learn more and fill out the expression of interest form.
NYC
LARSON
www.fyebike.com

Chapter 1: Program Overview

Since 2020, New York City has seen a rapid increase in the use of privately-owned electric-powered micromobility devices. This surge was driven by the need for travel alternatives during the COVID-19 pandemic, the 2020 legalization of all classes of electric bicycles (e-bikes) and electric scooters, and the growing popularity of on-demand food deliveries. E-bikes offer an affordable, convenient, and sustainable mode of transportation and are the vehicle of choice for thousands of hard-working delivery workers. However, the rapid adoption of these devices has resulted in a growing number of fires ignited or fueled by the lithium-ion batteries that power them. The best way to reduce fire risk is to promote the use of safer certified e-bikes and batteries and to encourage users to charge and store their batteries outside of their homes.

To better test the feasibility of outdoor e-bike charging, the New York City Department of Transportation (DOT) announced the E-bike Battery Charging Pilot Program in February 2024. Part of Mayor Adams's **Charge Safe, Ride Safe Action Plan,** the six-month pilot program deployed battery-swapping cabinets and e-bike charging docks on the street for privately owned e-bikes at five locations. NYC DOT recruited 118 test users who received unlimited free charging services. Only food delivery workers who owned Arrow Model 9 and Model 10 e-bikes—the most popular devices in the industry—were eligible to join. The pilot ran from March 7 to September 7, 2024, with a service extension for battery-swapping providers through February 2025.

The program's core goals were to enhance fire safety, incentivize e-bike use, and assess the adoption of new battery charging technologies among commercial cyclists. Through the pilot, DOT was able to explore pathways to deploy battery-charging technologies in NYC's complex public space environment and gather insights to inform future infrastructure investments. This evaluation report presents the findings of the six-month pilot and makes recommendations for how public e-bike charging could be part of the solution to reducing lithium-ion battery fires by promoting the use of certified batteries with e-bikes.

Context

The pilot program sought to address two major transportation issues in the city: promoting sustainable electric micromobility and preventing deadly e-bike fires caused by unsafe batteries and charging practices. From 2020 to 2023, structural fires caused or fueled by lithium-ion batteries rose from 30 to 268 annually, with deaths increasing from zero in 2020 to 18 in 2023. The surge in deadly fires has abated somewhat in 2024, with 236 fires and five fatalities as of November 12th. These fires have been linked to the widespread use of e-micromobility devices powered by large lithium-ion batteries, many of which do not meet industry safety standards.

New York City has a large population of commercial cyclists who rely on e-bikes to deliver food, primarily through on-demand delivery apps like DoorDash, Grubhub, and Uber Eats. A 2022 study by the New York City Department of Worker and Consumer Protection found that approximately 65,000 New Yorkers worked as food delivery workers in 2022, with 46% using e-bikes. Delivery workers are almost exclusively independent contractors rather than employees. On average, delivery workers' net earnings (which includes tips) was $11.12 an hour, without benefits (e.g., health insurance, paid sick leave, or workers' compensation insurance).

Under the gig economy model, delivery workers are responsible for purchasing, maintaining, charging, and storing their delivery vehicle. This combination of factors led many to acquire low-cost equipment and to use batteries well past their useful life. Lacking outdoor or employer-provided battery charging spaces, many delivery workers charge at-home. Although awareness of safe charging practices is growing, may workers have limited understanding of charging risks and safe charging practices. Tragically, some of the fatal fires caused by lithium-ion batteries have been attributed to these delivery workers.

In response to the rising fire risks from lithium-ion batteries, New York City is pursuing a range of actions, many of which are described in detail in **Charge Safe, Ride Safe**. These include passage of Local Law 39 (LL39) in late summer 2023, which requires all electric micromobility equipment sold, leased, or distributed in the city to meet relevant Underwriters Laboratories (UL) standards and to be certified by an accredited testing lab. Consistent with this law, all batteries used in the pilot swapping network are certified by UL.

Approach

This pilot was developed under the DOT Innovation Studio, a research and development initiative supported by Newlab, a Brooklyn-based venture platform for technology startups, and the New York City Economic Development Corporation. Each DOT Innovation Studio round focuses on a specific transportation challenge facing the agency and leverages emerging technologies to address it. With Newlab's technical expertise, the program team conducts industry research, identifies potential solutions, and pilots up to three technologies, each rigorously evaluated for impact and scalability. This particular pilot was conducted as part of the second round of the DOT Innovation Studio.

DOT worked closely with the New York City Fire Department (FDNY), which helped to select and evaluate battery-charging technologies, inform site plans, and inspecting station installations. DOT also consulted with experts in the field of battery and micromobility safety including national bike industry groups, UL Solutions, and academic research groups.

Delivery worker engagement was also key to the success of the program. With support from the Worker's Justice Project, parent organization of Los Deliveristas Unidos, and the New York City Food Delivery Movement, DOT sought input from food delivery workers at multiple stages of the program, including during program design, product evaluations, and pilot site selection. As high-mileage users of e-bikes, they provide unique insight into the battery charging needs of commercial cyclists. Finally, DOT engaged local public space managers, including the Downtown Brooklyn Partnership and Grace Church School, in the site planning and installation of stations.

Battery Charging Technologies

Three companies were selected to participate in the pilot program: PopWheels, Swobbee, and Swiftmile.

PopWheels: PopWheels offers a "batteries-as-service" model to their users through their battery-swapping cabinets. The cabinets provide users with access to UL-certified lithium-ion batteries, which are compatible with Arrow Model 9 e-bikes. Only batteries provided and maintained by the company can be charged in their cabinets. Test users can access one battery at a time. The NYC-based battery-swapping startup specializes in silverfish batteries compatible with the commonly used e-bikes among local delivery workers.

Swobbee: Swobbee offers a "batteries-as-service" model to their users through their battery-swapping cabinets. The cabinets provide users with access to UL certified, lithium iron phosphate (LFP) batteries, which are compatible with Arrow Model 10 e-bikes after a retrofit to the e-bike. Only batteries provided and maintained by company can be charged in their cabinets. Prior to their USA expansion, German-based Swobbee had experience providing battery-swapping cabinets for commercial fleets in Europe.

Swiftmile: Swiftmile provides access to charging through its electrified e-bike racks with three to four bays, which can provide fast charging for Arrow Model 9 and Model 10 e-bikes. Each bay has a charging cord that the user plugs into the battery of their parked e-bike. The smart charging features of the station ensure the batteries are receiving the proper level of amperage. Users charge their own batteries. Prior to the pilot, these racks were deployed to support shared fleets.

PopWheels' cabinet next to Swobbee's

Swiftmile's four-bay charging dock

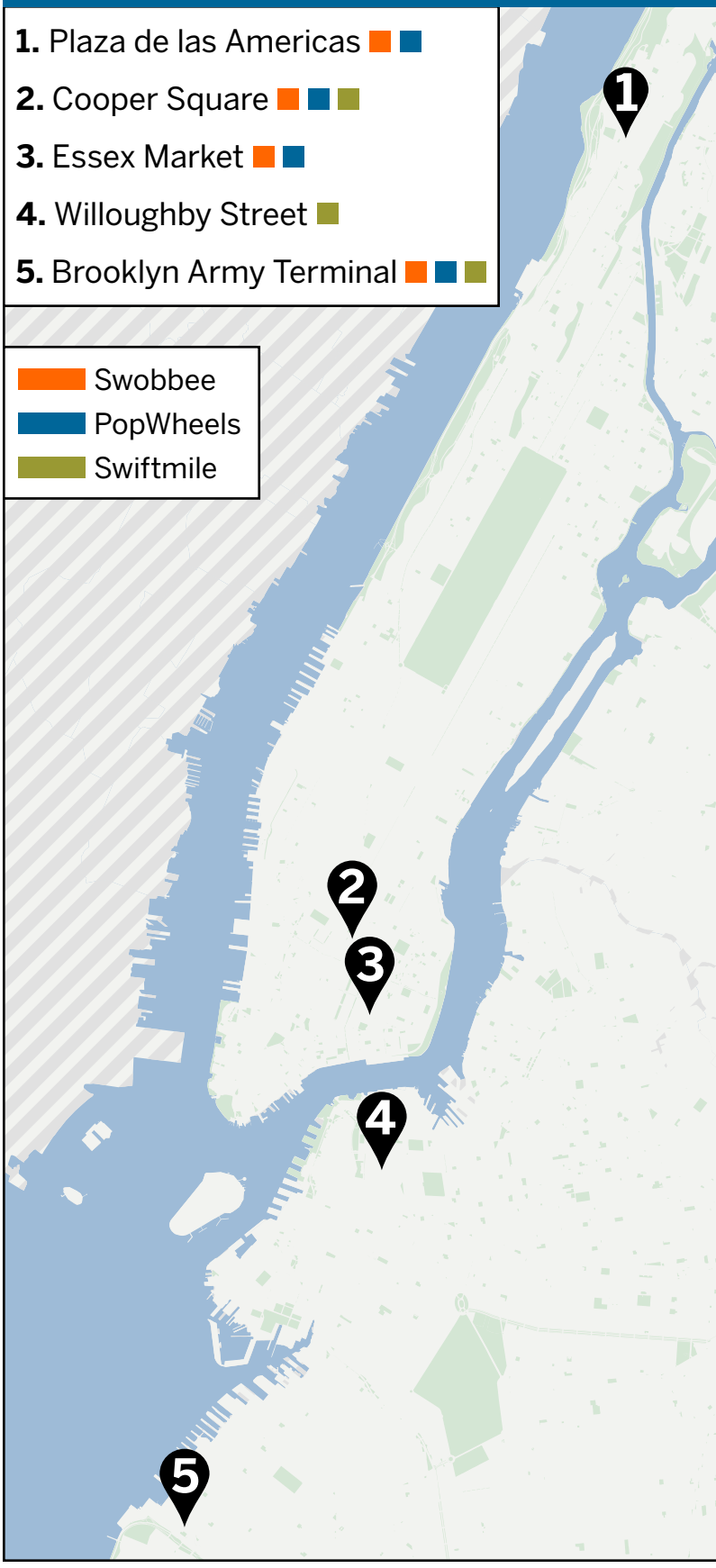
Pilot Locations

DOT installed one or more of these three technologies at five sites:

- **Plaza de las Americas (Washington Heights, Manhattan)**
  Swobbee and PopWheels
- **Cooper Square (East Village, Manhattan)**
  Swobbee, PopWheels, and Swiftmile
- **Essex Market (Lower East Side, Manhattan)**
  Swobbee and PopWheels
- **Willoughby Street (Downtown Brooklyn)**
  Swiftmile
- **Brooklyn Army Terminal (near Sunset Park, Brooklyn)**
  Swobbee, PopWheels, and Swiftmile

Site selection was guided by the availability of existing electrical service, space, and proximity to high-demand restaurant areas. No new power service was created at the pilot locations for the program; only existing power sources were used.

Figure 1: Map of Pilot Locations




popwheels
BATTERY SWAP NETWORK
FIRE DEPARTMENT
CITY OF
NEW YORK

Chapter 2: Program Design

Providing Service in a Diverse Electric Micromobility Ecosystem

In 2023, on behalf of the NYC Department of Transportation, Newlab conducted market research to examine the state of the e-bike charging industry in the United States (U.S.) and globally. This research revealed a lack of standardized product designs across the e-bike industry. Each e-bike model was typically built to accommodate a specific battery, and charging connectors were not universal—each battery required its own unique charger. This is still true today. Additionally, many e-micromobility devices and batteries sold in the U.S. had not undergone safety testing or certification to meet industry standards like UL 2271, UL's standard for e-bike batteries.

The lack of a single leading battery standard for e-bikes complicated DOT's effort to identify tech options for the pilot. To better understand the types of e-bikes and batteries in use, DOT conducted a survey among food delivery workers in 2023. The survey, which had 338 respondents, revealed that the Arrow Model 9 and Model 10 e-bikes were the most popular models among this group. To maximize the number of potential users for the pilot, DOT decided to test charging technologies that were compatible with these popular bike models.

Engaging Key Stakeholders in Technology Selection

DOT selected the pilot technologies based on feedback from focus group interviews with delivery workers and close collaboration with FDNY. To ensure the success of the pilot program, DOT involved these two key stakeholder groups from the outset. Delivery workers provided insights as the primary users of the charging equipment, while FDNY contributed fire safety expertise.

Prioritizing Fire Safety in Program Design

As a key consultant and stakeholder, the FDNY played a crucial role in incorporating fire safety measures into the program's design. The FDNY identified a challenge through this process: the fire review process for outdoor battery charging technologies had not yet been standardized due to the rapid pace of technological innovation. This required close coordination with various FDNY teams to thoroughly review the technologies.

To minimize the risk of battery thermal runaway, FDNY mandated that all companies cap charging at 95%. All charging products had fire safety features to increase safety:

Popwheels: Chargers inside battery cabinet switch to trickle-charging at 90% capacity and stop at 95%, while showing 100% to users. Trickle charging offers a slower, gradual charge to ensure proper voltage before increasing amperage. The cabinets' electrical systems include protections against overvoltage, overcurrent, and charging timeouts. Their UL-certified batteries have built-in battery management systems (BMS) that prevent overcharge, over discharge, over temperature, and voltage imbalance. Popwheels cabinets are exclusive to Popwheels batteries, which use a unique charge connector and verify the battery's serial number before charging.

Swobbee: Battery cabinets stop charging at the battery provider's defined voltage, extending the life of their LFP batteries. The BMS enables remote monitoring, adjusts charging settings for optimal safety, and enables the company to identify and remove unhealthy batteries from use. Swobbee cabinets can only charge their LFP batteries, which are more stable and less prone to thermal runaway, as compared to other lithium-ion battery chemistries.

Swiftmile: These e-bike charging racks use smart technology that starts with a trickle charge, ensuring proper voltage before increasing amperage. The system prevents overcharging by gradually reducing the current and maintaining a trickle charge for battery longevity and safety. The BMS monitors each session in near real time, shutting off a bay if an anomaly is detected, with user notifications if the battery requires servicing.

Finally, to foster a culture of community responsibility among participants, DOT only permitted authorized test users to access the charging technologies. These users underwent an onboarding process where companies provided key information on proper operation of their technologies. Additionally, DOT required all vendors to share direct access to the dashboards of each charging station, allowing the agency to monitor and address any operational issues in real time.

Addressing Battery Incompatibility

Swobbee's battery swapping network featured AES eBike 2.0 batteries, which are lithium iron phosphate (LFP) batteries with a shape form different from the "silverfish" style batteries used by the Arrow e-bikes. Swobbee installed a retrofit kit in their test users' e-bikes that enabled their battery to power the delivery workers' e-bikes. As seen in the figure below, the retrofit is comprised of a rear bike rack with a box that holds and connects the AES eBike battery to the electrical system of an Arrow Model 10 e-bike. The battery retrofit kit is wired to the e-bike motor to become the e-bike's source of power.

The Swobbee retrofit kit installed in Arrow Model 10 e-bike

Data Collection Considerations

DOT integrated robust data collection (both quantitative and qualitative) into the pilot to enable a comprehensive evaluation of the program upon its conclusion. The agency required all participating companies to grant DOT staff access to their station data in real time and to share weekly reports. DOT examined station data regularly to track progress and identify potential issues.

Furthermore, DOT conducted a baseline survey of test users during the onboarding phase to collect information about users' charging practices, e-bike usage, and other user profile details. Nearly four months into the program, DOT asked users to take a second survey to share insights into their experience using the technologies, their at-home charging practices, and e-bike usage. Finally, DOT organized in-person focus group sessions, where one-third of the pilot's frequent test users engaged in conversations with program staff about their experience participating in the program and vision for future investment. DOT offered monetary incentives to test users for survey responses and focus group participation. Surveys, focus group conversations, and research materials were made available in English, Spanish, French, Mandarin, and Bangla.

Site Selection Considerations

Given the cost and complexity of creating new power connections, DOT sought to identify potential locations with existing electrical service. DOT focused on sites that were in areas where delivery workers live and work and leveraged partnerships with local business improvement districts (BIDs).

Maintenance Considerations

Maintenance was an important piece of the program design process as stations were installed at highly trafficked public spaces. The three vendors were fully responsible for maintenance. Swiftmile hired local delivery workers to help conduct maintenance of their charging docks, while Swobbee contracted with Motivate–a local micromobility operator–to maintain their cabinets. Popwheels hired in-house staff. All companies remotely monitored their stations and conducted weekly in-person inspections and routine maintenance of the stations, such as trash pick-up and graffiti removal.


A safe way to match older New Yorkers with
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Chapter 3: Pilot Program Evaluation

About the Evaluation Report

Five main data sources were used to evaluate this six-month battery charging pilot: 1) station usage data, 2) user baseline surveys, 3) user midpoint surveys, 4) focus group sessions, and 5) one-on-one follow-up calls with test users. Additionally, DOT reviewed NYC311 reports and feedback submitted through the companies' customer service channels. NYC311 is NYC's non-emergency citizens' complaint and information hotline.

All vendors provided DOT staff with access to review and download their station data in real time. This report examines station data from March 7 (the date of the first test user recruitment event) to September 7, 2024. Test users were asked to complete a baseline survey as part of their onboarding. Sixty-nine out of 92 delivery workers who completed the survey did so before becoming users. This report only considers these 69 responses when assessing changes in user behavior.

Approximately four months into the pilot, test users were invited to complete a midpoint survey and attend in-person focus group sessions hosted by DOT. Sixty-six users responded to the mid-point survey, and 19 users participated in focus group sessions, conducted in multiple languages. Notes and materials from these sessions were analyzed to identify key themes and findings.

When comparing baseline and midpoint surveys, responses were weighted to address discrepancies in sample sizes. Another important data processing step was verifying that each unique user account corresponded to a single user and that there were no duplicates in the data, i.e. one user with more than one account. The number of enrolled test users was revised accordingly. Finally, for the purposes of this evaluation report, "frequent users" are defined as test users who completed at least one transaction per week for at least four weeks during a six-week period (from late July to early September).

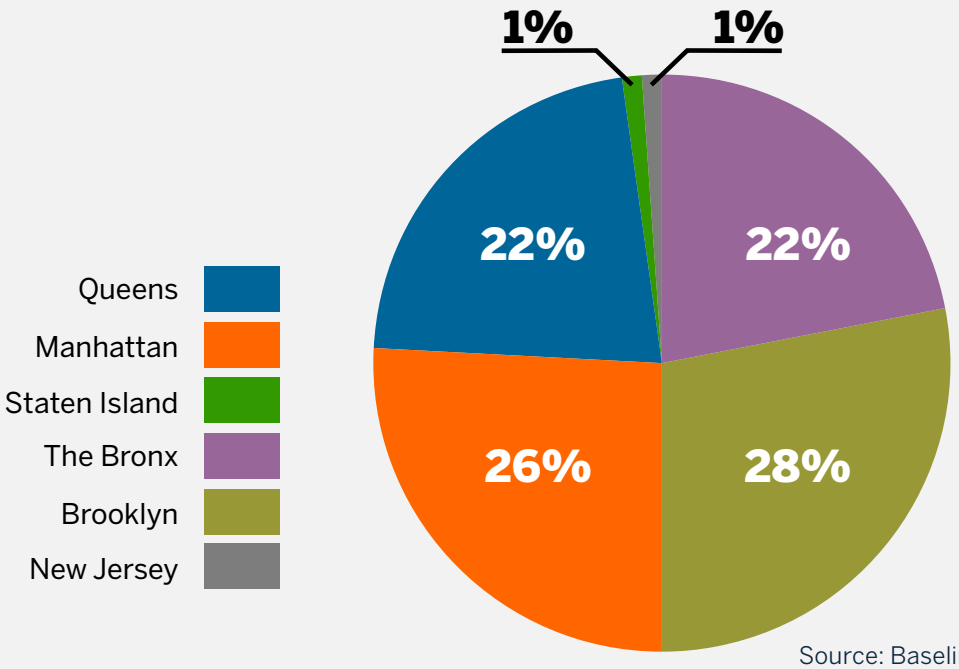
While all these data sources provide valuable insights into the program's successes and areas for improvement, it's important to recognize that access to a free service may have influenced participant ratings and feedback.

Test User Profile

A hundred and eighteen food delivery workers enrolled in the pilot. With the exception of one New Jersey resident, all test users lived in one of the five boroughs. Most of the test users were male, app-based delivery workers who delivered food to Manhattan neighborhoods. Notably, half of these users delivered for DoorDash, and one-third were "multiple appers," meaning they delivered for more than one app company throughout the week. Over half of pilot program participants were of Latin American descent, with West Africans making up the second-largest demographic. Preferred languages among users included Spanish, Mandarin, French, and Bangla.

Prior to joining the program, over half of test users commuted on their e-bikes consistently, with only 10% opting for public transit (delivery workers typically have to travel from the neighborhoods where they live to neighborhoods with high demand for food delivery, often in or around Manhattan). Most users (81%) charged their e-bike batteries at home, and 41% would return home to charge their batteries between delivery shifts. The length of these e-bike trips is significant, considering that 73% of test users lived in the outer boroughs, but delivered food primarily in Lower and Midtown Manhattan. Additionally, over half of the users regularly carried two or more batteries to meet their charging needs. This common practice exposes spare batteries to unnecessary wear and tear from exposure to weather and vibration, which contributes to the shortening of a battery's useful life.

Figure 2: Place of Residence of Test Users



Source: Baseline survey responses (92 sample)

Technology Performance

The evaluation revealed three key findings related to technology performance: 1) the new infrastructure was widely utilized by test users, 2) late afternoon was the most popular time for battery charging, and 3) technology usage was largely consistent throughout the week.

In terms of system usage, there were a total of 12,100 battery swaps during the pilot. Swobbee recorded 6,400 battery swaps, while PopWheels recorded 5,700. Additionally, Swiftmile registered 1,300 charging dock sessions over the course of the program. On average, active users swapped between 8 to 14 batteries or completed 4 to 7 charging sessions per week.

The higher number of transactions among Swobbee users may be attributed to the lower range of their LFP (lithium ferrophosphate) batteries compared to the users' personal batteries or PopWheels' NMC (nickel manganese cobalt) batteries. Survey data shows that 46% of Swobbee users reported traveling fewer miles with Swobbee's batteries than with their personal silverfish batteries. In contrast, 57% of PopWheels users reported that PopWheels' batteries provided the same mileage as their personal batteries. This difference in battery range likely explains why Swobbee saw a higher number of battery swaps than PopWheels, despite both companies having a similar number of test users and battery-swapping cabinets.

Table 1:
Survey responses to the question:
Are you traveling the same mileage after using the charging products compared to the alternative?

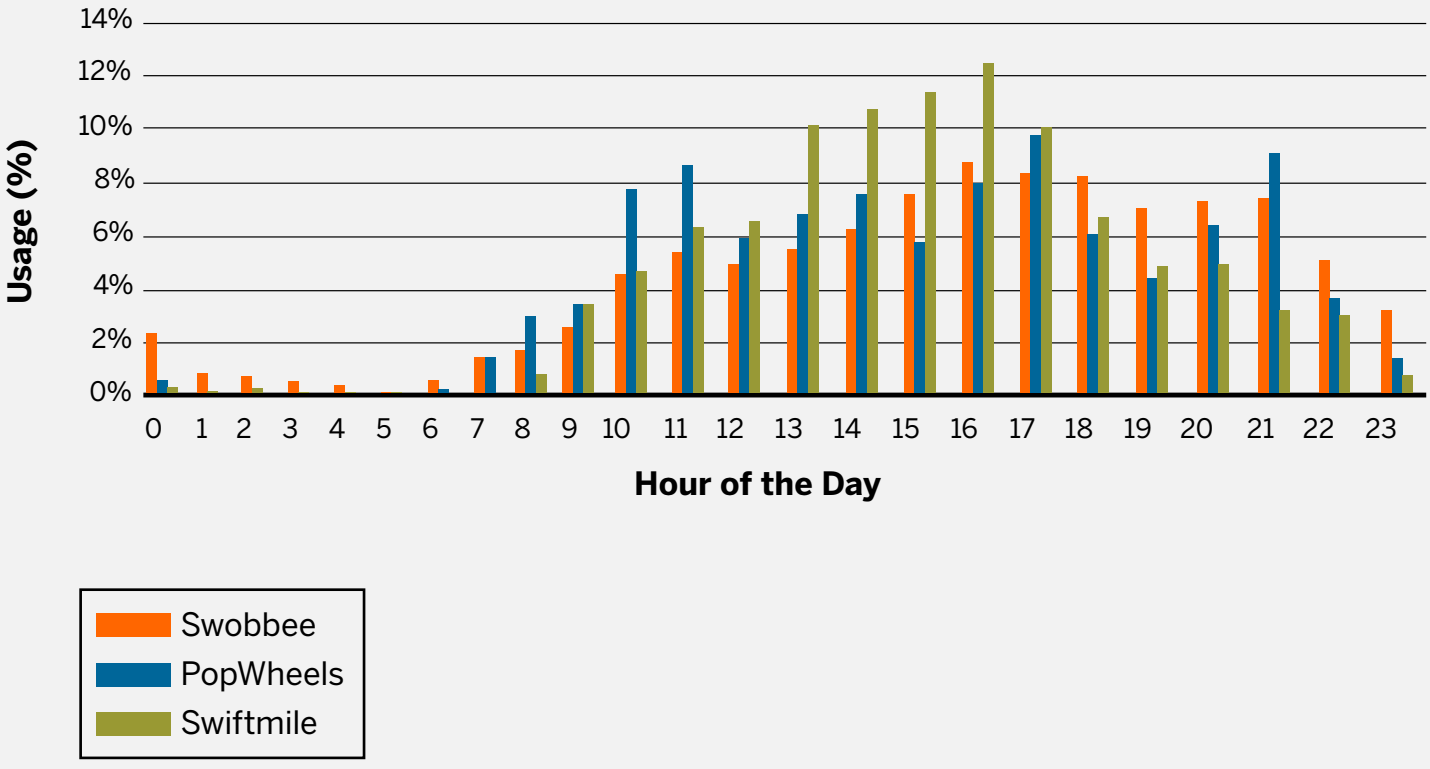
	PopWheels	Swobbee	Swiftmile
I cover less mileage	24%	46%	11%
I cover more mileage	19%	11%	6%
I cover the same mileage	57%	43%	83%

Source: Mid-point survey responses

Technology use fluctuated throughout the day, with late afternoon being the most popular time for charging across all three companies. Charging patterns were fairly consistent across the week. Demand for charging peaked at key periods before popular food delivery times: at 11 a.m. before the lunch rush, between 4 and 5 p.m. before the dinner rush, and around 9 p.m.at the end of the dinner shift and right before the start of the late-night delivery shift. This pattern suggests that many test users often charged their batteries right before starting their delivery shifts, ensuring they had enough power to complete a full shift without interruptions.

Time-of-day usage patterns between the battery-swapping services and e-bike charging docks differed significantly. As shown in Figure 3, Swiftmile usage peaked in the afternoon, with less activity during other parts of the day. In contrast, Swobbee and PopWheels demonstrated more evenly distributed usage throughout the day.

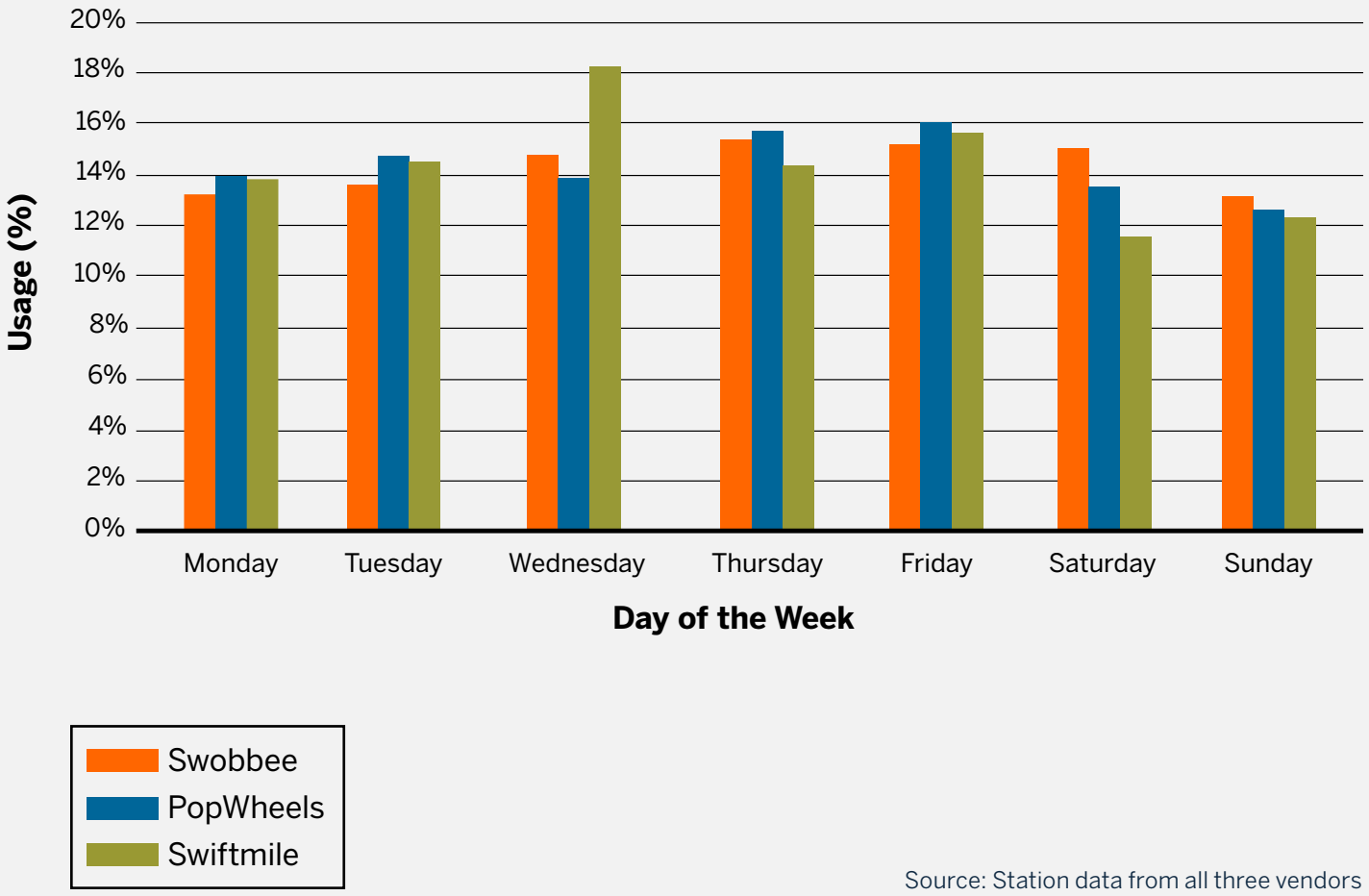
Figure 3:
Late afternoon was the most popular time for using the charging stations.



Source: Mid-point survey responses

For battery-swapping services usage was generally consistent across the week, with a slight drop on Saturdays and Sundays. Comparatively, Swiftmile saw more usage on Wednesdays.

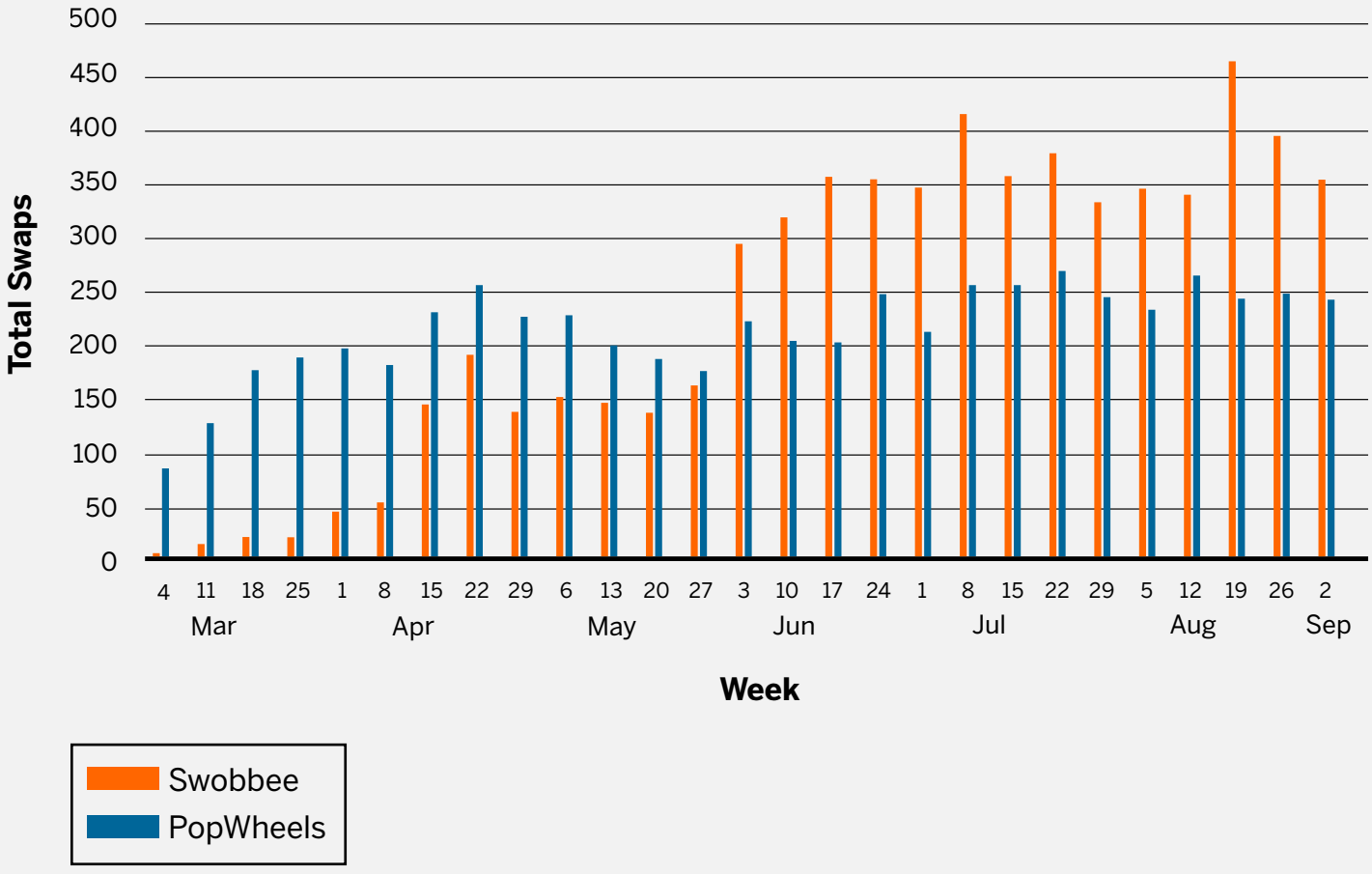
Figure 4:
Across all three vendors, technology usage remained generally consistent throughout the week, with slight declines over weekend days.



Source: Station data from all three vendors

In terms of service uptake of battery-swapping services, PopWheels had the most rapid user recruitment process, while Swobbee took several weeks to get users onboarded, due in great part to the required e-bike retrofits. Since Swobbee' s LFP batteries were not designed for the users' Arrow e-bikes, the company had to provide free battery retrofits to all participating users. The retrofit consisted of adding a rack with a battery box (or charger) in the back side of the e-bike. The Swobbee battery would slip into this box. The process took time and required user's trust.

Figure 5:
PopWheels had the most rapid uptake,
while Swobbee had an extended onboarding period.



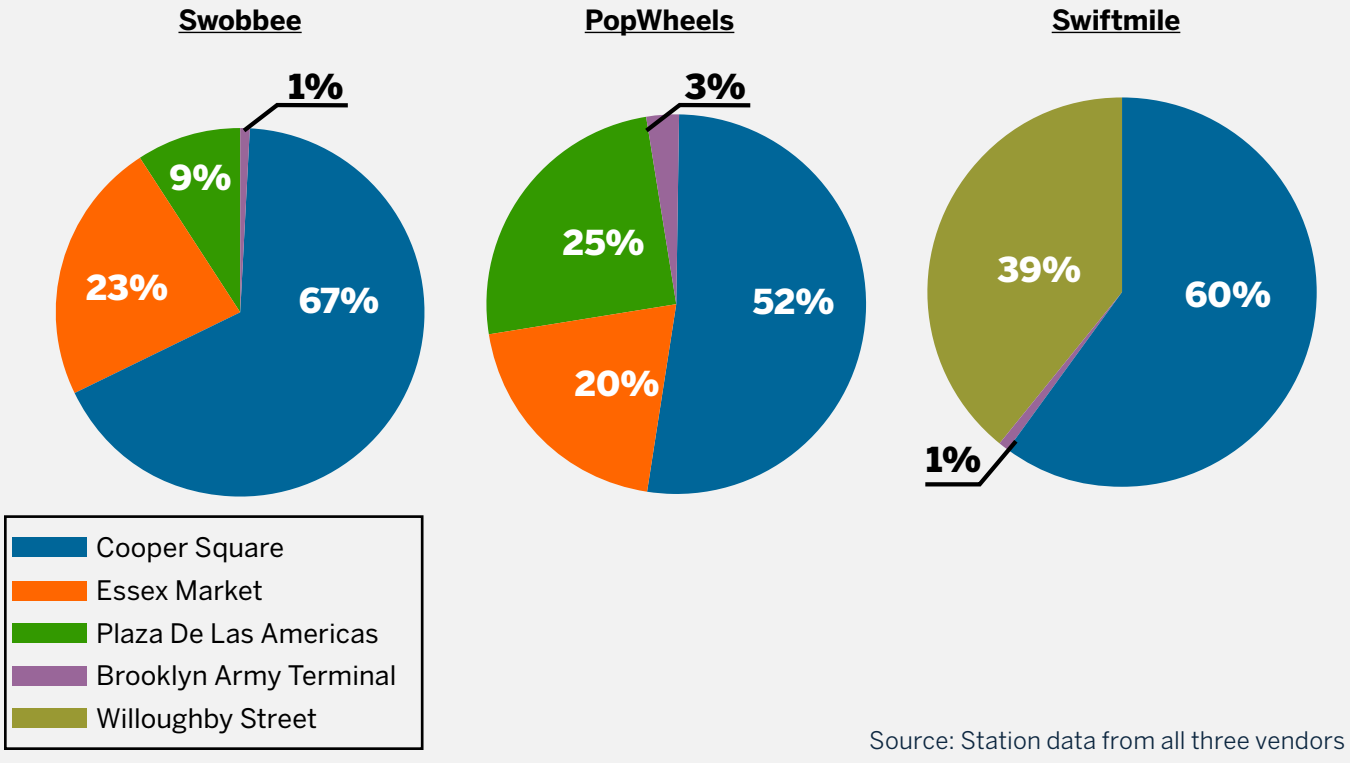
Source: Station data from PopWheels and Swobbee

Site Performance

Pilot locations near high demand restaurant areas were more popular. Cooper Square, located in the heart of the East Village, accounted for 59% of all transactions, making it the most popular site among users. In contrast, the Brooklyn Army Terminal charging hub saw the least activity, with only 230 swaps (for both PopWheels and Swobbee) and 10 Swiftmile charging sessions –representing just two percent of all transactions during the six-month pilot. The difference in use is likely due to Cooper Square's location in a bustling area of Manhattan, compared to the Brooklyn Army Terminal's more remote, industrial setting near Sunset Park in Brooklyn.

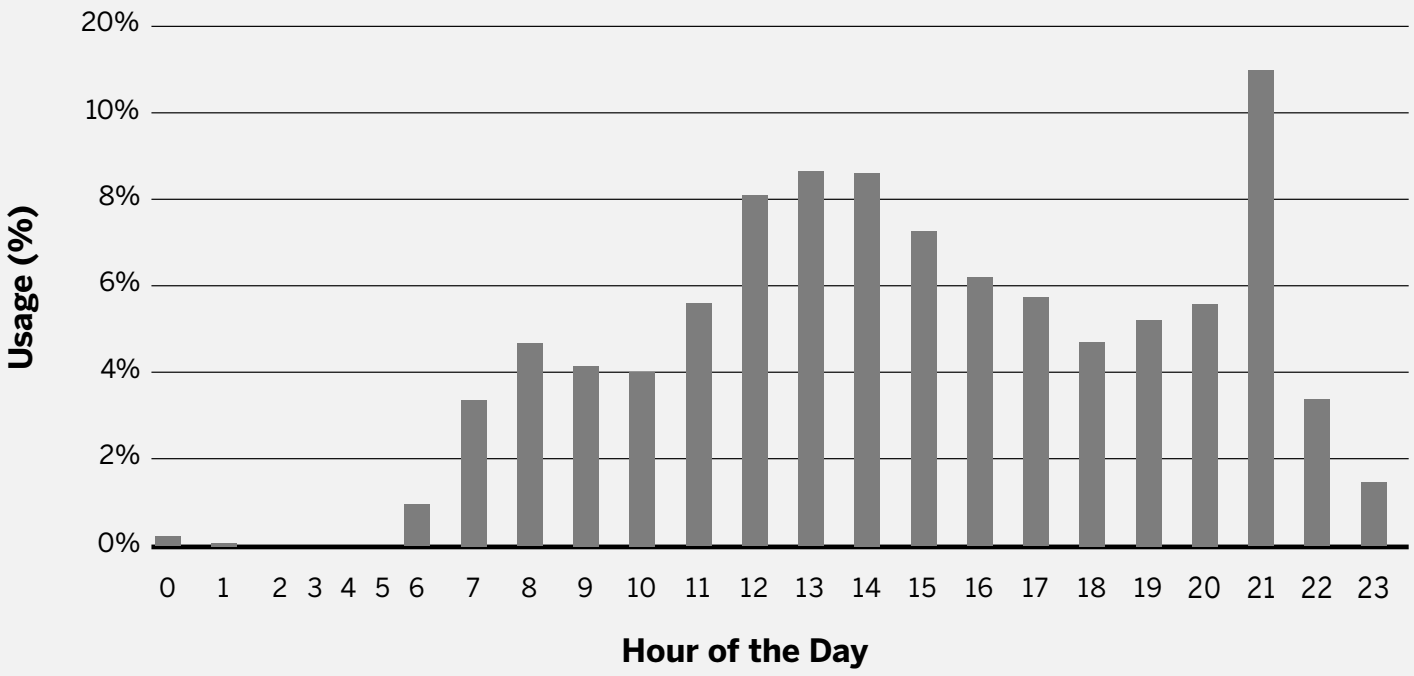
When examining site-specific data, time-of-day swapping patterns were generally similar across locations, except at Plaza de las Américas in Washington Heights. This site saw its highest usage at 9 p.m., unlike the late afternoon peak observed at the other locations. While further data collection is needed to understand the reasons behind this trend, onboarding surveys revealed that a majority of Manhattan-residing users lived in Upper Manhattan, in or near Washington Heights. The 9 p.m. peak may reflect users preparing to start their delivery shifts and users swapping before returning home.

Figure 6:
Among all three vendors, Cooper Square recorded the most transactions by a significant margin.



Source: Station data from all three vendors

Figure 7:
9 PM was the most popular time for battery swapping at the Washington Heights station.



Source: Station data from PopWheels and Swobee

User Retention

PopWheels and Swobbee demonstrated strong user retention, while 62% of registered Swiftmile users had discontinued using the charging docks by the end of the program. The reasons for stopping use varied across vendors.

For both PopWheels and Swobbee users, the primary reasons for discontinuing use were work-related hiatuses caused by illness, injury, or e-bike theft. DOT and the vendors documented multiple instances of test users reporting e-bike theft, sometimes with one of the vendors' batteries still attached. In some cases, users purchased new e-bikes that were incompatible with the charging technology they had been registered to use, making them ineligible to continue using the service.

For former Swiftmile users, poor charging performance was the most frequently cited reason for discontinuing use. The primary complaint was inconsistent power delivery, with many users believing that the charging docks became less effective when more than one e-bike was plugged in. Some reported that the docks failed to charge if a third user connected their e-bike. However, Swiftmile reported no such technical issues, attributing the problem to a misunderstanding of how the docks distributed power among multiple batteries. Despite this clarification, many users still perceived the docks as unreliable. Additionally, the 2-hour charging time for Swiftmile docks was seen as too long compared to the quicker battery-swapping services offered by competitors.

A few weeks into the program, many Swiftmile users switched to PopWheels and Swobbee, leading them to discontinue use of the Swiftmile racks entirely.

Fire Safety

Test users reported feeling safer having access to outdoor charging hubs, as many no longer worried about the risk of causing a fire at home while charging their batteries. In the midpoint survey, DOT asked respondents whether they still charged batteries at home on days when they used one of the three outdoor charging services. After comparing onboarding and midpoint survey responses across all vendors, DOT identified a 35% reduction in at-home charging. Among those who continued to charge at home, nearly half (47%) reported doing so "sometimes." PopWheels users showed the largest reduction in at-home charging, with a decrease of 88%. It is important to note that Swobbee provided users with home chargers for their safer LFP batteries, while PopWheels batteries could only be charged in their battery cabinets.

The survey results align with the focus group findings. Half of focus group participants reported they no longer charged their batteries at home, and all of those users were utilizing one of the two battery-swapping services. Among focus group participants who had continued to charge at home, nearly half reported doing so less frequently compared to their pre-pilot charging practices.

The pilot program also reduced the reliance on spare batteries among users. Survey data showed a 50% decrease in the use of spare batteries. In focus group sessions, test users indicated that they no longer felt the need to carry a spare battery, as they could either swap for a charged battery or stop at a charging dock mid-shift. Finally, there we no reported fires by the vendors or by users during the course of the pilot.

In summary, DOT identified positive trends on two key fire safety metrics: a reduction in both at-home charging and reliance on spare batteries. Access to outdoor charging technology can reduce the frequency of at-home charging and even completely eliminate it, minimizing fire risk in buildings.

Street Safety

Most test users felt safe using the charging hubs, with only one safety incident reported at Cooper Square. In this instance, the user's e-bike was stolen from the Switfmile rack while it was charging. Aside from this case, there were no other reported public safety incidents or traffic incidents related to the use or presence of the charging hubs at the five pilot locations.

During focus group sessions, when asked with about public safety at the pilot sites, participants cited high-foot traffic and good lighting at the main reasons they felt secure using the stations. Battery-swapping users believed that company-owned batteries helped deter theft, as thieves may be more cautions about being pursued by the well-resourced companies. Additionally, PopWheels users noted that the GPS trackers in the company's batteries provided an extra sense of security, knowing that if a battery was stolen or lost, it could be tracked by the company.

Quality of Life & Economic Impacts

Access to battery charging services improved the quality of life of test users. During focus group sessions, participants mentioned feeling more productive, as the services allowed them to accept more orders without worrying about the travel distances and their battery charge levels. Battery-swapping users appreciated not having to stop for long periods of time to charge, which gave them more time to be productive. Others noted that not having to carry the extra weight of a spare battery made their work more enjoyable. Many also highlighted the mental and emotional relief of no longer having to worry about the fire risks to themselves and their families from at-home battery charging. Additionally, it is important to note that DOT did not receive any reports or complaints from the general public regarding quality-of-life issues related to the charging hubs throughout the six-month pilot.

Operations

As with any pilot program, there were some initial challenges. The most significant disruption to operations stemmed from insufficient electrical load, particularly at the heavily used Cooper Square site. Since the stations drew power from existing sources not designed specifically for this case use, there were times when the electrical load was inadequate to meet the stations' demand. Downtimes for the battery charging cabinets was primarily caused by minor electrical issues, such as tripped breakers. The power delivery issues, cited by test users, at Swiftmile docks may have been caused by this limitation.

In accordance with FDNY guidelines, the charging products were designed not to charge batteries to 100%, a fire safety measure intended to minimize the risk of thermal runaway. This initially caused confusion amongst users, who assumed the equipment was malfunctioning.

Finally, DOT discovered that two Swiftmile users were sharing accounts, allowing them to initiate multiple charging sessions simultaneously, a practice that was against the pilot program's rules.

Maintenance

The relationship between test users and service providers played a key role in how users treated the infrastructure. PopWheels and Swobbee assigned dedicated staff to provide customer service for the pilot's test users. These staff members spent considerable time engaging with test users to improve service delivery. As a result, their users felt more invested in taking care of the cabinets and batteries, fostering a sense of community stewardship over the battery-swapping network. In contrast, Swiftmile did not maintain the same level of user engagement, and their stations appeared to receive less care from users. For example, Swiftmile users would chain and plug batteries–without their e-bikes–to charging bays for hours, sometimes overnight, preventing other users from using the occupied charging bays.

Areas for Improvement

This pilot program provided DOT with its first opportunity to test battery charging technologies in a public setting and marked the first recorded time battery-swapping services were tested under a direct-to-consumer model in the United States. Given this level of innovation, one of the program's key objectives was to identify areas for improvement.

While Swobbee provided a highly-rated service, some users were dissatisfied with the battery retrofit required to use their services. These users preferred the battery to be located under the saddle of their e-bike rather than above the rear wheel, where the retrofit kit was installed. This placement contributed to a bit of physical and mental discomfort for some users. Focus group participants reported instances where their retrofitted e-bike tilted due to the shifted center of gravity. Others were concerned that the battery could be easily stolen without them noticing or might slip out of the retrofit box while riding.

The most frequent complaint was the limited battery range of the Lithium Ferrophosphate (LFP) batteries supplied by the company. While LFP batteries are more stable and less prone to thermal runaway (and thus safer), the lower battery range compared to the silverfish batteries commonly owned by test users was a drawback. In response, Swobbee is currently developing an alternative LFP battery specifically designed for the e-bikes used by our local delivery workers.

PopWheels also received user feedback to improve their hardware. There were multiple reports of missing or broken battery keys. Each battery comes with a key that locks the battery to the e-bike and turns it on.

As previously discussed, a vocal group of Swiftmile users were dissatisfied with the quality of the charging experience with their docks. According to the company, many users misunderstood how the docks charged the batteries.

Another challenge was oversubscription of battery-swapping services. Users reported that there were not enough fully charged batteries available for the number of test users, forcing them, at times, to retrieve partially charged batteries from the cabinets. Many users requested adding more charging stations to the network and increasing capacity at existing locations.

Participants also provided valuable feedback on how to improve the design of the battery-swapping cabinets. For example, some pilot participants experienced instances where another user took a battery that was assigned to them. To prevent these conflicts, these users recommended limiting cabinet transactions to one customer at a time. In addition, others recommended adding weatherproofing features to the cabinets to protect batteries from future extreme weather events.

Willingness to Pay

Despite challenges with the charging products, program participants showed a strong willingness to pay for a monthly, unlimited subscription to maintain access to the services. During focus group sessions, DOT asked participants if they would consider paying for the service and, if so, under what conditions. All participants expressed interest in paying a monthly fee, with battery-swapping users willing to pay a higher fee than charging rack users. Additionally, participants indicated that for a full membership, they would like more batteries available at high-demand sites and a denser network of charging hubs, particularly in Manhattan.

Chapter 4: Key Lessons Learned

The key lessons learned from NYC DOT's Public E-bike Charging pilot are:

Public charging infrastructure can reduce fire risks. Access to pilot charging services altered charging habits among test users, decreasing reliance on at-home charging. This reduction means fewer lithium-ion batteries charged indoors, lowering the risk of fire incidents. Additionally, users became less dependent on spare batteries, which could over time lead to fewer lithium-ion batteries being stored indoors.

Location matters. Pilot sites near commercial corridors and in neighborhoods with high demand for food deliveries saw the highest utilization rates. Focus group participants requested for more stations in similar high-demand locations , particularly in Midtown Manhattan, the Upper East Side, and Upper West Side.

Hubs as a new street furniture typology. E-bike charging hubs represent a new street furniture type that can be incorporated into the agency's street design toolkit. These hubs require unique design and siting considerations to ensure public safety.

Successful technology adoption. Battery swapping proved to be highly popular, despite initial assumptions that local delivery workers preferred to use their own batteries. All focus groups participants who use battery swapping services reported a positive experience and expressed desire to continue using these services.

Community stewardship improves service. Service providers fostered strong relationships with test users, which in turn cultivated a culture of respect and care for the public charging infrastructure. This sense of community stewardship helped enhance the overall quality of service.

Street safety is an important design factor. Features like high foot traffic, good lighting, and surveillance cameras contribute to a heightened sense of security for users.

Sufficient power connections must be established to meet operational needs. Relying on existing power sources led to several operational challenges.

Charging services should be customized for the specific e-bikes being served. Charging services should be tailored to the specific e-bikes being served. Any required adaptations or retrofits can slow down technology adoption and lead to issues over time.

Users are willing to pay for services. Focus group participants expressed willingness to pay for charging services, provided that more stations are installed in key areas.

The findings from this report will help guide the development of further safe, equitable, and sustainable e-bike infrastructure throughout New York City.