New York City Delivery Workers: Insights on Travel Patterns and E-Mobility

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New York City Delivery Workers: Insights on Travel Patterns and E-Mobility

Final Report

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Abstract

Over 65,000 delivery workers rely on micromobility to distribute food, groceries, and packages across New York City's (NYC) five boroughs. Electric bicycles (e-bikes) and, in some locations, gas mopeds, are common modes of transportation for these workers. This project aims to better understand delivery worker travel patterns and needs and help inform future policy and programmatic solutions around e-bikes. The project was structured around three main tasks: a literature review, data collection and analysis, and a benefit-cost analysis (BCA). This report details those efforts and findings, and their implications for supporting worker access to micromobility options.

Keywords

micromobility, delivery workers, e-bikes, travel patterns, charging behavior, shared mobility

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Acronyms and Abbreviations

~	about or approximately
BCA	benefit-cost analysis
CO_2	carbon dioxide
DDOT	District Department of Transportation
EB	eastbound
EUAC	equivalent uniform annual cost
Kg	kilograms
Km	kilometers
LCCA	life-cycle cost analysis
LDA	latent Dirichlet allocation
MNL	multinomial logit
NB	northbound
NLP	natural language processing
NPV	net present value
NYC	New York City
NYC DOT	New York City Department of Transportation
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
PCE	Peninsula Clean Energy
PDP	partial dependence plot
RCEA	Redwood Coast Energy Authority
SB	southbound
UL	Underwriters Laboratory
WB	westbound

Executive Summary

As New Yorkers increasingly rely on food and other delivery services, understanding the needs, preferences, and travel patterns of New York City's (NYC) delivery workers, specifically the significant number who rely on micromobility such as bikes and mopeds, becomes imperative. The landscape of offerings for electric bicycle (e-bike) purchases, rental services, batteries, and battery charging is dynamic, with some, but not all, devices meeting required fire safety standards. At the same time, e-bike trade-in and charging programs, such as those piloted by the E-Mobility Project and the New York City Department of Transportation (NYC DOT), have sought to influence delivery worker use, reduce fire risks, and discourage a transition back to greenhouse gas-emitting mopeds.

This project used data collection and analysis to better understand e-bike and moped use among New York City (NYC) delivery workers to help guide any future policies and programs. A literature review established a baseline understanding of existing rental services, battery charging and trade-in program options in the five boroughs, and regulations and trends relevant to delivery worker transportation. A sample screenline data collection in October 2024 revealed that mode share differs between Manhattan and the outer boroughs, with more moped use in Brooklyn and Queens and higher percentages of rental e-bikes and overall delivery worker volumes in Manhattan. An intercept survey of over 300 delivery workers provided insight into modal preferences, including why workers may choose gas mopeds over electric modes (e-modes). Finally, a benefit-cost analysis (BCA) quantified ownership costs by mode, showing that Underwriters Laboratory (UL)–certified e-bikes are competitively priced when considering costs over 5 years, including accounting for e-bike replacements during this period.

This report details these efforts and their implications for enhancing worker access to safe, sustainable micromobility options. The findings suggest several key programmatic considerations for future e-bike rebate or trade-in initiatives, as well as battery charging programs.

Future programs could tailor outreach and recruitment strategies for e-bike trade-in and charging programs to reflect language, current mode choice, and work duration, for example, by prioritizing multilingual program materials, targeting boroughs with higher concentrations of delivery workers, and designing messaging that resonates with both new and more experienced workers. In addition to groups that expressed interest in trade-in programs, workers with 6 months to 1 year of experience, those who speak Spanish, individuals working primarily in Manhattan, and residents of Queens are promising potential participants in programs designed to encourage safe UL-certified e-bikes, as they are particularly likely to use personal e-bikes.

Workers currently relying on rental bike services (24% of respondents) have a high overall interest in both trade-in and battery swapping programs, although many mentioned concerns about bike theft. Programs could therefore explore complementary measures, such as subsidized secure parking, lock distribution, or partnerships with delivery platforms to address theft-related risks.

Survey respondents who expressed moderate interest in a rebate program (23% of respondents) identified cost as the most significant barrier, followed by concerns regarding mandatory trade-in requirements. Future programs could maximize participation by offering tiered incentives that balance affordability with flexibility, such as rebates without mandatory trade-in obligations, or alternative credit schemes for those unwilling to part with their current device.

The intercept survey revealed that 65% of current gas moped users surveyed had previously relied on e-modes, such as e-bikes, electric scooters (e-scooters), and electric mopeds (e-mopeds), but transitioned due to the need for longer travel ranges, higher speeds, and the perceived inconvenience or safety risks of battery charging. Future programs could directly address these concerns by offering incentives for higher-performance, UL-certified e-bikes with extended range and safer charging technologies.

Reducing reliance on gas mopeds will also require targeted interventions for workers outside Manhattan, particularly those based in Brooklyn and Queens, where gas moped use is more prevalent. Survey results indicate that workers with longer delivery experience are more likely to use gas mopeds, with uptake becoming more common after 6 months of work, likely due to perceived durability and operating efficiency. To counteract this trend, programs could emphasize the long-term cost advantages of e-bike ownership, highlighting that although upfront purchase prices may be higher, ongoing maintenance and fuel expenses for gas mopeds are substantially greater, as revealed by the BCA analysis.

For battery charging behavior, nearly 70% of respondents reported not charging batteries during work hours, and approximately half of those who charge off-shift do so at home. This indicates the value of developing battery-swapping infrastructure at popular work hubs and ensuring access to safe charging or swapping options near residential areas. Given the concentration of work in Manhattan and residential charging in the Bronx, strategically locating such facilities could enhance both convenience and safety.

1 Introduction

Over 65,000 delivery workers use micromobility to deliver food, groceries, and packages across New York City's (NYC) five boroughs (NYC Office of the Mayor 2022). In 2023, devastating fires led the City Council and Mayor's Office to pass a law mandating that all electric bicycles (e-bikes) sold in the city meet Underwriters Laboratory (UL) standards. However, many uncertified bikes remain in use. Certain models that meet these new standards often come with significantly higher upfront costs compared to non-certified models and gas mopeds. Meanwhile, the landscape of e-bike rental services and battery charging options continues to evolve, both shaping and responding to delivery worker habits and travel patterns.

The E-Mobility Project (formerly the Equitable Commute Project) works with New York City and New York State governments to help protect the livelihoods of working cyclists and make high-quality micromobility options financially accessible to all New Yorkers. The E-Mobility Project is an advisor to the NYC Mayor's Task Force on Micromobility, the NYC Department of Transportation (NYC DOT), and the NYC Economic Development Corporation, and collaborates with dozens of community-based organizations. With support from Uber and DoorDash and in partnership with Spring Bank, the E-Mobility Project launched a trade-in program with NYC bike shops. Known as the Sustainable, Affordable, Fire-safe E-bike (SAFE) Program, it allowed delivery workers to exchange and recycle noncompliant e-bikes for discounted UL2849-certified e-bikes.

Building on this work, the current project assisted NYSERDA with complementary research, including data collection and evaluation, to better understand the needs of delivery workers and shape future policy and programmatic solutions around e-bikes in New York State (NYS). The project included three main tasks: a literature review, data collection and analysis, and a benefit-cost analysis (BCA). The data collection and analysis task incorporated both screenline data collection and an intercept survey. This report details those efforts and findings and discusses their implications for supporting worker access to improved micromobility options.

2 Task 1: Literature Review

The project's literature review, completed in December 2024, provided an extensive summary of existing e-bike rental services in New York City, delivery worker mobility patterns, and the current understanding of mode shifts from e-bikes to gas mopeds. The review also covered a nationwide stated preference study, summaries of e-bike battery capacities and charging behaviors, comparisons between e-bikes and gas mopeds, and findings on public e-bike battery swapping and charging services.

The following highlights key findings from the literature review as they relate to New York City, updated where necessary to reflect current conditions. Appendix A includes the full literature review.

2.1 E-bike Rental Services in New York City

Based on partnerships with the City's largest food delivery platforms, JOCO (Grubhub), Whizz (DoorDash and Grubhub), and Zoomo (Uber Eats) are three popular e-bike rental services among NYC delivery workers. Table 1 summarizes these options.

As of September 3, 2024, JOCO offers the lowest upfront rental rate for short-term rentals. For rental periods longer than 1 month, and excluding company discounts, Whizz offers the lowest upfront cost. Zoomo is the most affordable rental option for Uber Eats workers, while DoorDash workers receive the lowest cost with Whizz. Of the three, Whizz offers the lowest purchase price for an e-bike, the highest maximum speed, and the longest distance range on a full battery. JOCO has the easiest signup process, the lowest rate for on-the-road recharging or battery swaps, and the most flexible contract terms.

Table 1. Summary of E-bike Rental Service Features

Information as of September 2024.

Company	Lowest Price Offered	Lowest Battery Price and Charging Price	Purchase Option	Sign-up Requirements
Zoomo	• Offers one type of bike • $15/week for Uber Eats or $39/week for other services • Pricing varies by contract length • $99 one-time refundable deposit for all plans • 12-week contract for the lowest rate	• Subscription includes a charger • Optional extra battery, $15/week plus a $50 refundable deposit	• $149/month for 12 months to own the bike (Uber Eats riders) • Otherwise $249/month • $200 down payment applies to both plans	• No specified age requirement • Must have valid government-issued photo ID, proof of address, and bank card • Requires an in-person appointment • Website available in English, French, and Spanish
Whizz	• Offers three types of bikes • $159/month ($39.75 per week) • Pricing varies by bike specs • One-month minimum, billed monthly	• Subscription includes a charger • New battery, $500 • Used battery (older model), $200	• $149/month for 12 months to own a new bike • $490 upfront for a refurbished model	• Must have a U.S. photo ID and bank card • Must be at least age 18 • Requires in-person appointment • Website available in English, French, Spanish, and Russian
JOCO	• Offers one type of bike • $79/week for best value • Pricing differences are based on contract length • Access the bike for 6 hours at a time • Billing cycle depends on contract length	• JOCO charging hubs are free for JOCO users • No other information about renting or buying extra batteries	• No purchase information available	• Purchase pass through app (bank card required) • Must self-report being age 18 or older • Website available in English but the app may be translatable on users' phones

2.2 New York City Delivery Worker Profile and Travel Patterns

In 2022, the NYC Department of Consumer and Worker Protection (DCWP) published its findings on app-based food delivery workers (DCWP 2022). The study uses data from various apps (i.e., Uber Eats, DoorDash, Grubhub, and Relay), as well as online and in-person surveys of delivery workers . Key findings included the following:

- About 95% of all delivery workers are between ages 18 and 54
- Almost 40% “speak English less than very well”
- Nearly half identify as Hispanic, followed by one-quarter of non-Hispanic Black or African, 16% Asian or Pacific Islander, and 10% White and other
- The gender ratio between male and female workers is 3:1
- 43.9% use a car as their primary mode of transportation

- 46% report using an e-bike as their primary mode (likely representing both e-bikes and mopeds)
- More than half of all e-bike trips cover distances between 0.5 and 1.49 miles, while trips longer than 4 miles account for the greatest share of deliveries by car
- For deliveries 2 and 4 miles, more workers complete these trips by car (39%) than by e-bikes (21%)

At the time of the DCWP study, Uber Eats, DoorDash, Grubhub, and Relay composed nearly 99% of all food deliveries in New York City. According to app data from the fourth quarter of 2021, areas such as Kips Bay and Murray Hill in Manhattan had the highest delivery counts (Streetblog NYC 2023b).

2.3 E-bikes versus Gas Mopeds

Understanding the differences in vehicle specifications between e-bikes and gas mopeds is important because many delivery workers may be switching from one to the other. Gas mopeds provide a distance range about twice that of an e-bike. Top speeds for gas mopeds are typically up to 30 miles per hour (mph), while top speeds for e-bikes (for brands normally used in New York City) range from 20 to 25 mph (HIMIWAY 2023).

NYC regulations require e-bikes to travel below 15 mph (NYC DOT 2025b). E-bikes are allowed to travel in vehicle lanes with speed limits no greater than 30 mph. Although e-bike users do not need to register with the New York State Division of Motor Vehicles (DMV), they must be age 16 or older. In contrast, moped users must obtain a license and a registration for all Class A through C mopeds. No mopeds may travel on bike lanes. Class C mopeds may travel up to 20 mph, Class B up to 30 mph, and Class A up to 40 mph (NYC DOT 2025b).

Typical personal e-bike battery capacities range from around 0.4 to 0.75 kilowatt-hours (kWh) (Macfox Bike 2024), with charging times between 3 and 6 hours (Chub 2024). The DCWP survey found that e-bike delivery workers replaced their batteries about twice a year. A 2023 NYC DOT survey reported that 83% of the 338 delivery worker participants recharged their batteries during work hours (NYC DOT 2023).

2.4 New York City Delivery Workers Switching from E-bikes to Gas Mopeds

Several NYC news outlets have recently reported that food delivery workers are switching from e-bikes to gas mopeds. In July 2023, *Streetsblog NYC* interviewed five workers and one bike shop owner and reported that delivery workers made the switch because e-bike batteries ran out during shifts and due to fears of City crackdowns and landlord restrictions following e-bike fire incidents (Streetsblog NYC 2023a). A June 2024 *Gothamist* article cited similar reasons based on accounts from "several workers" (Gothamist 2024). A June 2024 *Curbed* article reported that NYC delivery workers are switching from e-bikes to mopeds to meet the more stringent delivery time requirements from delivery apps following the minimum wage law, based on accounts from three workers (Healy 2024).

2.5 National E-bike Rebate Program Examples

E-bike rebate programs designed specifically for delivery workers are rare compared to those for the general public. However, understanding the structure and details of both types can help inform NYS and NYC policymakers in future program design. The following summarizes selected U.S. examples.

2.5.1 San Francisco Delivery Worker E-bike Pilot

Outside New York City, the San Francisco E-Delivery Pilot is the only known pilot program assessing e-bike use among delivery workers. Aimed at promoting mode shift from cars to e-bikes, the program provided free e-bikes to San Francisco residents who were age 18 or older, worked at least 4 hours per week for one or more delivery services, participated in data collection and survey activities, had prior biking experience, owned a smartphone, and had health insurance (San Francisco Environment Department 2024).

The pilot launched two e-bike cohorts of 15–20 e-bike riders each (30 total) and one driver control group of 30 drivers. Each e-bike cohort ran for a total of 6 months, from June 2023 through March 2024.

Among e-bike participants, 82% reported they would continue to use their e-bike for deliveries, and all said they would continue using them for other activities. However, participants cited several barriers such as safety concerns, inadequate bike infrastructure, and a lack of secure storage and charging facilities. Survey feedback highlighted the need for improved bike lanes, safer riding conditions, and more robust infrastructure, as well as ongoing incentives and support to encourage more delivery workers to switch from cars to e-bikes.

2.5.2 Northern California Rebate Programs

Three Northern California programs, Redwood Coast Energy Authority (RCEA), Peninsula Clean Energy (PCE), and Contra Costa County, offer rebates for the general public (Johnson, Fitch-Polse, and Handy 2023). None requires previous bike ownership.

- RCEA: Provides their energy customers an after-purchase rebates of 50% of the e-bike price, up to $500, for approved models.
- PCE: Offers point-of-sale discounts or rebates of 80% of the e-bike price, up to $800, for verified low-income residents of San Mateo County.
- Contra Costa County: Provides after-purchase rebates of $150 or $300 for e-bikes, conversion kits, or pedal-equipped electric mopeds (e-mopeds), limited to verified low-income residents.

A participant survey across all three programs found that 66% of 577 respondents used their e-bikes as a primary mode one to three times per week after two months, up from 28% before the rebate.

2.5.3 Washington, DC, E-bike Incentive Program

The Washington, DC, Department of Transportation (DDOT) offers an incentive program to help residents purchase e-bikes by issuing vouchers to approved applicants (DDOT 2025). The most recent application window opened in February 2025. DDOT selects voucher recipients through a lottery, distinguishing between preferred and standard applicants. Preferred applicants must be enrolled in the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF), Medicaid, or the DC Healthcare Alliance. Recipients purchase e-bikes or accessories at authorized retailers, and DDOT reimburses the retailer directly.

E-bike voucher values reach up to $1,500 for preferred applicants and $750 for standard applicants. In 2024, DDOT received and reviewed over 2,800 applications and issued 335 vouchers totaling $500,000.

2.6 E-bike Programs in New York City

New York City has introduced a number of programs in recent years to accommodate the rapid growth of e-mobility in the city, especially amongst delivery workers. These address both e-bikes themselves, as well as the need to charge these devices. These programs are summarized in the following sections.

2.6.1 E-bike Trade-in Program

Informed by the E-Mobility Project's SAFE Program, NYC DOT launched its E-Bike Trade-in Program for delivery workers in January 2025. The program aims to reduce fire risks from uncertified batteries and remove faster, heavier, illegal mopeds from NYC streets (NYC DOT 2025a).

Participants must be NYC residents aged 18 or older, have earned at least $1,500 in 2024 as food delivery workers, and own an eligible, operable device for trade-in. Selected participants receive a new certified Whizz Storm 2 e-bike with a spare certified battery in exchange for their unsafe devices and batteries. Those who are selected must complete an online safety training course on safe riding practices. As of September 2025, the application period has closed, and the agency is distributing 402 certified e-bikes.

2.6.2 Battery Swapping and Charging Services

NYC DOT conducted a pilot study with PopWheels, Swobbee, and Swiftmile from March to September 2024 (subsequently extended to February 2025 for PopWheels only) to provide delivery workers with safer and more efficient e-bike charging solutions (NYC DOT 2024c). PopWheels and Swobbee allow users to swap depleted batteries for fully charged ones at designated charging cabinets, while Swiftmile provides users with access to a charging station. Compared to the near-instant battery-swapping options from PopWheels and Swobbee cabinets, Swiftmile users generally need about 2 hours to fully charge a depleted e-bike battery. The study included five locations across Manhattan and Brooklyn with mixed equipment from the three companies using existing power sources.

The pilot program included 118 delivery workers as participants. Prior to the pilot, 81% of participants charged their bike batteries at home. During the 6-month pilot, across all locations, participants used the battery-swapping cabinets 12,100 times, 6,400 of which were with Swobbee and 5,700 with PopWheels. Compared to the charging cabinets, Swiftmile docks saw a total of 1,300 uses across all locations (NYC DOT 2024c). The pilot showed that overall demand for charging peaked at key periods before popular food delivery times: 11 a.m. before the lunch rush, between 4 p.m. and 5 p.m. before the dinner rush, and 9 p.m. around the end of the dinner shift and immediately before the late rush. Usage remained consistent throughout the week, with slight declines on weekends across all three vendors. Regarding user retention, PopWheels and Swobbee had demonstrated strong retention, while 62% of registered Swiftmile users had stopped using the docks by the end of the program, likely because Swiftmile users often mentioned relatively poor charging performance.

Overall, the pilot program found a 35% reduction in at-home charging among participants, especially for PopWheels users, who reported an 88% reduction in at-home charging (NYC DOT 2024c). Participants also reported a 50% reduction in spare battery usage. When asked about continued usage of similar services after the pilot, participants expressed a strong willingness to pay for a monthly, unlimited subscription to maintain access to these services. NYC DOT extended the battery-swapping services through February 2025.

3 Task 2: Data Collection, Analysis, and Support

The data collection and analysis task of this project comprised two main subtasks: a screenline data collection effort and an intercept survey. The following describes their methodology and key findings.

3.1 Methodology

3.1.1 Screenline Data Collection

A screenline is an imaginary line across a path or roadway where cyclists (or pedestrians or vehicles) are counted when they cross the line during data collection efforts. The goal of the screenline data collection was to obtain an accurate picture of delivery worker travel volumes, patterns, and modes through sample counts at select locations. The screenline data collection took place on Thursday, October 24, and Friday, October 25, 2024, during estimated lunch and dinner “peaks” for food delivery: 12 p.m. to 2 p.m. and 5:30 p.m. to 7:30 p.m. The team chose five locations: 8th Avenue and 50th Street in Manhattan, 6th Avenue and 38th Street in Manhattan, the entry/exit point to the Queensboro Bridge bike path in Manhattan, Ashland Place and DeKalb Avenue in downtown Brooklyn, and 11th Street and 44th Drive in Queens (Figures 1 and 2).

Teams were assigned to each location to record counts in 15-minute intervals, distinguishing between delivery and nondelivery workers and by micromobility mode: personal e-bike, rental bike, standup scooter, moped, personal pedal bike, Citi Bike (electric and pedal), and other (e.g., cargo bike) (Figure 3). The research teams used context clues, such as food bags and handlebar covers, to distinguish delivery workers from other riders. They were also given reference visuals of the various modes.

However, the methodology has some limitations. During commute rush hours, research teams might have experienced confusion about the mode or rider category due to the high traffic volume or a lack of clear identifying features (e.g., a delivery worker not carrying food bags). As a result, they were instructed to note each rider’s category to the best of their judgment.

Figure 1. Screenline and Intercept Survey Data Collection Locations

Source: Google Maps (2025).

Figure 2. Screenline Location Details

Source: Google Maps (2025).

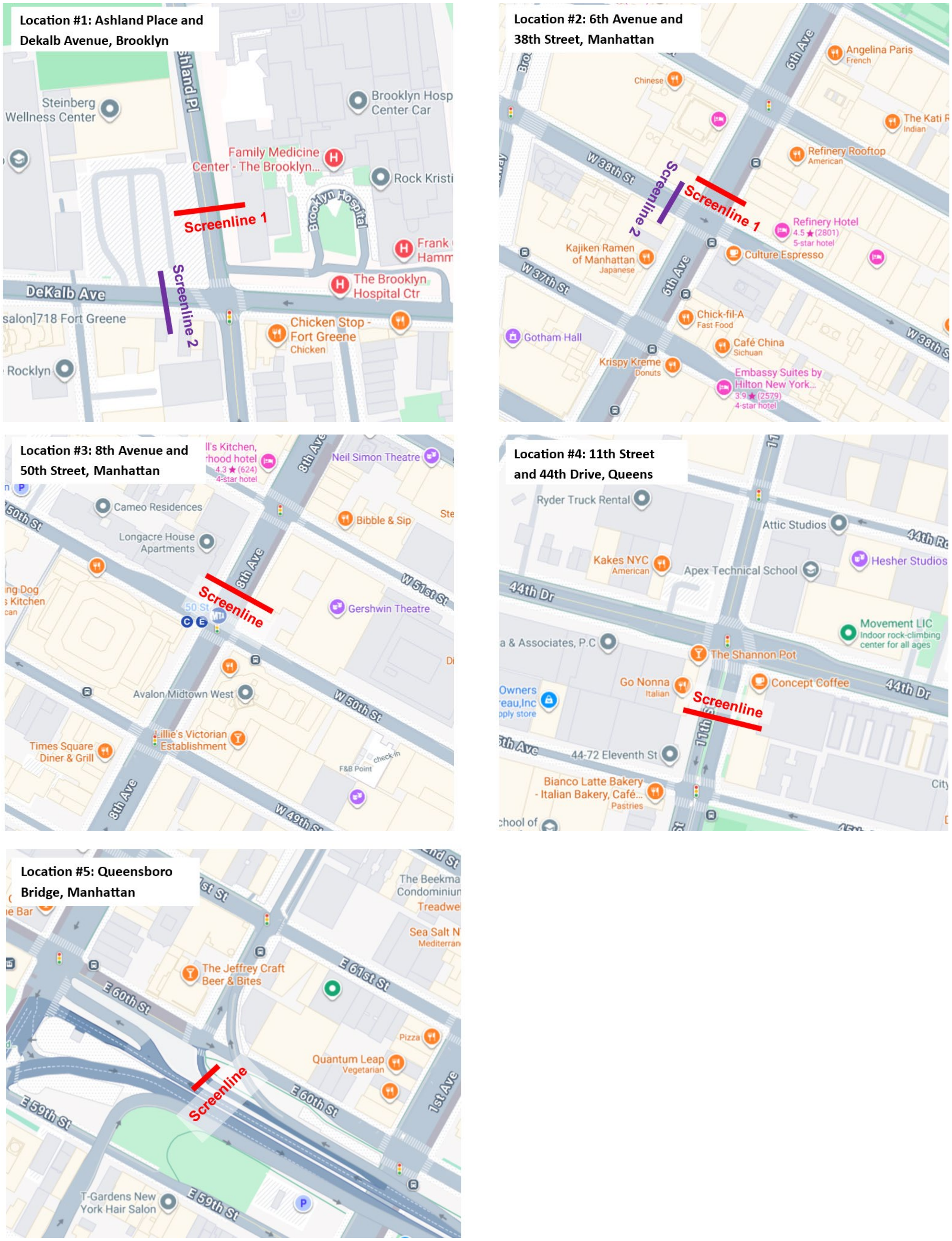


Figure 3. Mode Definition

Source: Zoomo 2024, Whizz 2024, JOCO 2024, Xtracycle 2025, Hiboy 2025, Walmart 2025, Ebay 2025, Global Source 2025, Citibike 2025

3.1.2 Intercept Survey

An intercept survey is an informal, in-person interaction used to gather on-site feedback from research subjects. The goal of this intercept survey was to collect information on delivery workers' experiences, work patterns, modes, battery charging habits, and, importantly, attitudes toward and interest in e-bike incentive programs. The survey instrument was developed online in a survey platform, Qualtrics, and is included in full in Appendix B.

The survey instrument assessed delivery workers' travel characteristics across four distinct linguistic cohorts: English, Spanish, French, and Chinese. To ensure that the findings from each group were statistically meaningful, the team set a target sample size of at least 67 completed surveys per language cohort to provide a foundational understanding of travel characteristics. The overall goal was to secure at least 300 completed surveys to ensure a robust and representative aggregate dataset.

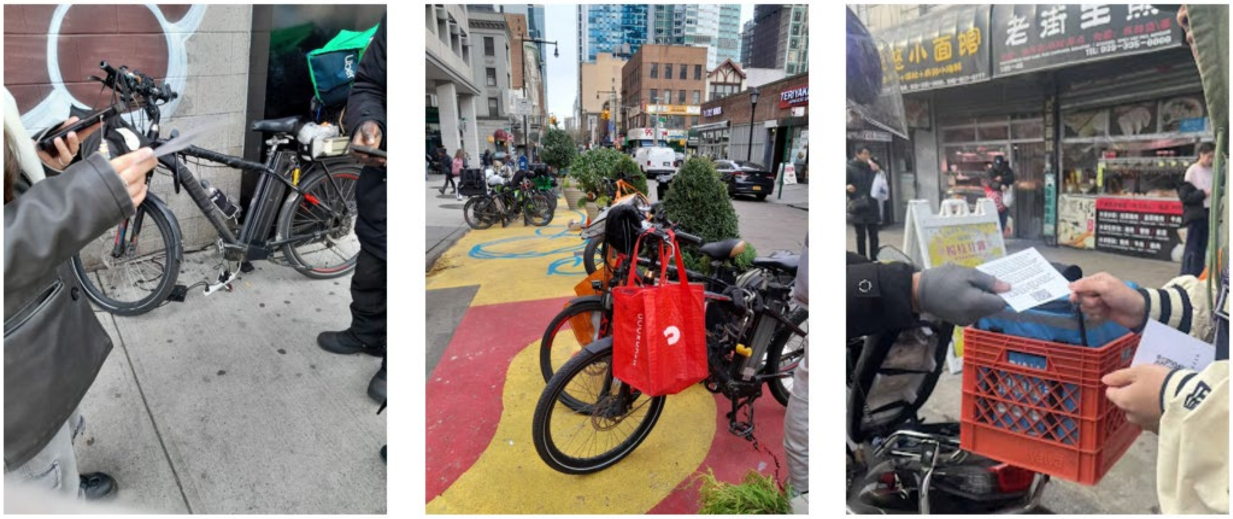
The team generated a QR code to allow willing delivery worker respondents to navigate to the survey page, select their preferred language, and complete the survey on their own phone. As an incentive, anyone who completed the survey and provided a valid email address received a $15 Amazon e-gift card.

Survey teams conducted approximately 65 field visits between mid-January and mid-May 2025. Each visit lasted two hours, with two surveyors typically working together at one location. The surveyors carried custom-printed survey postcards with the QR code and a short explanation in each of the four languages to show workers when they approached (Figure 4). In all, surveyors visited 43 unique locations in four of the five boroughs, concentrated in midtown and lower Manhattan, where the screenline data indicated the greatest volumes of delivery workers and identified rest hubs. The intercept locations were selected by identifying and analyzing fast food and ghost kitchen clusters, reviewing news articles on known delivery worker rest hubs, examining language group population maps, and drawing insights from related programs and stakeholders (such as lessons from NYC DOT's e-bike survey and conversations with DoorDash and Uber).

The team conducted the survey using an intercept design, which may introduce nonresponse and coverage bias, particularly if some delivery worker groups were underrepresented at the selected sites and times. While the overall sample exceeded 300 and the subgroup targets were met for English, Spanish, and French, the Chinese-language subgroup fell short, which may have limited statistical precision. In addition, rental e-bike users may be overrepresented in the sample relative to the broader delivery workforce, which could affect the generalizability of mode-specific findings. To reduce such bias, the team applied methods such as stratified sampling and balanced class weights during the results analysis.

Figure 4. Intercept Survey Card

Figure 5. Intercept Survey Field Visit Example



In addition to descriptive statistics, the team analyzed multiple-choice questions in the survey using a Multinomial Logit (MNL) model and a Machine Learning model, Random Forest with partial dependence plot (PDP), to understand correlations and feature importance. The MNL model is well-suited for categorical data and small samples (McFadden 1974). The Random Forest model is nonlinear and can explore hidden patterns. Appendix B included a detailed survey analysis methodology.

3.2 Findings

3.2.1 Screenline Data Collection

Overall, the screenline data collection revealed that Midtown Manhattan had the highest micromobility volumes and the highest percentage of rental e-bikes, likely due to proximity to Whizz, Zoomo, and JOCO hubs. For nondelivery workers, surveyors frequently observed Citi Bike usage at all locations. Standing scooters also accounted for a notable mode share (4% to 20%).

Among delivery workers, mode share differed between Manhattan and outer borough locations (Brooklyn and Queens). Manhattan had the greatest percentage of delivery workers using a personal e-bike, while the combined share of personal e-bikes and moped users was greater in Brooklyn and Queens (Figure 6). Nondelivery workers outnumbered delivery workers at all locations except 6th Avenue and 38th Street in Manhattan. Appendix C includes the full screenline results.

Table 2. Screenline Volumes by Day and Location

Location, Direction of Travel	Thursday, 10/24/2024				Friday, 10/25/2024			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.
1. Ashland and DeKalb, NB/SB	210	324	229	379	220	251	208	316
1. Ashland and DeKalb, WB	79	157	155	226	90	124	185	163
2. 6th Ave. and 38th St., NB	687	671	446	698	578	598	439	641
2. 6th Ave. and 38th St., EB	252	234	148	131	175	189	146	161
3. 8th Ave. and 50th St,. NB	354	375	428	718	398	511	324	520
4. 11th St. and 44th Dr., NB/SB	74	96	131	338	104	95	193	308
5. Queensboro Bridge, EB/WB	210	310	468	1153	163	314	517	825

Figure 6. Delivery Worker Travel Mode Share in Manhattan, Outer Boroughs, and All Locations

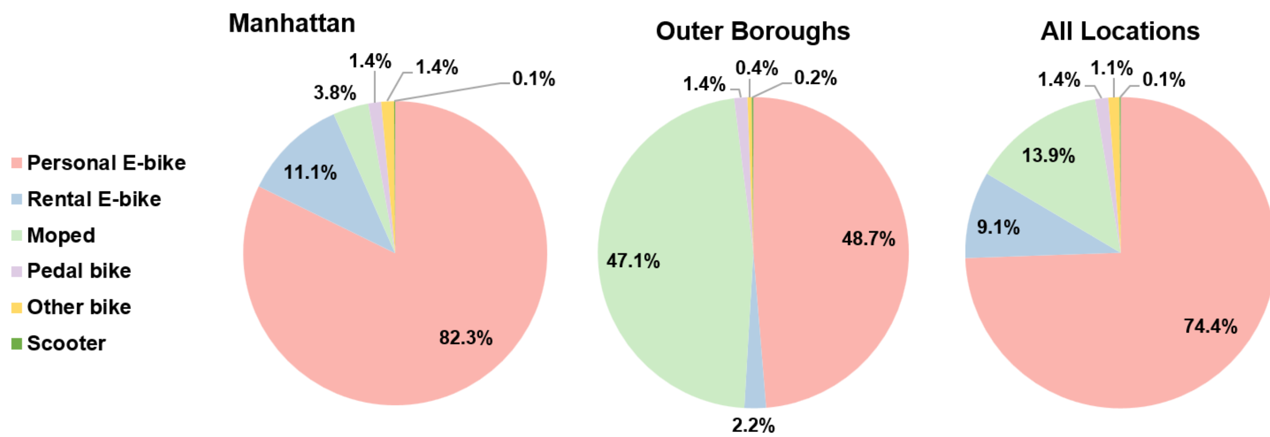
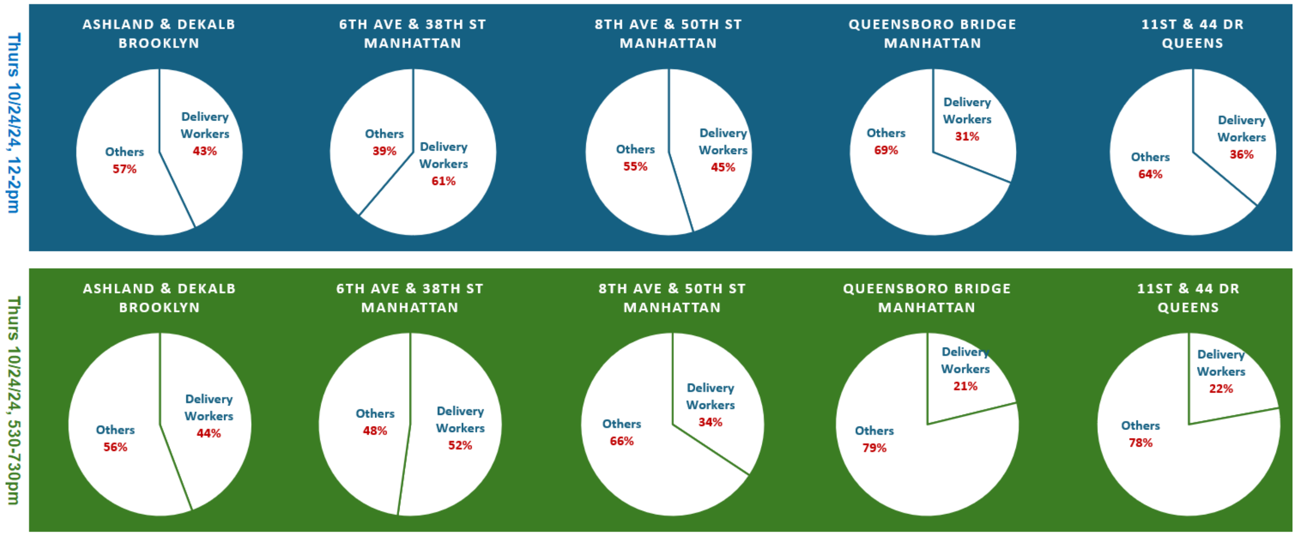


Figure 7. Delivery Worker versus Nondelivery Worker Volumes by Location and Time



3.2.2 Intercept Survey

The intercept survey collected a final tally of 331 responses, representing a response rate of approximately 38% of the delivery workers approached. Respondents reported having home ZIP codes throughout the five boroughs and the surrounding region, with concentrations in Sunset Park and Crown Heights in Brooklyn and the South Bronx (Figure 8). The language breakdown of respondents was 46.5% French, 25.1% Spanish, 21.8% English, and 6.6% Chinese (Figure 10).

Over half of responders reported that their work borough was Manhattan (55%). While the sample was almost evenly distributed by experience, delivery workers with less than 6 months of experience accounted for the largest share (30.8%). More than half had been delivering for a year or less (53.5%).

As shown in Figure 11, most delivery workers work more than 5 days a week (86.2%) and at least 7 hours per day (73.7%). Comparison with other available sources (Figueroa 2021; DCWP 2022) indicates that the survey sample broadly represents NYC's delivery workforce, capturing key characteristics such as the predominant languages spoken and typical work patterns (e.g., hours per day and days per week).

Figure 8. Respondent Home ZIP Codes

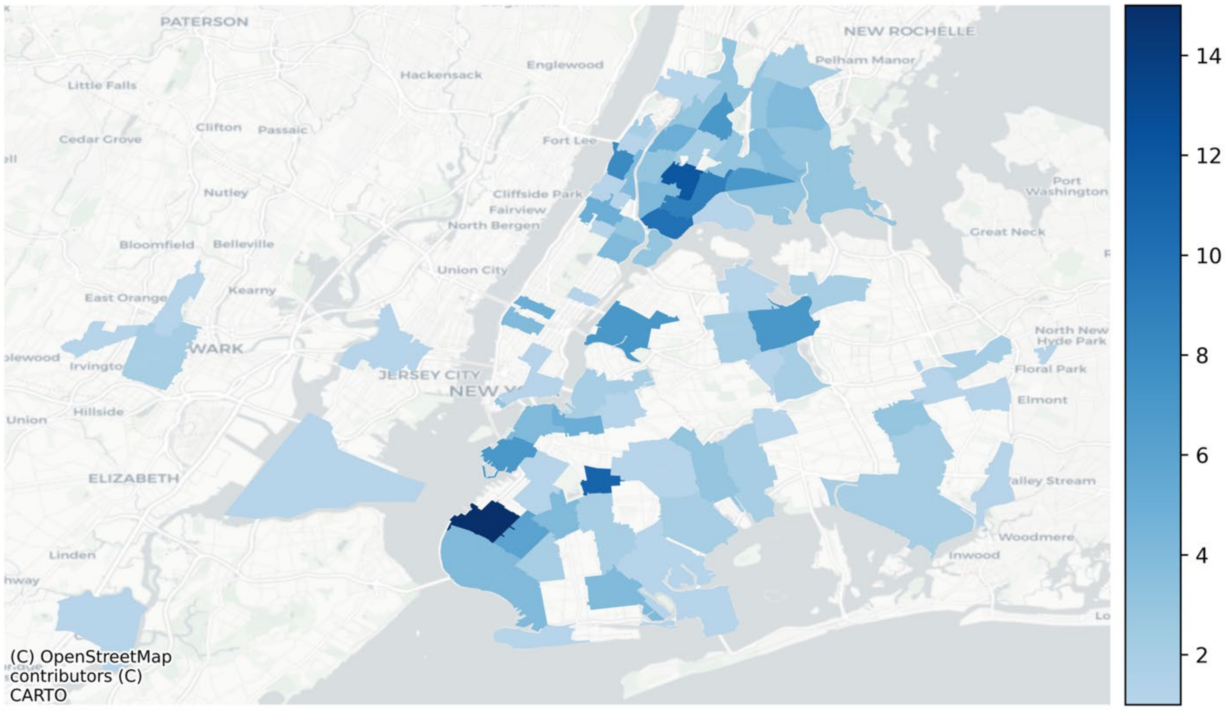
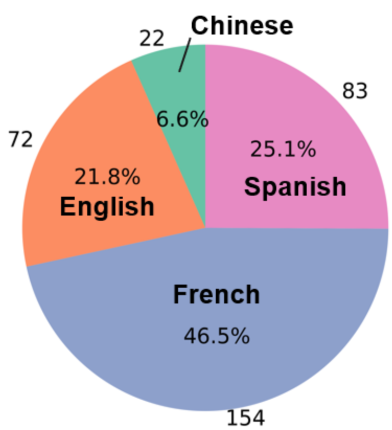


Figure 9. Respondent Language and Work Duration

Distribution of delivery worker respondents by primary survey language (left) and length of time working in delivery (right).



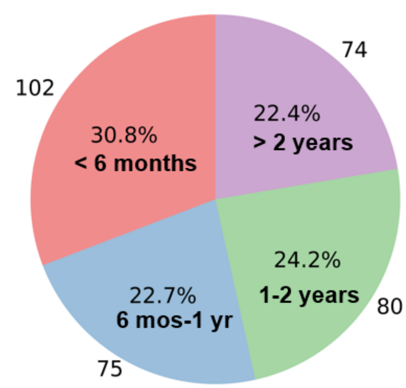
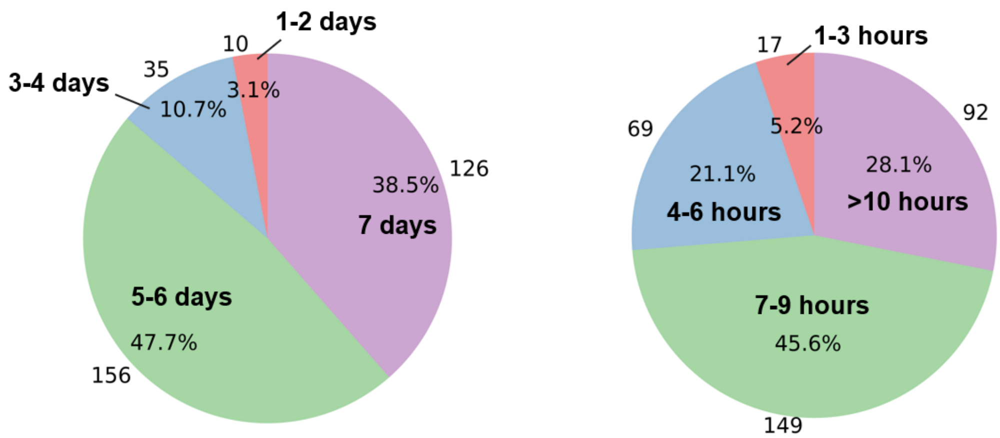


Figure 10. Respondent Days Worked Per Week and Hours Worked Per Day

Distribution of delivery worker respondents by number of days worked per week (left) and average hours worked per day (right).



The following sections provide more detailed survey results and key insights on mode choice and interest in the e-bike trade-in program. Appendix D includes complete survey results.

3.2.2.1 Mode Choice and Mode Switching

As shown in Figure 11, nearly half of all respondents used their own personal e-bike for deliveries (47.9%), followed by rental e-bikes (24.4%), gas mopeds (13.4%), e-mopeds (7.2%), pedal bikes (4.6%), and other modes (2.6%). Although this mode split aligns broadly with the overall screenline modal mix, personal e-bikes were less common in the survey results (compared with 74.4% in the screenline observations), while rental e-bikes appeared more frequently (compared to 9.1%). This difference may reflect the nature of the intercept survey's focus on rest hubs, where rental e-bike users may be more concentrated.

Among respondents working in Manhattan, personal e-bikes were the most common (51.8%). In Brooklyn, personal e-bikes and gas mopeds were used at more comparable rates (34.7% and 29.2%, respectively), likely reflecting restrictions on mopeds crossing bridges into Manhattan.[1] Of respondents

[1] As of June 26, 2025, NYC regulations allow moped users to operate on the Brooklyn Bridge and the lower roadway of the Queensboro Bridge. During the survey period, however, moped access to/from Manhattan from those boroughs was technically prohibited(NYC Rules 2025).

who use gas mopeds (n = 40), almost two-thirds (65%) reported switching from an e-bike or e-moped within the past three years. They cited the ability to travel longer distances as the primary reason for switching, followed by the difficulty of finding charging locations, faster speeds, and concerns about battery safety (Figure 12).

The machine learning model identified five key factors most strongly associated with mode choice: duration as a delivery worker, language, home borough, work borough, and daily working hours (Figure 14).

Figure 11. Respondent Modes, All Boroughs

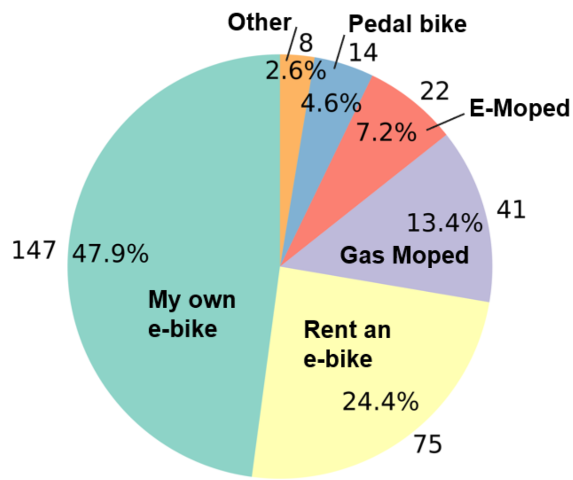


Figure 12. Reasons for Switching to Gas Mopeds

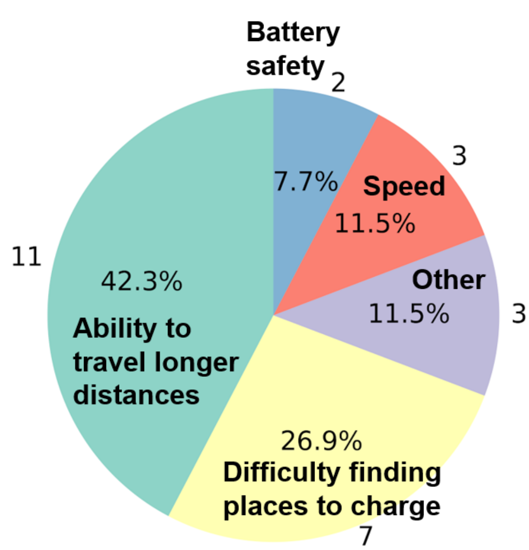


Figure 13. Mode Breakdown by Work Borough

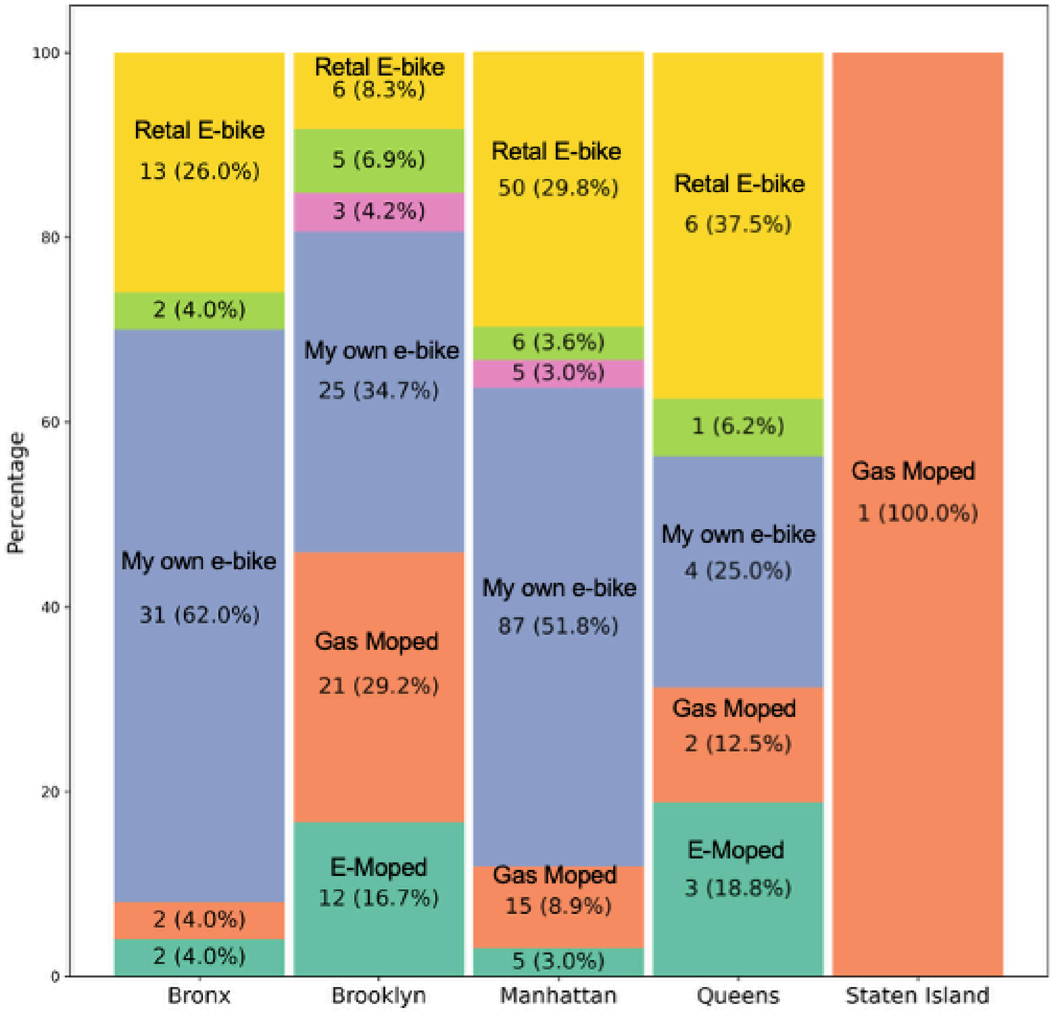
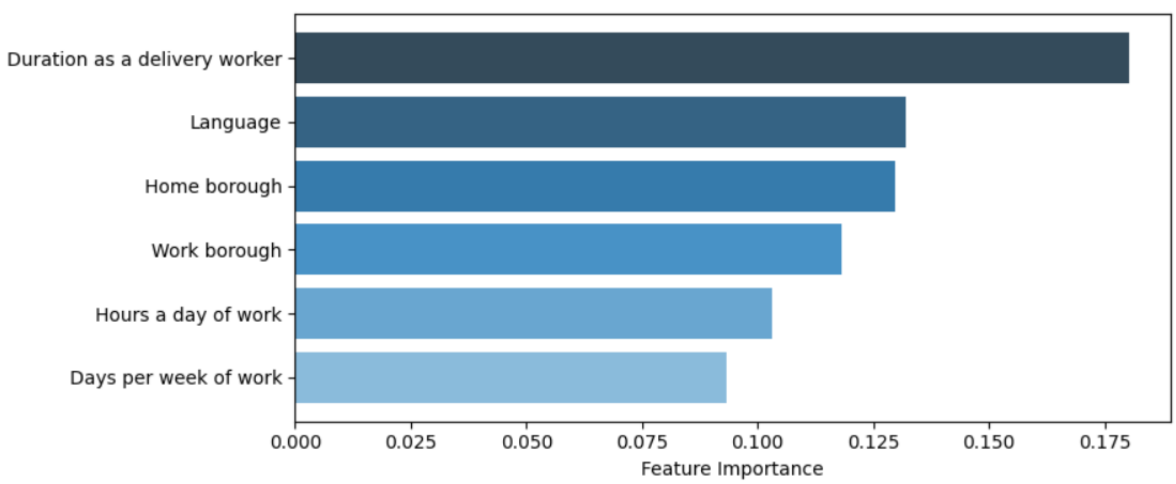


Figure 14. Feature Importance for Mode Choice



In an MNL model, a positive correlation between an attribute and an outcome indicates that the value of the attribute increases, and the likelihood of choosing that specific outcome rises relative to the baseline outcome. Conversely, a negative correlation means that as an attribute increases, the probability of choosing that option decreases. Using personal e-bikes as the baseline, the following factors were statistically significant in explaining mode choice:

- Gas mopeds
  - More likely to be used by workers with more than 6 months of experience
  - More likely to be used by workers who work outside of Manhattan
- Rental e-bikes
  - More likely to be used by workers who work 10 or more hours per day
  - More likely among those who work primarily in Manhattan or Queens
  - More likely among English or French speakers
- E-mopeds
  - More likely to be used by workers who work outside of Manhattan

The MNL estimation indicates that, relative to personal e-bikes, respondents with less than 6 months of delivery experience and those whose primary work borough is Manhattan show a significantly lower likelihood of selecting gas mopeds as their primary travel mode. Respondents who work more than 10 hours per day, those based in Manhattan or Queens, and English or French speakers demonstrate a higher probability of using rental e-bikes. Working in Manhattan is also associated with a reduced probability of using e-mopeds as the primary mode.

These findings are consistent with the descriptive results. For instance, 98% of gas moped users report more than 6 months of delivery experience, and 63% work outside Manhattan. Similarly, 92% of rental e-bike users speak French or English, and 75% work in Manhattan or Queens. Among e-moped users, 73% report working outside Manhattan.

For respondents who use personal e-bikes, the random Forest Model with PDPs indicates that having 6 months to 1 year of delivery experience, speaking Spanish, working in Manhattan, residing in Queens, and working 4–6 hours per day are key factors associated with this travel mode choice (Figure 15). For gas moped users, both the MNL and PDP results indicate that longer delivery experience increases the likelihood of choosing gas mopeds, with uptake becoming more common after 6 months of work.

Figure 15. Five Most Influential Predictors of Choosing a Personal E-Bike as Primary Mode

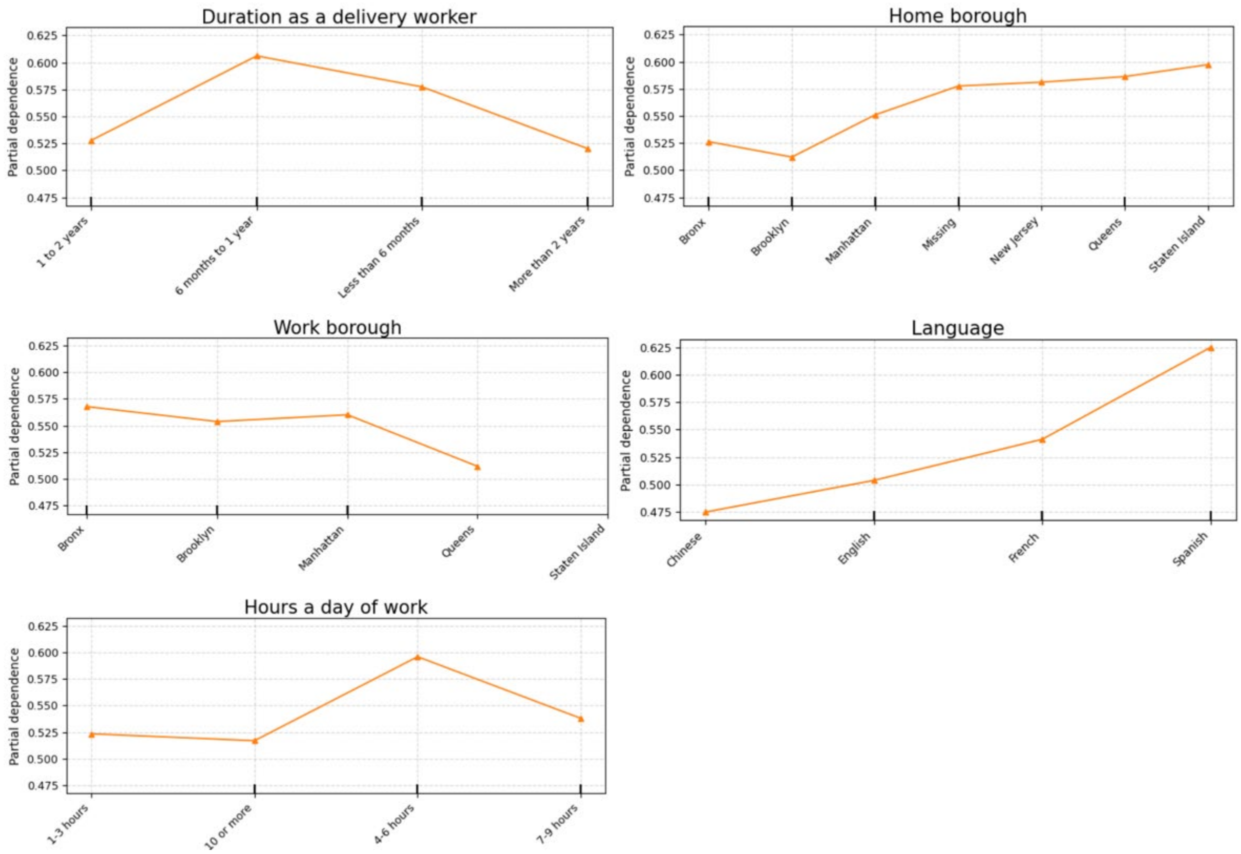
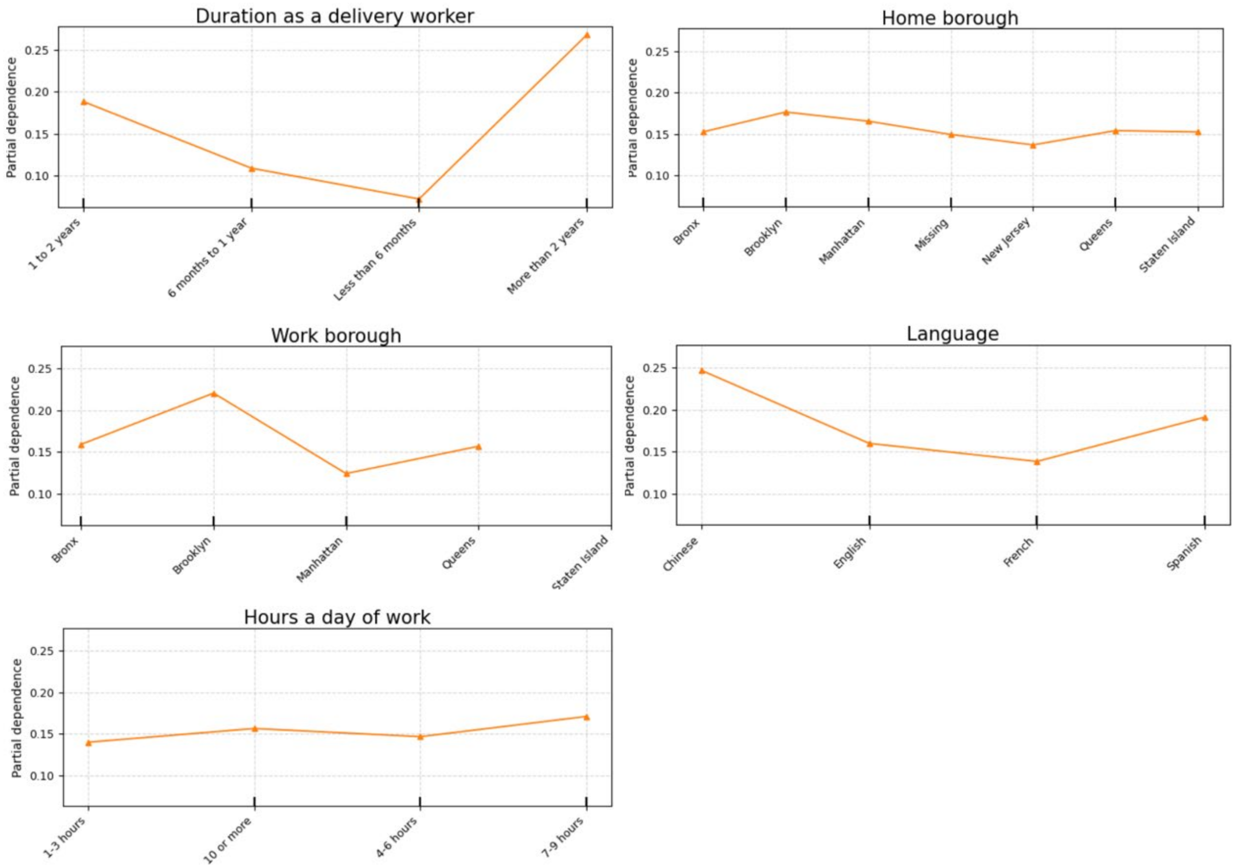


Figure 16. Five Most Influential Predictors of Choosing a Gas Moped as Primary Mode

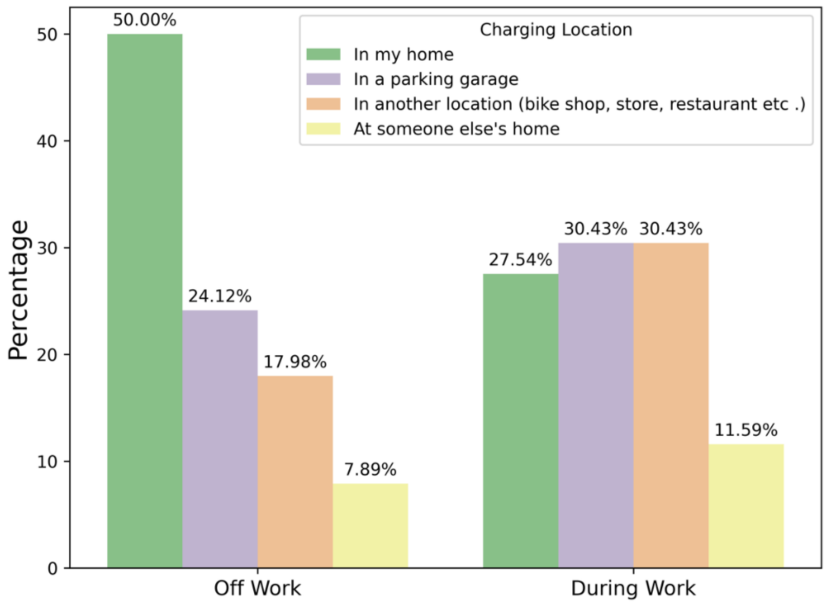


3.2.2.2 Battery Charging Habits for E-mobility Users

For respondents who reported using e-modes, charging frequency was almost evenly split: 35.9% charged once per day, 37.2% charged twice per day, 16.5% charged more than twice a day. Most respondents (69.6%) did not charge their batteries during their work hours, likely indicating that some workers bring an extra battery with them to support their full-time schedules.

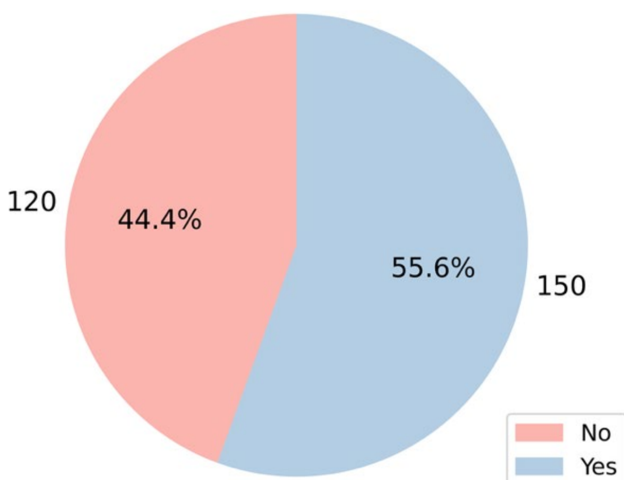
For those charging during work hours (n = 69), responses were roughly evenly split among workers charging at home during the work day (30.4%), in a parking garage (30.4%), or at another location such as a bike shop (27.5%) (Figure 11). Fewer respondents reported charging at someone else's home during work (11.6%). For those charging outside work hours (n = 228), charging most commonly took place at home (50%), followed by a parking garage (24.1%), another location (18%), or someone else's home (7.9%).

Figure 17. Battery Charging Location



Respondents were asked about their interest in a network of safe battery-charging and swapping cabinets, where users pay a subscription fee to access the service, although the devices would not be owned by them. Figure 18 shows that more than half of respondents (55.6%) indicated interest in participating in this type of battery cabinet program.

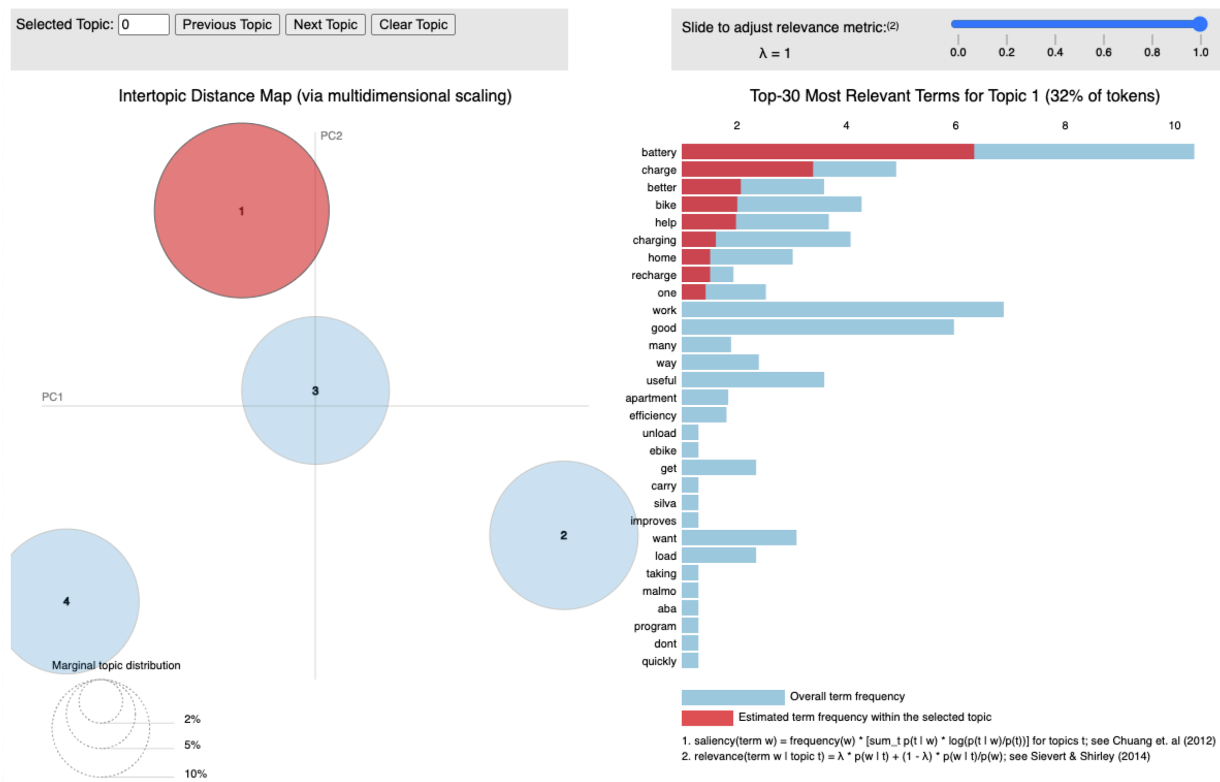
Figure 18. Battery Cabinet Interest



To understand the reasons behind this selection, the team examined the open-ended text responses to the questions. Figure 19, an example of the text analysis output using Natural Language Processing (NLP) with Latent Dirichlet Allocation (LDA), summarizes the topics extracted from the text response and indicates why workers expressed interest in a battery cabinet program. The most relevant terms in each area of the intertopic distance map identify the main theme in each general topic. As shown in Figure 19, the reasons for battery cabinet interest fall under four general categories:

1. Battery cabinets help charge and recharge
2. The cabinets are important, convenient, and can save money
3. The cabinets are useful and can help extend working hours
4. Using the cabinets helps avoid charging at home, making the process safer

Figure 19. Topic Modeling Result Using Natural Language Processing with Latent Dirichlet Allocation for Interest in Battery Swapping



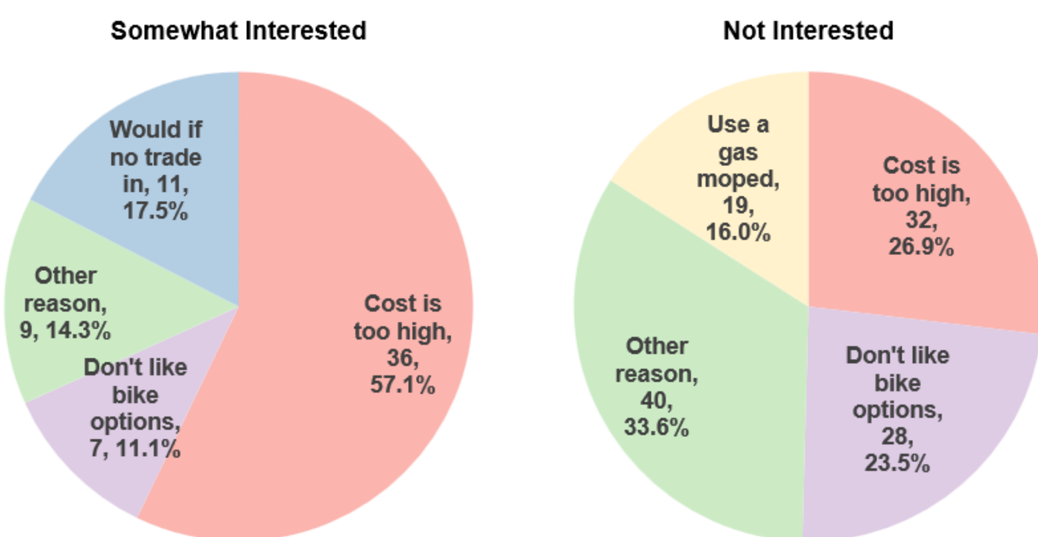
Combined with observations from Figure 17 on battery charging locations during and after work, the results suggest that placing battery cabinets in popular work and home locations, (i.e., Manhattan and the Bronx, respectively, as shown in Figure 20, would be most effective.

Figure 20. Interested Participants' Home and Work Locations

3.2.2.3 *Trade-in Program Interest and Obstacles*

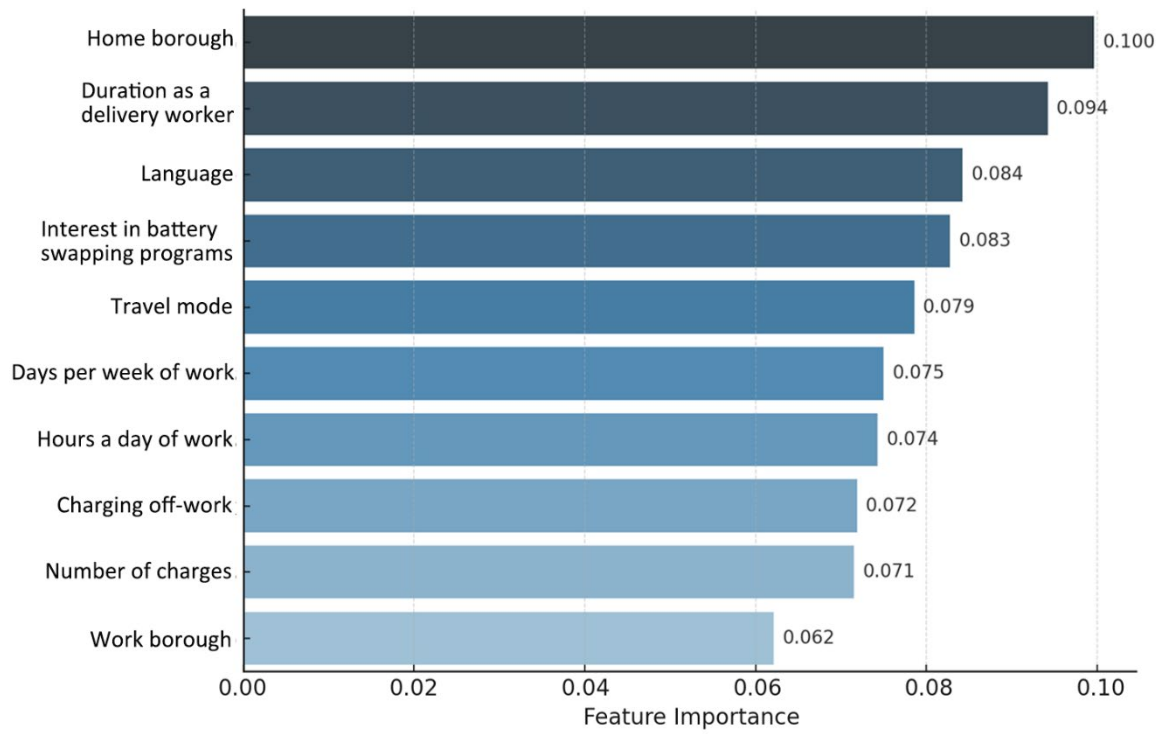
A key survey question asked workers about their interest in trade-in programs (Figure 21). Overall, 159 of 278 respondents (57%) expressed interest or partial interest in the topic. Those who were "somewhat interested, but have concerns" most often cited cost as their main issue, followed by trade-in obligations (i.e., having to trade their current bike or moped for the new e-bike). Among uninterested respondents (43% of 278), the most common reasons cited were cost, dissatisfaction with the available trade-in bike options, or satisfaction with their current gas moped or bike.

Figure 21. Trade-in Program Interest



The machine learning model results show that home borough, delivery work duration, language, interest in a battery swapping program, and current mode were the five most important factors influencing trade-in program interest (Figure 22).

Figure 22. Feature Importance for Trade-in Program Interest



Statistically significant factors that correlated with trade-in program interest included the following:

- "Somewhat interested" respondents were:
    - More likely to have either less than 6 months or more than 1 year of delivery experience
    - More likely to currently not rely on a shared charging location
    - More likely to be English or French speakers
    - More likely to charge in locations other than home during work hours (at someone else's home, parking garage, or store)
- "Very interested" respondents were:
    - More likely to be French speakers
    - More likely to show interest in a battery-swapping program
    - More likely to use rental e-bikes as their current mode

The MNL analysis identified several factors significantly associated with respondents' level of interest in the e-bike trade-in program. Respondents were more likely to express moderate interest (i.e., "somewhat interested, but have concerns") if they had either less than 6 months or more than 1 year of delivery experience, did not rely on shared charging locations, charged in places other than home during work hours, and spoke English or French. Not using shared charging locations (e.g., charging at someone else's home, at private garages, or at informal outlets) was generally associated with a higher interest in the trade-in program. However, within this broader group of nonshared charging users, those who specifically charged at home during work hours were less likely to express interest. This suggests variation within nonshared charging behaviors—while some users who charge in other locations showed moderate interest, those relying on home charging during work hours were comparatively less engaged.

Among respondents who reported being very interested, French speakers, individuals expressing interest in a battery-swapping program, and those currently using rental e-bikes as their primary mode were all positively correlated with strong interest in the trade-in program. Although rental e-bike users may not possess a device eligible for trade-in, their statistically significant association with both trade-in and battery-swapping interest suggests a broader inclination toward e-mobility solutions within this subgroup of delivery workers. The PDPs indicate a consistent trend with the MNL model results. These findings highlight the role of work practices, language background, charging arrangements, and current mode choice in shaping delivery workers' willingness to engage with trade-in initiatives.

4 Task 3: Benefit-Cost Analysis

The goal of the BCA task was to estimate the total ownership cost over 5 years for three scenarios:

1. Gas mopeds
2. E-mopeds
3. UL-certified e-bikes

The analysis utilized available data to determine one-time and recurring costs over 5 years, the salvage value at the end of the period (i.e., the residual value of the e-bike or moped), costs and frequency of items needing replacement within the 5 years (including the vehicles themselves), and the annual distance traveled.

4.1 Background

To facilitate scenario testing and comparison of both costs to delivery workers and environmental impacts from emissions over time, the team created a spreadsheet-based tool incorporating two components:

1. Life-cycle cost analysis (LCCA) component
2. Carbon dioxide (CO_2) emission estimation component (Figures 23 and 24)

LCCA quantifies and assesses the financial costs of alternative scenarios; in this case, the total cost of moped or e-bike ownership for delivery workers. The project team's past work informing this task includes Gao (2018, 2019) and Ozbay (2003, 2004). Appendix F includes the User Guide for the tool.

To ensure cost comparability, the project team assumed an annual mileage of 10,000 miles for all three alternatives.[2] Additional assumptions include the following:

- Analysis period: 5 years, with a 3% discount rate
- Mode alternatives:
    - Gas moped: low, mid, and high initial purchase costs of $800, $1,500, and $3,000
    - E-moped: low and high initial purchase costs of $1,000 and $1,500
    - UL-certified e-bike: best available initial purchase cost of $1,500

[2] The uniform 10,000-mile assumption serves as a comparative analysis; actual distances travelled will vary based on factors including the number of deliveries completed, and so forth.

- Estimated work days and charge frequency: Based on per-project survey results
- Gas and electricity prices: 2025 values used
- Other assumptions: Device and battery lifespans, battery purchase cost, emission rates use the midpoint of the ranges found via literature

Figure 23. Life-Cycle Cost Analysis Worksheets

INPUT

Input	
Output	
Auto-calculated	

Project Detail	
Location:	NYC
Project purpose:	Life cycle cost estimation for the three popular modes among food delivery workers

Analysis Options:		
Alternatives:	Alt A:	Gas Moped
	Alt B:	E-moped
	Alt C:	UL-certified e-bike
Weeks per year:	52	
Analysis period (years):	5	
Discount rate (%):	3%	

Initial Purchase Costs						
Initial device purchase cost ($):	Alt A:	1,500	Alt B:	1,000	Alt C:	1,500
Additional material (e.g., handlebar mittens and helmet) purchase costs ($):	Alt A:	60	Alt B:	60	Alt C:	60
Registration fees ($):	Alt A:	64.25	Alt B:	64.25	Alt C:	n/a

Recurring Costs						
Maintenance schedule (Every XX years):	Alt A:	1	Alt B:	1	Alt C:	1
Number of maintenance per year:	Alt A:	2	Alt B:	2	Alt C:	2
Number of maintenance activity in analysis period:	Alt A:	10	Alt B:	10	Alt C:	10
Annual maintenance fee ($):	Alt A:	400	Alt B:	300	Alt C:	250
Annual insurance fee ($):	Alt A:	75	Alt B:	75	Alt C:	n/a
Estimated annual travel distance (miles):	Alt A:	10,000	Alt B:	10,000	Alt C:	10,000
Full charges per working day:	Alt A:	n/a	Alt B:	1.45	Alt C:	1.59
Working days per week:	Alt A:	5.92	Alt B:	5.5	Alt C:	5.71
Gallons of gas/ full battery charges per year:	Alt A:	90.9	Alt B:	414.7	Alt C:	472.1
Energy consumption per charge (kwh):	Alt A:	n/a	Alt B:	1.44	Alt C:	0.48
Price per gallon gas/ kwh electricity ($)	Alt A:	3.186	Alt B:	0.2567	Alt C:	0.2567
Annual gas refill/ battery recharge electricity cost ($):	Alt A:	289.6	Alt B:	153.3	Alt C:	58.2
Device purchase cost ($):	Alt A:	1,500	Alt B:	1,000	Alt C:	1,500
Device lifespan distance limit (miles):	Alt A:	20,000	Alt B:	23,000	Alt C:	23,750
Device lifespan estimate (years):	Alt A:	2	Alt B:	3	Alt C:	3
Additional number of device purchase in analysis period:	Alt A:	2	Alt B:	1	Alt C:	1
Purchase at year:	Alt A:	2, 4	Alt B:	3	Alt C:	3
Battery purchase cost ($):	Alt A:	n/a	Alt B:	300	Alt C:	500
Battery lifespan estimate (years):	Alt A:	n/a	Alt B:	3	Alt C:	2
Additional number of battery purchase in analysis period:	Alt A:	n/a	Alt B:	1	Alt C:	2
Purchase at year:	Alt A:	n/a	Alt B:	3	Alt C:	2, 4

Figure 23. (continued)

OUTPUT

Cost Estimation						
Initial purchase costs ($):	Alt A:	***1,624***	Alt B:	***1,124***	Alt C:	***1,560***
Recurring annual costs ($):						
(A) Annual Maintenance ($):	Alt A:	1,832	Alt B:	1,374	Alt C:	1,145
(B) Insurance ($):	Alt A:	343	Alt B:	343	Alt C:	0
(C) Gas refill/ battery recharge cost ($):	Alt A:	1,326	Alt B:	702	Alt C:	266
Total recurring costs ($):	Alt A:	***3,502***	Alt B:	***2,419***	Alt C:	***1,411***
Additional purchase costs ($):						
(A) Replace the device ($):	Alt A:	2,747	Alt B:	915	Alt C:	1,373
(B) Replace the battery ($):	Alt A:	0	Alt B:	275	Alt C:	916
Total additional purchase costs ($):	Alt A:	***2,747***	Alt B:	***1,190***	Alt C:	***2,288***
Salvage Value ($):	Alt A:	***-701***	Alt B:	***-323***	Alt C:	***-449***

Total Life Cycle Cost (LCC)

Net present value (NPV): Current value of a future stream of payments over the entire life of an investment discounted to the present.
Equivalent Uniform Annual Cost (EUAC): The yearly costs of an alternative as if they occurred uniformly throughout the analysis period.
*Note: Whether PV or EUAC is used, the decision supported by the analysis will be the same.

Total NPV ($):	**Alt A:**	**$7,172**	**Alt B:**	**$4,410**	**Alt C:**	**$4,811**
EUAC ($):	**Alt A:**	**$1,566**	**Alt B:**	**$963**	**Alt C:**	**$1,051**
% Difference (from Alt A)	-	-	**Alt B:**	**-38.5%**	**Alt C:**	**-32.9%**

Figure 24. Emission Estimate Worksheet

Emission Estimation

Project Detail	
Location:	NYC
Project purpose:	Life cycle cost estimation for the three popular modes among food delivery workers

Analysis Options:		
Alternatives:	Alt A:	Gas Moped
	Alt B:	E-moped
	Alt C:	UL-certified e-bike
Weeks per year:	52	
Analysis period (years):	5	

Emissions Estimate						
Emissions rate (g CO2/person-km)	Alt A:	90	Alt B:	21	Alt C:	15.5
Annual travel distance (mi):	Alt A:	10,000	Alt B:	10,000	Alt C:	10,000
Annual travel distance (km):	Alt A:	16093	Alt B:	16093	Alt C:	16093
Annual emissions (kg CO2/person):	Alt A:	**1448.4**	Alt B:	**338.0**	Alt C:	**249.4**
Analysis period total (kg CO2/person):	Alt A:	**7242.0**	Alt B:	**1689.8**	Alt C:	**1247.2**
% Difference (from Alt A)	-	-	Alt B:	**-76.7%**	Alt C:	**-82.8%**

Initial purchase costs for all modes included the device itself, handlebar mittens, a helmet, and registration fees (if applicable). Recurring and additional costs (if applicable) include annual maintenance, annual insurance, gallons of gas or full battery charges, a spare battery, and the need to repurchase a device, assuming a lifespan of 2 or 3 years.

Salvage value is the residual value of the device at the end of the analysis period. The LCCA calculates the net present value (NPV), which is the current value of a future stream of payments over the entire life of the investment, discounted to the present. From the NPV, the equivalent uniform annual cost (EUAC) can also be calculated; this is the yearly cost of an alternative as if the payments were spread evenly throughout the analysis period. Table 3 summarizes the cost components and their corresponding methodology.

Table 3: Cost Components and Methodology

Cost Component	Methodology
Initial costs *(I)*	Sum of initial device purchase, helmet, mittens, license, and registration
Annual recurring costs *(R)*	Maintenance, insurance, gas/electricity $PV = C\frac{(1+DR)^N-1}{DR(1+DR)^N}$; C: cost; DR: discount rate, N: year in the future
Additional purchase costs (*RP)*	Device, battery, and charger $PV = \frac{C}{(1+DR)^N}$
Salvage value *(SV)*	SV = Replacement Cost × (Remaining Life ÷ Total Useful Life) $SV = -Device\ Replacement * \frac{Service\ life - (Analysis\ Period\ - \#replacement * Service\ Life)}{Service\ Life} * \frac{1}{(1+DR)^{Analysis\ Period}}$
Total NPV	$NPV_{tot} = I + R + RP + SV$
EUAC	$EUAC = NPV * DR * \frac{(1+DR)^N}{(1+DR)^N-1}$

4.2 Findings

The LCCA results show that, for total ownership costs, the lowest cost options are a UL-certified e-bike or an e-moped with a low assumed device cost (Figure 25 and Table 4). However, a low-cost e-moped may use noncertified or substandard batteries that do not meet fire safety standards. With certified batteries, an e-moped could cost 9% more than a similarly certified e-bike ($5,224 versus $4,811).

The ownership cost of a gas moped could range from 14% to 124% higher ($5,492 or $10,772) than a certified e-bike. Even at the low device cost for a gas moped (half the price of an e-bike), total ownership remains 14% higher, primarily due to elevated annual costs such as fuel and maintenance.

Gas and battery charging costs (a subset of recurring annual costs) are:

1. Gas moped: $290
2. E-moped: $153
3. E-bike: $58

This results in cost savings of 79.9% for e-bike users compared to gas moped users and 62.1% compared to e-moped users. E-moped users save 47.1% compared to gas moped users. In terms of emissions, a UL-certified e-bike can reduce CO_2 emissions by 82.8% compared to a gas moped and by 26.2% compared to an e-moped (Table 5).

Figure 25. 5-Year Net Present Value by Mode

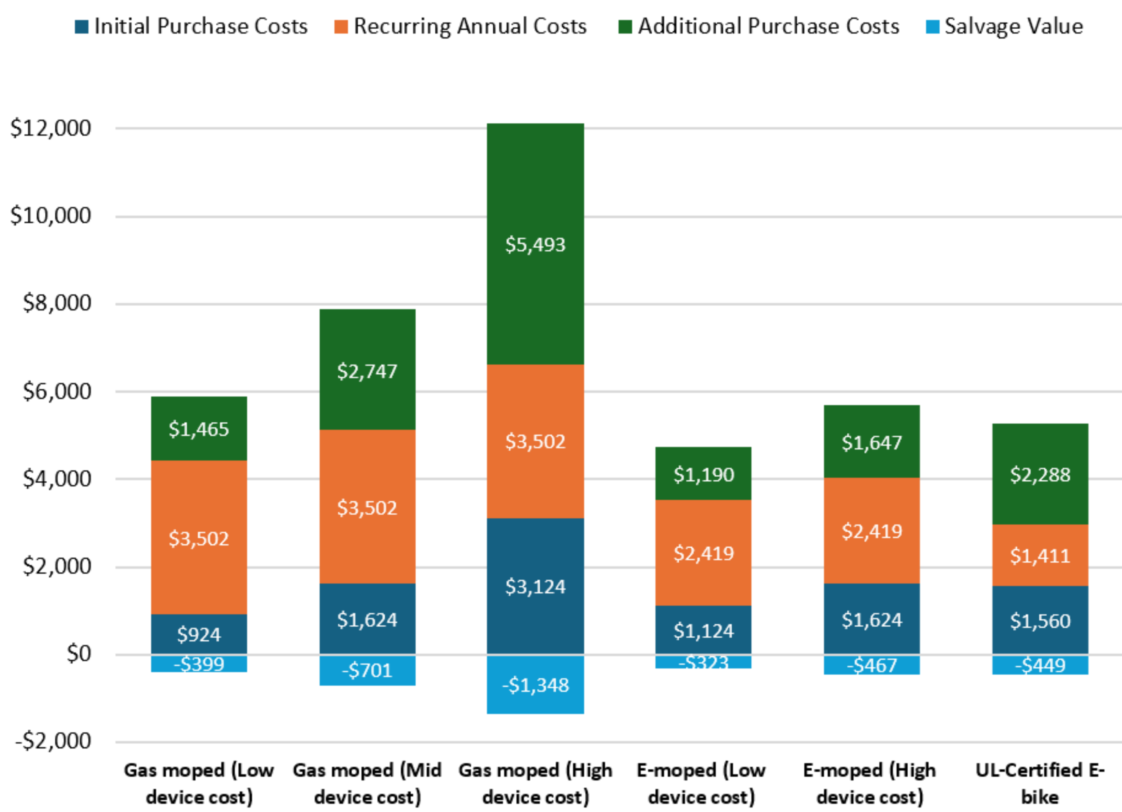


Table 4. 5-Year Net Present Value by Mode

Vehicle	Initial Purchase Costs	Recurring Annual Costs	Additional Purchase Costs	Salvage Value	5-Year NPV	EUAC
Gas moped (low device cost)	$924	$3,502	$1,465	-$399	$5,492	$1,199
Gas moped (mid device cost)	$1,624	$3,502	$2,747	-$701	$7,172	$1,566
Gas moped (high device cost)	$3,124	$3,502	$5,493	-$1,348	$10,772	$2,352
E-moped (low device cost)	$1,124	$2,419	$1,190	-$323	$4,410	$963
E-moped (high device cost)	$1,624	$2,419	$1,647	-$467	$5,224	$1,141
UL-certified e-bike	$1,560	$1,411	$2,288	-$449	$4,811	$1,051

Table 5. Emissions Estimate by Mode

Performance Metric	Gas Moped	E-Moped	UL-Certified E-Bike
Emissions rate (g CO2/person-km)	90	21	15.5
Annual travel distance (miles; km)	10,000; 16,093	10,000; 16,093	10,000; 16,093
Annual emissions (kg CO2/person	1,448.4	338.0	249.4
Annual period total (kg CO2/person)	7,242.0	1,689.8	1,247.2
Percent difference from Gas Moped	—	-76.7%	-82.8%

5 Conclusions

This project aimed to better understand the needs of delivery workers and inform future policy and programmatic solutions around e-bikes in New York State. The literature established a baseline understanding of existing rental services, battery charging and trade-in program options in the five boroughs, and regulations and trends relevant to delivery worker transportation. The sample screenline data collection in October 2024 revealed that mode share differs between Manhattan and the outer boroughs, with more moped use in Brooklyn and Queens and higher percentages of rental e-bikes and overall delivery worker volumes in Manhattan. The intercept survey amassed a robust data source regarding delivery worker habits and modal preferences, including reasons why workers may choose gas mopeds over e-modes. Finally, the BCA quantified ownership costs by mode and showed that UL-certified e-bikes are competitively priced when considering costs over 5 years.

5.1 Conclusions on Trade-in, Rebate, Battery Charging, and Swapping Programs

As State or municipal agencies consider programs to encourage the use of safe, UL-certified e-bikes, the findings of this study identified several key programmatic considerations. Sociodemographic, current mode choice, and work-related factors influenced an individual's interest in participating in various programs. Specifically, home borough, duration as a delivery worker, and language background correlated with willingness to participate in e-bike rebate, trade-in, and battery swapping programs. Future programs could tailor outreach and recruitment strategies to reflect these variables, for example, by prioritizing multilingual program materials, targeting boroughs with higher concentrations of delivery workers, and designing messaging that resonates with new versus more experienced workers.

Modeling results showed that delivery workers with 6 months to 1 year of experience, those who speak Spanish, individuals working primarily in Manhattan, and residents of Queens are particularly likely to use personal e-bikes. In addition to groups that expressed interest in trade-in programs (e.g., French speakers), this group may be particularly interested in trade-in and rebate efforts. Delivery workers who speak French and currently rely on rental bike services also showed high interest in e-mobility (i.e., in both trade-in and battery swapping programs), although many mentioned concerns about theft as an impediment to adopting personal e-bikes. Future programs could therefore explore complementary measures, such as subsidized secure parking, lock distribution, or partnerships with delivery platforms, to address theft-related risks.

Survey respondents who expressed moderate interest in a rebate program frequently identified cost as the most significant barrier, followed by concerns regarding mandatory trade-in requirements (i.e., having to trade their current bike or moped for the new e-bike). Future programs could maximize participation by offering tiered incentives that balance affordability with flexibility, such as rebates without mandatory trade-in obligations or alternative credit schemes, for those unwilling to part with their current device.

The intercept survey revealed that many current gas moped users had previously relied on e-modes but transitioned due to the need for longer travel ranges, higher speeds, and the perceived inconvenience or safety risks of battery charging. Future programs could directly address these concerns by offering incentives for higher-performance, UL-certified e-bikes with extended range and safer charging technologies. Clear communication around performance standards and battery safety certifications may also reduce skepticism among potential participants.

Reducing reliance on gas mopeds will require targeted interventions for workers outside Manhattan, particularly those based in Brooklyn and Queens, where gas moped use is more prevalent. Survey results indicate that those with longer delivery experience are more likely to use gas mopeds, with uptake becoming more common after 6 months of work, likely due to perceived durability and operating efficiency. To counter this trend, programs could emphasize the long-term cost advantages of e-bike ownership, highlighting that while upfront purchase prices may be higher, ongoing maintenance and fuel expenses for gas mopeds are substantially greater, as revealed by the BCA analysis.

For battery charging behavior, nearly 70% of respondents reported not charging batteries during work hours, and approximately half of those who charge off-shift do so at home. This finding indicates the value of developing battery-swapping infrastructure at popular work hubs and ensuring access to safe charging or swapping options near residential areas. Given the concentration of work in Manhattan and residential charging in the Bronx, strategically locating such facilities could enhance both convenience and safety.

Overall, these findings show that successful e-bike programs must account for work practices, language diversity, charging behaviors, and mode choice patterns. By addressing barriers related to cost, safety, and infrastructure, and by tailoring outreach to specific worker groups, future programs can support safe, sustainable modes among delivery workers.

5.2 Limitations and Other Lessons Learned

The team encountered several challenges that are worth noting in the context of both the study findings and future research efforts. In analyzing the intercept survey data, the team faced challenges in simplifying categorical features, balancing sample sizes, addressing missing values, managing collinearity, and accounting for possible nonlinear relationships. For the CBA analysis, this study applied a uniform annual travel distance assumption of 10,000 miles to provide a standardized baseline for comparing modes. However, this assumption does not reflect the actual annual travel distance of delivery workers in New York City. Existing evidence on delivery worker travel distances is limited, with available examples sometimes drawn from international contexts; for example, about 100 kilometers (62 miles) per day for delivery workers who use gas mopeds in Mexico City (Carreon et. al. 2024). Travel distances are highly context-dependent and influenced by factors such as delivery demand, platform practices, and urban form. Consequently, the true distribution of annual travel distances for NYC delivery workers remains uncertain. Future work could develop city-specific estimates to reduce this uncertainty and improve the robustness of benefit-cost analyses.

Conducting the intercept survey itself presented limitations, including the challenge of administering surveys during the extremely cold months of early 2025. The cold weather discouraged workers from lingering outside. However, intercept surveying still proved the most effective method compared with other distribution approaches. The project team also attempted to identify worker “influencers” to share the survey with friends and followers and coordinated with the Workers Justice Project/Los Deliveristas Unidos to circulate the survey link through the organization’s WhatsApp group. While these strategies generated some engagement, they did not substantially increase overall response rates. Delivery worker receptiveness to engage with the surveyors also varied by day and location. The surveyors estimated how many workers they approached versus those willing to take the survey and found that only about 38% agreed to participate. Response rates varied by language group; for example, engagement appeared lower among Chinese-speaking workers, who were the least receptive despite being approached by native Chinese-speaking surveyors, while Spanish- and French-speaking surveyors seemed to facilitate greater participation.

Researchers should interpret these patterns cautiously because the survey took place in the first half of 2025, a period marked by heightened concerns around immigration policy and enforcement. Such contextual factors likely contributed to reduced overall response rates and may have influenced which groups of delivery workers felt comfortable participating. Further research would help disentangle language-related effects from broader structural or contextual influences. The intercept survey yielded an overall margin of error of about 5%, with most sublanguage groups falling within the 5%–10% range, while the Chinese-language subgroup was higher at around 21%. These margins of error suggest that the overall findings are reasonably reliable, although results for the Chinese subgroup should be viewed with caution due to the wider confidence interval.

Engaging delivery workers will likely continue to be a challenge when recruiting delivery workers to participate in future e-bike programs. While financial incentives may provide some motivation, additional outreach strategies, such as leveraging delivery app platforms, chat groups, or partnerships with more local community organizations, could be explored to enhance participation.

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Appendix A. Literature Review Technical Memorandum

A.1 Acronyms and Abbreviations

CC	Contra Costa County
CO_2e	carbon dioxide equivalent
DCWP	New York City Department of Consumer and Worker Protection
DMV	New York State Department of Motor Vehicles
e-bike	electric bike
e-moped	electric moped
e-scooter	electric scooter
e-tuk-tuk	electric tuk-tuk
EV	electric vehicle
FDNY	Fire Department of New York
FOIL	Freedom of Information Law
GHG	greenhouse gas
Kg	kilograms
Km	kilometers
kWh	kilowatt-hour
mph	miles per hour
MT	metric tons
NOx	nitrogen oxide
NYC	New York City
NYCHA	New York City Housing Authority
NYC DOT	New York City Department of Transportation
NYS	New York State
PCE	Peninsula Clean Energy
RCEA	Redwood Coast Energy Authority
RFIS	radio frequency identification
SMS	short message service
UK	United Kingdom
UL	Underwriters Laboratory
VMT	vehicle miles traveled
VOC	volatile organic compound
W	watts

A.2 Overview

The team conducted a comprehensive review of existing electric bike (e-bike) rental services in New York City (NYC), including Zoomo, Whizz, JOCO, and GoFly. This review summarizes their business models, e-bike options, and battery capacities, and offers a detailed understanding of the current market landscape. In addition, the team examined a range of publicly available reports, research papers, and news articles on delivery worker mobility patterns. Key studies include the NYC Department of Consumer and Worker Protection (DCWP) Survey, recent news on delivery drivers shifting from e-bikes to gas mopeds, and findings from various e-bike rebate programs across the U.S. The review also covered a nationwide stated preference study, summaries of e-bike battery capacities and charging behaviors, and comparisons between e-bikes and gas mopeds regarding costs, emissions, miles traveled, and other relevant factors. Lastly, the team summarized findings on public e-bike battery swapping and charging services in New York State.

A.3 Existing E-bike Rental Services in New York City

This section details the three popular e-bike rental services among food delivery workers in New York City: Zoomo, Whizz, and JOCO. We include each company's contract length, rental price, purchase option, bike specifications, and an overview of the rental process. We also briefly describe an emerging rental service, Fly E-bike's GoFly.

A.3.1 Zoomo

While Zoomo offers electric moped (e-moped) rentals in the United Kingdom (UK), the company provides e-bike rentals only in the U.S. Zoomo offers three plans with different contract lengths, ranging from 2 to 12 weeks, using the same bike (Zoomo 2024). Riders are billed every week. A refundable one-time $99 deposit is included in each contract. All plans include a battery charger with the e-bike, which has a range of approximately 37 miles and a maximum speed of up to 20 miles per hour (mph). Table A-1 provides a rental price breakdown by the contract length and the company the rider works for.

Table A-1. Zoomo Rental Price Breakdown by Company

Source: Zoomo (2024).

Contract Length	Uber Eats NYC	Other Companies
2 weeks	$35/week	$59/week
6 weeks	$25/week	$49/week
12 weeks	$15/week	$39/week

As Table A-1 shows, Zoomo offers an exclusive deal for Uber Eats workers in New York City to save $24 per week on each of the three rental plans. Regardless of their company, delivery workers can rent an additional battery for the e-bike for $15 per week, with a $50 refundable deposit. Zoomo also provides optional theft insurance for $9 per week to reduce a rider's liability in the event of theft and loss. To rent an e-bike, Zoomo customers of all ages must make an in-person appointment at the only storefront in New York City and bring a valid government-issued photo ID, proof of address, and a bank card. Zoomo's website offers three languages: English, French, and Spanish. Other than rental services, Zoomo customers may opt to own the bike after 12 months, with an initial $200 down payment. The monthly installment for delivery workers with Uber Eats is $149, which is $100 less than that for workers with other companies. In other words, the total purchase price for a Zoomo e-bike is $1,988 for Uber Eats workers and $3,188 for workers with other companies.

A.3.2 Whizz

Rentals with Whizz must be 1 month or longer. Whizz offers three plans with different bike and accessory options (Whizz 2024), as Table A-2 illustrates. Whizz does not require a deposit. All plans include a battery charger. The Storm-1 bike covers up to 60 miles with pedal assist before battery depletion, while the Storm-2 bike has a range up to 85 miles with pedal assist. Whizz advertises the latter as an e-bike that allows delivery workers to "work all day without recharging" (Whizz). Both models provide a maximum speed of up to 25 mph. While Whizz does not offer the option to rent additional batteries, customers may buy a new Storm-2 model battery for $500 or a secondhand Storm-1 model battery for $200. Similar to the discount offered between Zoomo and Uber Eats, Whizz riders who work for DoorDash receive a 15% discount on all Whizz products.

Table A-2. Whizz Rental Price Breakdown

Source: Whizz (2024).

Contract Length	Uber Eats NYC	Other Companies	Package Details
Plan 1	$135/month	$159/month	Storm-1 bike and charger
Plan 2	$169/month	$199/month	Storm-2 bike and charger
Plan 3	$220/month	$259/month	Plan 2 plus extra battery, protection plan for reducing a rider's liability in the event of theft and loss, backpack, helmet, and chain lock

To rent an e-bike with Whizz, customers must be 18 years or older and make an in-person appointment where they present a valid U.S. photo ID and a bank card. Whizz's website offers four languages: English, French, Spanish, and Russian. For purchase options, customers may choose between a refurbished Breeze model (with a range of 30 to 50 miles with pedal assist and maximum speed up to 20 mph) for $490, and a brand-new Storm-2 model for $1,490 upfront, or 12 monthly installments of $149 (i.e., $1,788 in total). DoorDash riders receive a 15% discount on the monthly installment and upfront cost.

A.3.3 JOCO

While JOCO offers three contract lengths, riders must visit a JOCO location every 6 hours regardless of their rental plan. Table A-3 presents the price breakdown by contract length (JOCO 2024). JOCO does not require a deposit for any plan. All plans include a bike with a range of up to 30 miles before battery depletion and a maximum speed of up to 20 mph.

Table A-3. JOCO Rental Price Breakdown

Source: JOCO (2024).

Contract Length	Price
6 hours	$15
24 hours (i.e., a day)	$24 (unlimited 6-hour rentals in this window)
168 hours (i.e., a week)	$79 (unlimited 6-hour rentals in this window)

JOCO's website does not provide information on renting extra batteries. However, this may be due to the requirement that customers visit a JOCO location every 6 hours, where free charging is provided. New York City has 24 shared charging locations by JOCO and two JOCO + Grubhub rest stops. The latter provides battery-swapping options in addition to shared chargers. JOCO does not offer any purchase option and has a specified lost or stolen fee of $2,250. Instead of requiring in-person appointments, customers who are age 18 or older can download the JOCO app and purchase a pass based on the desired contract length. While the JOCO website only offers information in English, many phones may allow users to change the language of the JOCO app.

A.3.4 GoFly

The e-bike manufacturer, Fly E-bike, offers a rental option for customers in New York City at a rate "as low as $6.6 per day, and own after 10 months" (Fly E-bike 2024). However, the company's website does not provide additional information on rental or purchase costs, contract length, or requirements. GoFly requires all customers who are 18 years or older to inquire at a store location with their U.S. photo ID and a bank card. According to its website, the rental e-bike from GoFly requires 5 to 6 hours to be fully charged. GoFly advertises that its bikes are "perfect for a full day of deliveries," with a range of up to 90 miles and a maximum speed of up to 25 mph.

A.3.5 Summary of E-bike Rental Services

Table A-4 summarizes the e-bike rental and purchase options from Zoomo, Whizz, and JOCO. Based on our review, JOCO offers the lowest upfront rental rate for short-term rentals (1 week or less). For rental periods longer than 1 month, without considering company discounts, Whizz offers the lowest upfront cost. However, Zoomo is the cheapest rental service for workers with Uber Eats, while DoorDash workers receive the lowest cost service with Whizz. Among the three services, Whizz offers the lowest purchase price for an e-bike, the fastest maximum speed, and the longest distance range on a full battery. JOCO has the easiest signup process, the lowest rate for on-the-road recharge or battery change, and the most flexible contract length.

Table A-4. Summary of Rental Services

Company	Lowest Price Offered	Lowest Battery Charging Price	Purchase Option	Sign-up Requirements
Zoomo	• Offers one type of bike • $15/week for Uber Eats or $39/week for other services • Pricing varies by contract length • $99 one-time refundable deposit for all plans • 12-week contract for the lowest rate	• Subscription includes a charge • Optional extra battery, $15/week plus a $50 refundable deposit	• $149/month for 12 months to own the bike (Uber Eats riders) • Otherwise $249/month • $200 down payment applies to both plans	• No specified age requirement • Must have valid government-issued photo ID, proof of address, and bank card • Requires an in-person appointment • Website available in English, French, and Spanish
Whizz	• Offers three types of bikes • $159/month ($39.75 per week) • Pricing varies by bike specs • One-month minimum, billed monthly	• Subscription includes a charger • New battery, $500 • Used battery (older model), $200	• $149/month for 12 months to own a new bike • $490 upfront for a refurbished model	• Must have a U.S. photo ID and bank card • Must be at least age 18 • Requires in-person appointment • Website available in English, French, Spanish, and Russian
JOCO	• Offers one type of bike • $79/week for best value • Pricing differences are based on contract length • Access the bike for 6 hours at a time • Billing cycle depends on contract length	• JOCO charging hubs are free for JOCO users • No other information about renting or buying extra batteries	• No purchase information available	• Purchase pass-through app (bank card required) • Must self-report being age 18 or older • Website available in English, but the app may be changeable

A.4 New York City Department of Consumer and Worker Protection Report

In 2022, the DCWP published its findings on app-based food delivery workers in New York City (DCWP 2022). The study uses data from various apps (i.e., Uber Eats, DoorDash, Grubhub, and Relay), an online survey with 7,956 responses (distributed to 123,000 workers) from workers who performed deliveries in New York City in the fourth quarter of 2021, and 465 responses from an in-person 58-item survey in 2022. While the DCWP report covers many aspects of delivery workers' income and safety conditions on the job, the review focused on demographic information, mode choice, travel distance, and delivery hotspots. According to the survey results:

- About 95% of all delivery workers are between the ages of 18 and 54; 57% are ages 18–34, and 38% are ages 35–54.
- 39% of the delivery workers "speak English less than very well."
- Nearly half of the workers identify as Hispanic, followed by one-quarter of non-Hispanic Black or African, 16% Asian or Pacific Islander, and 10% White and others.
- The gender ratio between male and female workers was 3:1.

Figure A-1 uses delivery app data to summarize the delivery workers' mode choice, work hours, and delivery counts. Of all workers, 43.9% used a car as their primary mode of transportation while on the job. While around 46% of workers reported using an e-bike as their primary mode, the report's authors suggested that many moped users misreported their vehicle as an e-bike. As a result, the 46% reported using app data represents a combination of e-bike and moped delivery workers. The report also includes the delivery trip distribution by travel distance in Figure A-2. More than half of all trips completed on e-bikes cover a distance between 0.5 and 1.49 miles, while trips longer than 4 miles make up the greatest share of all deliveries by car. For deliveries between 2 and 4 miles, more workers completed these trips by car (39%) than by e-bikes (21%). The DCWP survey also found that participants replaced e-bike batteries roughly1.74 times per year. However, the survey does not report battery charging habits for e-bike delivery workers.

Figure A-1. Department of Consumer and Worker Protection Results for Delivery Workers' Mode Choice and Work Statistics

	Workers (%)	Hours (%)	Deliveries (%)	Hours per Week	Deliveries per Hour
Non-Car	56.1	69.4	77.7	22.2	1.869
E-bike	46.1	54.1	65.8	21.3	2.030
Walking	8.7	13.5	10.2	25.7	1.266
Motorcycle	1.3	1.8	1.7	25.2	1.530
Other	<0.1	<0.1	<0.1	17.6	1.626
Car	43.9	30.6	22.4	17.5	1.128

Figure A-2. Department of Consumer and Worker Protection Results for Delivery Workers' Trip Distance Distribution

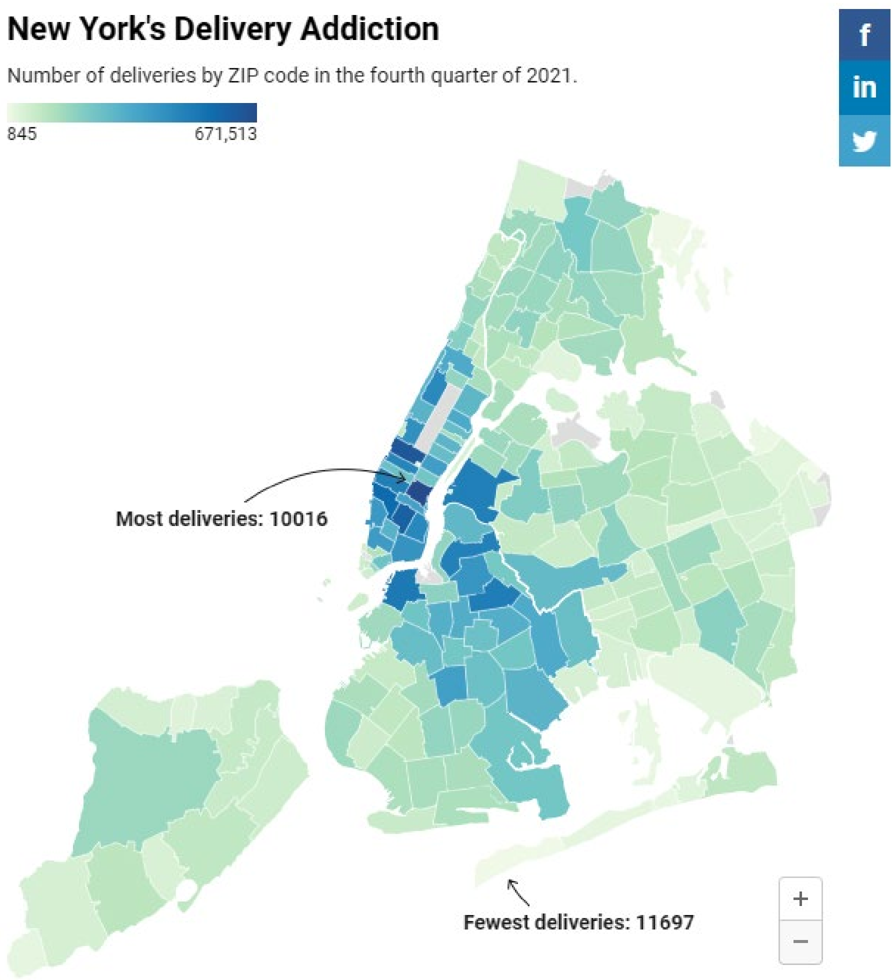
	E-bike	Car	All Modes
Miles per trip (mean)	1.45	3.12	1.77
Distribution of trips, by miles travelled (%)			
0.00 - 0.49	9	2	15
0.50 - 0.99	26	8	21
1.00 - 1.49	26	12	19
1.50 - 1.99	17	13	14
2.00 - 2.49	11	12	10
2.50 - 2.99	6	10	7
3.00 - 3.49	3	9	4
3.50 - 3.99	1	8	3
4.00+	1	26	7
Total	100	100	100

[a] "All Modes" include e-bikes, cars, motorcycles, and walkers.

At the time of the DCWP study, Uber Eats, DoorDash, Grubhub, and Relay composed nearly 99% of all food deliveries in New York City. According to app data in the fourth quarter of 2021, areas such as Kips Bay and Murray Hill in Manhattan had the highest delivery count, as shown in Figure A-3. However, the DCWP report does not offer information on mode breakdown by delivery areas or delivery workers' frequent work areas. Nevertheless, the DCWP report with survey results remains the most relevant source of information and a crucial reference for delivery workers in New York City.

Figure A-3. Number of Deliveries by ZIP Code in the Fourth Quarter of 2021

Source: StreetblogNYC (2023); data source, DCWP via Freedom of Information Law (FOIL).



A.5 San Francisco Emerging Mobility Study Services and Delivery Worker E-bike Pilot

Between 2019 and early 2020, the city of San Francisco, CA, conducted a study (Nutt-Beers 2020) to better understand the work conditions of gig workers with emerging mobility companies such as Uber and Lyft. Specifically, the study used surveys for on-demand ride-hailing and food delivery workers. While the complete list of survey questions is not publicly available, the study's website suggests that the survey included questions on demographics, insurance, weekly work hours, and, specifically for food delivery workers, bike usage. Regarding bike use, 18% of the surveyed food delivery workers used bikes as their primary mode, with half using an e-bike. 33% of the delivery workers currently using bikes had "no additional expenses to perform their work to the best of their abilities." When asked why they chose bikes over cars, 52% of the delivery workers reported that car purchase prices were too expensive, and 77% reported that the vehicle maintenance costs were too high. Furthermore, 77% of bike food delivery workers believed this mode increased their opportunities to exercise, and 83% believed that they delivered faster on bikes. Interestingly, 70% of the food delivery workers surveyed would switch to a bike or consider doing so if offered financial incentives. The study concluded that a growing potential exists to expand bicycle delivery in San Francisco to reduce traffic congestion and meet California's ambitious climate goals. The study further suggested a rebate program for delivery workers and another for the public, but did not provide details on pricing for such programs. Nonetheless, this survey study on food delivery workers in San Francisco led to the E-bike Delivery Pilot (San Francisco Environment Department 2023).

The San Francisco E-delivery Pilot assesses e-bike usage for delivery workers. The program provides free e-bikes to delivery workers in the city who meet the following criteria (San Francisco Environment Department 2023):

1. Be a San Francisco resident
2. Be 18 years of age or older
3. Work for one or more delivery services in San Francisco for at least 4 hours per week over a 1-month study period
4. Participate in data collection and survey activities during the 1-month study period
5. Have previous experience riding bicycles in San Francisco
6. Have a smartphone
7. Have insurance

Participants who successfully complete the study get to keep the e-bike and accessories (i.e., helmet, food bag, lock). Phase 1 of the program began in spring 2023, and Phase 2 will start in fall 2024. However, at the time of this literature review, no publicly available reports on the program's progress were found. The program aims to collect data on delivery worker participants' earnings, trip origins and destinations, trip routes with miles and duration, and total work time, comparing active versus inactive miles. The findings from this pilot program will be released after its completion, likely in 2025.

A.6 New York City Delivery Workers Switching from E-bike to Gas Mopeds

Several NYC news outlets have recently reported that food delivery workers are switching from e-bikes to gas mopeds. In July 2023, *Streetsblog NYC* interviewed five workers and one bike shop owner and reported that delivery workers switched from e-bikes to gas mopeds due to e-bike batteries running out while on the job and fears of e-bike crackdowns from the city government and landlords amidst battery fire incidents (Streetsblog NYC 2023). However, it was reported that many of these new moped users lacked licenses and registrations. A June 2024 *Gothamist* article reported that delivery workers are switching from e-bikes to gas mopeds for the same reasons cited in the Streetsblog NYC article based on accounts from “several workers” (Gothamist 2024). A June 2024 *Curbed* article reported that NYC delivery workers are switching from e-bikes to mopeds to meet the more stringent delivery time requirements from delivery apps following the minimum wage law, according to accounts from three workers (Healy 2024). While these articles provide insights into the trend of delivery workers switching from e-bikes to gas mopeds, it is worth noting that these sources are based on information of a limited scale.

A.7 Lessons from General E-bike Rebate Programs

Since e-bike rebate programs designed explicitly for delivery workers remain a novelty, this review includes findings from two case studies related to e-bike rebate programs for the general public. The first study focuses on e-bike usage and emissions, while the second is a hypothetical study on rebate program participation.

A.7.1 Case Study 1: Findings from Northern California E-bike Rebate Programs

Three Northern California programs, Redwood Coast Energy Authority (RCEA), Peninsula Clean Energy (PCE), and Contra Costa County (CC), offer rebates for the general public (Johnson, Fitch-Polse, and Handy 2023). None requires previous bike ownership.

RCEA provides after-purchase rebates of 50% of the e-bike price, up to $500, for approved models. This program does not have a maximum bike price limit. RCEA participants must be energy customers, and the program limits one rebate per electric account. PCE provides point-of-sale discounts or after-purchase rebates of 80% of the e-bike price or up to $800 from all new Class 1–3 e-bikes with motors of 750 watts (w) or less, with a maximum bike price of $1,800. Participants in the PCE program must be low-income residents of San Mateo County, verified with a full page of the 1040 tax return form. The CC program offers after-purchase rebates of $150 or $300 for Class 1–3 e-bikes, e-bike conversion kits, or pedal-equipped e-mopeds with a maximum speed of 30 mph or less. The maximum bike price for CC is $5,000. Participation is restricted to Contra Costa County residents who are age 18 or older and low-income (verified through tax documents or enrollment in a public assistance program), and the program limits one rebate per household.

Among the 577 survey respondents from the participant lists of the three programs, around 66% reported using their e-bike as their primary mode one to three times per week after the first 2 months, an increase from 28% before the rebate. After a year, those who used their e-bike as their primary mode one to three times per week decreased to 52% of respondents, which was still higher than before participating in the rebate. About 60% of respondents charged their bike one to three times per week, another 30% charged one to three times monthly, and 10% charged daily. Around 52% of respondents replaced car trips with e-bikes after the first 2 months, and this figure dropped to about 37% after 1 year. Nearly 50% of participants rode their e-bikes for fewer than 200 miles after the first 2 months (roughly fewer than 3.5 miles per day). 24% reported between 200 and 400 miles in the same period (~3.5 to 7 miles per day). The most common trip purposes among the survey respondents were recreation, social outings, and shopping/errands. Overall, 2 months after participating in the rebate, respondents replaced about 35%–44% of their car vehicle miles traveled (VMT), resulting in a reduction of 12–44 kilograms (kg) of carbon dioxide (CO_2e) per person each month.

A.7.2 Case Study 2: Survey on Factors Influencing E-bike Rebate Participation

Jones et al. designed a stated preference survey to understand which factors may have the greatest impact in encouraging people to participate in the hypothetical rebate program, especially regarding financial incentives (Jones et al. 2024). The incentive questions provided choices ranging between $150 and $1,200. Figure A-4 shows an example of the questions. The survey received 2,241 responses from people using or interested in using e-bikes across 20 U.S. cities.[3] While the study did not include large metropolitan areas such as New York City or Chicago, it provides the following useful information:

- Point-of-sale incentive is more cost-effective than a mail-in rebate (up to 30% more inframarginal adoption for the same budget)
- Income-based segmented e-bike incentive programs could be more cost-effective than broad-based incentives, with up to $422 of potential savings per bike for the prior.

3 Ann Arbor, MI; Atlanta, GA; Austin, TX; Boston, MA; Charlotte, NC; Denver, CO; Hartford, CT; Madison, WI; Minneapolis, MN; New Orleans, LA; Phoenix, AZ; Portland, OR; Richmond, VA; Salt Lake City, UT; San Diego, CA; San Jose, CA; Seattle, WA; St. Louis, MO; Tampa, FL; and Washington, DC.

Figure A-4. An Example of the Stated Preference Survey Used by Jones et al.

<table>
<tr><td colspan="5">Please choose the bike you would be most likely purchase if these were your only three options for purchasing a new bicycle or e-bike. If you would not purchase any of the provided alternatives, then please select the ‘Would not buy a bicycle or an e-bike' option.</td></tr>
<tr><th>Characteristics:</th><th>Conventional Bike</th><th>Standard E-Bike</th><th>Cargo E-Bike</th><td rowspan="9">Would not buy a bicycle or an e-bike</td></tr>
<tr><td>Max Assisted Speed</td><td>n/a</td><td>28 mph</td><td>20 mph</td></tr>
<tr><td>Throttle</td><td>n/a</td><td>Yes</td><td>No</td></tr>
<tr><td>Range</td><td>n/a</td><td>25 miles</td><td>75 miles</td></tr>
<tr><td>Removable Battery</td><td>n/a</td><td>No</td><td>Yes</td></tr>
<tr><td>Price</td><td>$1,000</td><td>$2,400</td><td>$4,100</td></tr>
<tr><td>Discount</td><td>$0</td><td>$800</td><td>$800</td></tr>
<tr><td>Discounted Price</td><td>$1,000</td><td>$1,600</td><td>$3,300</td></tr>
<tr><td>Discounted Type</td><td>n/a</td><td>Point-of-Purchase Discount</td><td>Mail-in Rebate</td></tr>
</table>

A.8 General E-bike versus Gas Moped

This section compares e-bikes and gas mopeds in terms of device specifications, emissions, batteries or tanks, and costs.

A.8.1 Specification Comparisons: Electric Bike, Gas Moped, and Electric Scooter

Understanding the differences in vehicle specifications between e-bikes and gas mopeds is important because delivery workers may be switching from the former to the latter. As Figure A-5 shows, gas mopeds provide a distance range about twice that of an e-bike. While the top speeds shown in Figure A-5 appear comparable between an e-bike and a gas moped, it is worth noting that the source is an e-bike retailer referencing its own premium selections. A more comparable speed for e-bikes frequently used by delivery workers in New York City is around 20 to 25 mph, as reported by Zoomo, Whizz, and JOCO (JOCO 2024, Whizz 2024, Zoomo 2024). Due to their short range, electric scooters (e-scooters) are not commonly used by delivery workers. In summary, gas mopeds generally cover longer distances and reach higher speeds than e-bikes, which may influence a delivery worker’s decision to switch from an e-bike to a gas moped.

Figure A-5. Comparison of E-bike, Moped, and E-scooter Specifications

Source: HIMIWAY (2023).

Feature	E-Bike	Moped	Scooter
Propulsion	Electric motor	Gasoline engine	Electric motor
Top speed	Up to 28 mph	Up to 30 mph	Up to 20 mph
Range	Up to 50 miles	Up to 100 miles	Up to 20 miles
Weight	30-50 lbs	100-200 lbs	20-50 lbs
Portability	It can be folded for easy storage and transportation	Not foldable	It can be folded for easy storage and transportation

A.8.1.1 Micromobility Speed and Operation Regulations in New York City

In October 2025 New York City reduced the city speed limit for all classes of e-bike, as well as e-scooters, to 15 mph (NYC Office of the Mayor, 2025). All classes of e-bike and scooter are still allowed in bike lanes and may travel in vehicle lanes with speed limits no greater than 30 mph (Figure A-6). Although e-bike users do not need to register with the New York State Division of Motor Vehicles (DMV), they must be at least 16 years old. There is no age or registration requirement for e-scooter users. In contrast, all moped users must obtain a license and a registration. No mopeds may travel on bike lanes. Class C mopeds can travel up to 20 mph, Class B mopeds up to 30 mph, and Class A mopeds up to 40 mph.

Figure A-6. Micromobility Regulation Summary

Source: NYC DOT (2025).

E-BIKES & MORE

Know the difference

Not everything is an e-bike. Know the differences - and always ride legally and safely.

	E-BIKE CLASS 1	E-BIKE CLASS 2	E-BIKE CLASS 3	MOPED CLASS C	MOPED CLASS B	MOPED CLASS A	E-SCOOTER
	Pedal assist	Throttle with pedals	Pedal assist or throttle with pedals	Limited use motorcycle	Limited use motorcycle	Limited use motorcycle	Under 100 lbs
How fast can it go?	20 MPH	20 MPH	25 MPH	20 MPH	30 MPH	40 MPH	20 MPH
How fast may I go? °	15 MPH	15 MPH	15 MPH	AS POSTED	AS POSTED	AS POSTED	15 MPH
Do I need a Driver's License?	NO (Must be 16)	NO (Must be 16)	NO (Must be 16)	YES	YES	YES (Plus M endorsement)	NO
Does my bike need a license plate?	NO	NO	NO	YES	YES	YES	NO
Does my bike need a Vehicle Identification Number (VIN)?	NO	NO	NO	YES	YES	YES	NO
Do I need to register my bike with the DMV?	NO	NO	NO	YES	YES	YES	NO
Can I ride in bike lanes?	YES	YES	YES	NO	NO	NO	YES
Can I ride in vehicle lanes?	YES*	YES*	YES*	YES**	YES**	YES**	YES*
Can I ride on bridges?	YES (Only in bike lanes)	YES (Only in bike lanes)	YES (Only in bike lanes)	YES† (Only in vehicle lanes)	YES† (Only in vehicle lanes)	YES† (Only in vehicle lanes)	YES (Only in bike lanes)
Can I ride in park drives and greenways?	YES	YES	YES	NO	NO	NO	YES
Do I need to wear a helmet?	RECOMMENDED (YES, if working)	RECOMMENDED (YES, if working)	YES	RECOMMENDED	YES	YES	RECOMMENDED

*Vehicle lanes with speed limits no greater than 30 MPH.

**Right lane and/or shoulder, except when making a left turn.

†Except the Manhattan, Williamsburg, and Queensboro (upper level) Bridges. No mopeds can be ridden on these bridges.

°E-bikes and e-scooters are prohibited from going above 15MPH on any city street.

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A.8.1.2 *Micromobility Emissions*

This section discusses emissions from various micromobility modes, such as e-bikes, e-cargo bikes, e-scooters, and electric vehicles (EVs). De Bortoli et al. (2023) conducted a study in France and found that an e-bike's carbon footprint averages around 13 grams (g) of CO_2e per kilometer (km) traveled, slightly higher than that of a pedal bike (10–12 g of CO_2e per km). The calculation includes a full life-cycle analysis based on France's power grid. For reference, in 2023, France's power grid emitted

56 gCO_2 per kWh, while New York State's grid emitted 237 gCO_2 per kWh, indicating that France's grid was less carbon-intensive in 2023 (EIA 2024, Tiseo 2024). E-bikes' emissions were lower than the 60–75g of CO_2e per km emitted by an EV in France. The study found that 94% of greenhouse gas (GHG) emissions from an e-bike come from its manufacture, especially for bikes with aluminum frames. McQueen et al. created a tool to model person-miles traveled and GHG reduction potential in Portland, OR (McQueen, MacArthur, and Cherry 2019). This study found that with a 15% increase in e-bike mode share, total CO_2 emissions in the study area would decrease by 11%,

Various sources reported that e-bikes have zero tailpipe emissions and are the most efficient motorized transportation option available today. E-bikes create 91% fewer carbon emissions than gasoline-powered vehicles, 82% fewer than electric vehicles, 87% less than gas motorbikes, and 80% less than gas mopeds (TNMT 2021). In New York City, about 55% of weekly vehicle trips are under 5 miles (RMI 2023). If 25% of these trips were replaced with e-bikes, this would reduce CO_2e emissions by 4,779 metric tons (MT) per week, the equivalent to removing 51,971 vehicles from the road each year (RMI 2023).

E-bikes can also help reduce GHG emissions by encouraging more cycling. One survey study found that e-bikes can boost cycling trips by up to 50% and attract new groups of cyclists, including older adults, women, and those with health issues (MacArthur et al. 2018).

Aside from the modes discussed earlier, the New York City commercial cargo e-bike pilot showed that cargo bikes could help save seven tons of CO_2 emissions per year in the freight space (NYC DOT 2021). Each cargo e-bike could cover an average of 20 service miles per day, replacing van or box truck miles.

In summary, the team reviewed several international articles on micromobility emissions. Regarding full life-cycle emissions, pedal bikes range from 8 to 12 g CO_2 per person-km, e-bikes range from 13 to 18 g CO_2 per person-km, e-mopeds are around 21 g CO_2 per person-km, gas mopeds are around 90 g CO_2 per person-km, dockless e-scooters are around 102 g CO_2 per person-km, and EVs are around 60–99 g CO_2/person-km (TNMT 2021, De Bortoli 2023).

A.8.2 E-bike Battery and Charging Habits

This section discusses the e-bike battery capacity and user charging habits. E-bike battery capacity is an important component of this study.

A.8.2.1 Capacity

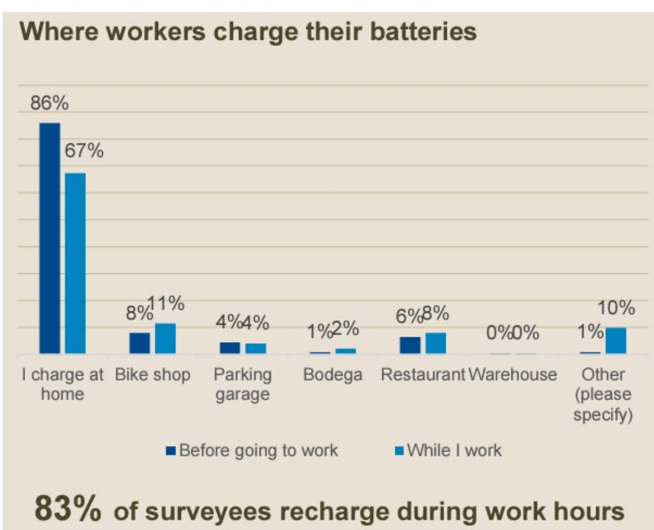
A typical personal e-bike battery capacity ranges from around 0.4 to 0.75 kWh (Macfox Bike 2024). Of the three most popular e-bike rental services in New York City, Whizz's latest model has a capacity of 1.2 kWh, Zoomo's is around 0.6 kWh, and JOCO did not report its capacity. The typical charging time for an e-bike battery ranges from 3 to 6 hours (Chub 2024b). With the average electricity cost in the New York City area at ~28.8 cents per kWh (Chub 2024a) and a typical charger operating at 85%–95% efficiency, fully charging a depleted e-bike battery costs ~34.56 cents or less with access to an outlet. By comparison, a gas moped has a typical tank capacity of 1 to 3 gallons (Bikepics 2023). Using the gas price of ~$3.50/gallon as of September 2024, a full tank for a moped costs between $3.50 and $10.50, at least 10 times the cost of fully charging a depleted e-bike. However, the time involved in pumping gas for a moped is significantly shorter than that required to charge an e-bike.

A.8.2.2 Charging Habits

The DCWP survey found e-bike delivery worker participants replace their batteries around twice a year. A survey by NYC DOT in 2023 reported that 83% of the 338 delivery worker participants recharge their batteries during work hours, as Figure A-7 shows (NYC DOT 2023). Among the participants who reported charging their batteries during work, 67% charged at home, 11% at a bike shop, 4% at a parking garage, 8% at a restaurant, and 10% at other locations. For those who charge before going to work, 86% charged at home, 8% at a bike shop, 4% at a parking garage, 1% at a bodega, 6% at a restaurant, and 1% at other locations.

Figure A-7. Department of Transportation Delivery Worker Battery Survey Results

Source: NYC DOT (2023).



Aside from the Delivery Worker Battery Survey, NYC DOT conducted another survey for the battery-swapping pilot and provided additional information on delivery workers' charging habits (NYC DOT 2024b).Outside of New York City, we found a few studies regarding e-bike users' charging habits. Below, we report the findings from two case studies conducted on university campuses regarding the battery-charging habits of e-bike users.

Kohlrautz and Kuhnimhof conducted a survey study in Germany with 281 e-bike commuter participants from a university and assessed their charging frequency preferences. When free charging is offered, 18% of participants never charge their e-bike at work or school, while the other 82% charge at frequencies ranging from daily to less than once a week. In this scenario, about 50% charge their battery at work or school at least once a week. Commuting distance is the most significant factor when charging is free at work or school. However, when only paid charging is offered, 61% of participants reported never planning to charge their e-bike at work or school, while about 16% charge their battery there at least once a week. When the charging is paid, commute distance is no longer a significant factor influencing a commuter's battery charging habits at work or school.

Another study by Rios, Golab, and Keshav (2016) is based on a Canadian university's test ride program from the summer of 2014 to October 2015 with 31 participants and recorded more than 2,000 charging events. This study collected data using a sensor attached to the bike battery. The bike used in the study had a motor speed up to 20 mph, and a depleted battery would charge between 4 and 5 hours. The average trip duration from participants is around 16.8 minutes. While 10% of charging events occurred when the battery was less than 10% full, more than 25% of charging events started when the battery was more than 90% full. On average, each participant charged about 67 times during the study period (roughly charged every 6 days); each charge lasts about 2.3 recorded trips.

Due to limited information on delivery workers' e-bike battery charging habits, conducting further research is important to better understand this topic.

A.8.2.3 E-bike versus Gas Moped Costs

Based on the literature review, Table A-5 summarizes the estimated costs of e-bikes and gas mopeds. While the initial costs of e-bikes and gas mopeds are comparable, gas mopeds appear to have a much higher maintenance cost, in addition to the requirement of license registrations and insurance. Fines for driving an unregistered vehicle in New York State range from $75 to $300 (additional surcharges may apply), depending on the duration of the lapse (NYS Senate 2024). Mopeds in New York State are classified by top speed, and each class has specific registration and licensing requirements. Under legal compliance assumptions, the overall costs of using gas mopeds exceed those of e-bikes.

Table A-5. E-bike and Gas Moped Cost Comparison

Vehicle Type	Purchase Cost	Battery or Gas Cost	Additional Cost	Estimated Total Cost
E-bike	• $500–$10,000 • Mid-range e-bikes are between $1,000 and $3,000 (Nokoyo 2024b)	• UL-certified batteries: $300–$900 (broad web estimate) • Replace every 3 - 5 years • Full charge costs: less than $0.50 per charge	• Annual maintenance: $150 (basic tune-ups every 6 months) to $500 (plus specific fixes) (Nokoyo 2024a)	• $320–$1,200 annually, including electricity and maintenance • Initial cost: $1,000–$3,000
Gas moped	• Typically $1,000–$3,000 (James 2023)	• Gas per tank: ~$3.5–$10.5	• Registration and plates: ~$105 (extra charge with lender (NYS Department of Motor Vehicles 2024) • Insurance: ~$50.10/month (basic) or ~$115.78/month (enhanced) (Yale 2024); • Tune ups: ~$80–~$350 annually • Tire change: ~$100 (both tires) (The Scooter Lounge 2024)	• Insurance: $600–$1,400 annually • Maintenance: $160–$800 annually • Assuming 30 tanks of gas: $100–$300 annually • Initial cost: $1,000–$3,000 plus $105 registration

A.9 E-bike Battery Swapping or Charging Services in New York State

This section summarizes publicly available battery-swapping or charging services for e-bike users in New York City and beyond.

A.9.1 Overview

The two most prominent e-bike battery swapping and charging options in New York City are PopWheels and Swobbee. Both allow users to swap depleted batteries. PopWheels, a Brooklyn-based company focusing on creating battery solutions for delivery workers, uses Underwriters Laboratory (UL)-certified lithium batteries compatible with 90% of the e-bikes commonly used by delivery workers (i.e., Arrow-7, 9, 10, Fly-9, and Fly-11) (PopWheels 2024b). Delivery workers can use the PopWheels smartphone app or short message service (SMS) to check out batteries on demand. Similar to PopWheels, the German-based company Swobbee (2024) provides battery charging and swapping cabinets. Swobbee also offers battery and e-moped rental services in Germany, starting from €9.90 and €129 per month, respectively. Users may access the batteries using a radio frequency identification (RFID) card via the display on the charging cabinet or via the Swobbee app on smartphones (Swobbee 2024).

In addition to these three services in New York City, the New York State–based company re:Charge (2024) offers a universal wireless charging station for e-bikes. They are currently deployed in Amsterdam, NY, near the State capital. Other examples of e-mobility charging solutions in the U.S. and worldwide include Bikeep (2024), an Estonia-based company that offers docked parking and charging stations for e-bikes and e-scooters; Oyika (2023), an Indonesia- and Thailand-based company that provides users with a subscription to battery charging and swapping stations for e-motorbikes, electric tuk-tuks (e-tuk-tuks), and EVs; ENYRING (2023), a Germany-based subsidiary of Yamaha Motor that offers a subscription to access battery swapping and charging stations; and Tiler (2024), a Netherlands-based company that provides universal wireless charging for e-bikes via the tile and the kickstand.

A.9.2 NYC DOT Pilot Study Results

NYC DOT conducted a pilot study with PopWheels, Swobbee, and Swiftmile from March to September 2024 to provide delivery workers with safer and more efficient e-bike charging solutions (NYC DOT 2024b). In contrast to the charging cabinets provided by PopWheels and Swobbee, Swiftmile offered charging stations where bikes and scooters would be charged without detaching the batteries. Compared to the near-instant battery-swapping options offered by PopWheels and Swobbee cabinets, Swiftmile users generally need about 2 hours to fully charge a depleted e-bike battery.

The study included five locations across Manhattan and Brooklyn with mixed equipment from the three companies: Plaza de las Americas (Washington Heights, Manhattan; cabinets only), Cooper Square (East Village, Manhattan; cabinets and charging docks), Essex Market (Lower East Side, Manhattan; cabinets only), Willoughby Street (Downtown Brooklyn; charging docks only), and Brooklyn Army Terminal (Sunset Park, Brooklyn; cabinets and charging docks). Locations with cabinets had equipment from both PopWheels and Swobbee. Charging and swapping cabinets were available at four of the pilot locations, while charging docks were available at three. The equipment used for this pilot program relied solely on existing power sources. The battery-swapping and charging options available through this pilot program were compatible with Arrow e-bike models 9 and 10, which the NYC DOT identified as the most commonly used among NYC delivery workers in a survey with 338 participants (NYC DOT 2023). The pilot program only allowed batteries to be charged to 95% full under guidance from the Fire Department of New York (FDNY).

The pilot program included 118 delivery workers. Prior to the pilot, 81% of participants charged their bike batteries at home, 41% reported returning home to charge batteries between shifts, and more than 50% carried two or more batteries to meet their charging needs. The pilot program gathered residence data from 92 participants, revealing that 28% lived in Brooklyn, 26% in Manhattan, 22% in Queens, 22% in the Bronx, 1% in Staten Island, and 1% in New Jersey.

During the 6-month pilot, across all locations, the battery-swapping cabinets were used 12,100 times, with the Swobbee and PopWheels systems being used 6,400 and 5,700 times, respectively. According to the survey conducted 4 months into the pilot, Swobbee users reported the highest percentage of feeling batteries charged or swapped via the program "covered less mileage." as Figure A-8 illustrates. The response suggests that the higher count of Swobbee usage may be attributed to relatively worse battery performance (NYC DOT 2024b). Compared to the charging cabinets, Swiftmile docks were used 1,300 times in total across all locations. On average, active PopWheeels and Swobbee users swapped 8 to 14 batteries per week, while Swiftmile users completed 4 to 7 charging sessions weekly (NYC DOT 2024b).

Figure A-8. Survey Result for Mileage When Using Pilot Batteries

Source: NYCDOT (2024b).

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%

The pilot program showed that the overall demand for charging peaked at key periods before popular food delivery times: 11:00 a.m. before the lunch rush, between 4:00 p.m. and 5:00 p.m. before the dinner rush, and 9:00 p.m. around the end of the dinner shift and immediately before the late rush. This pattern suggests that many participants charged their batteries just before starting their delivery shifts, hoping that they had enough power to complete a full shift without interruptions. When inspecting the usage breakdown by company throughout the day, it is worth noting that the Swiftmile charging docks were mostly used in the early afternoon, while the PopWheels and Swobbee cabinets had a more evenly distributed usage throughout the day (Figure A-9). Turning to the usage breakdown by company and day of week (Figure A-10), the NYC DOT observed that usage remained generally consistent throughout the week, with slight declines over the weekends across all three vendors.

Figure A-9. Usage Breakdown by Company and Hour of the Day

Source: NYC DOT (2024b).

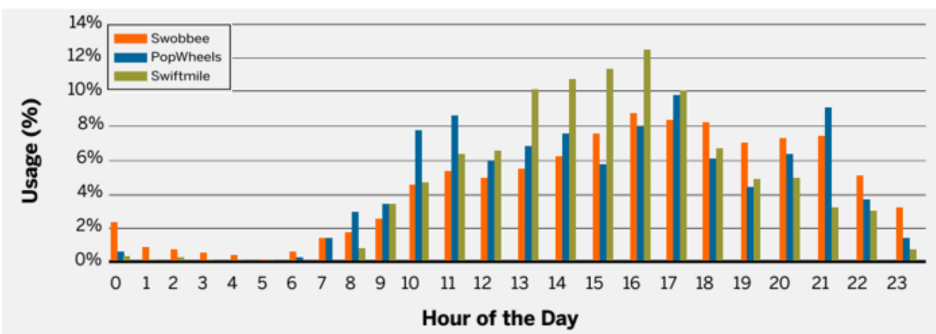
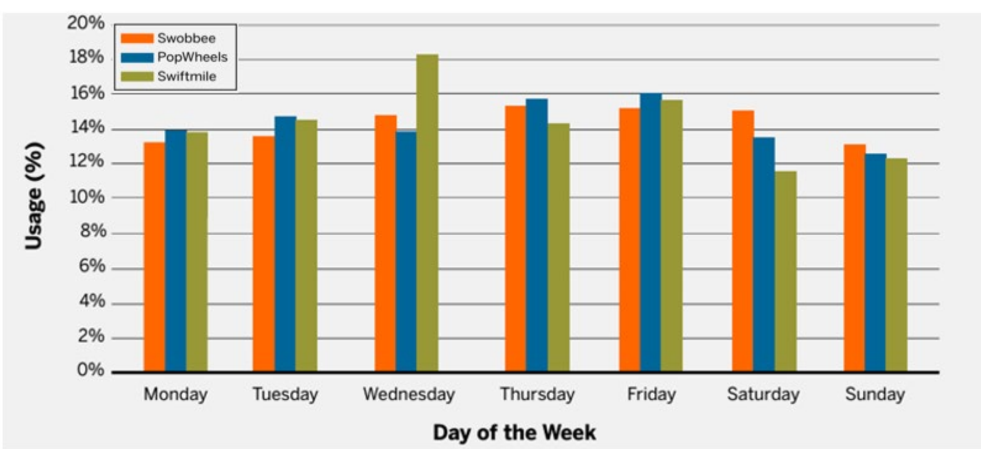


Figure A-10. Usage Breakdown by Company and Day of the Week

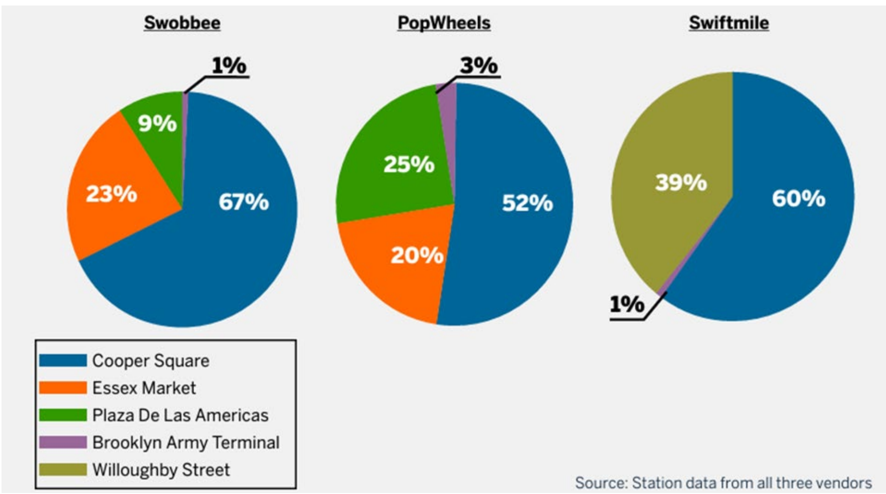
Source: NYC DOT (2024b).



The Cooper Square test location recorded the highest number of transactions, while the Brooklyn Army Terminal saw the least number of users among all locations (Figure A-11). This discrepancy may have been due to Cooper Square's location in a busy area of Manhattan, compared to the Brooklyn Army Terminal's more remote, industrial setting near Southwest Brooklyn.

Figure A-11. Usage Breakdown by Company and Test Location

Source: NYC DOT (2024b).



While site-specific data show that time-of-day swapping and charging patterns were generally similar across all locations, Plaza de las Americas in Washington Heights stands out as an anomaly, with the highest usage at 9:00 p.m., unlike the later afternoon peak at other locations. One possible explanation is that many Manhattan-based participants reside in or near Washington Heights, so the 9:00 p.m. charging peak may reflect users swapping before returning home.

Regarding user retention throughout the program, PopWheels and Swobbee demonstrated strong retention, while 62% of registered Swiftmile users stopped using the docks by the end of the program. Swiftmile users often reported relatively poor charging performance, noting that the docks seemed less effective when multiple e-bikes were plugged in due to inconsistent power delivery. In addition, the 2-hour charging window for a depleted e-bike battery at Swiftmile docks is much longer than the near-instantaneous swaps at battery-swapping cabinets, which may have discouraged some users from choosing the docks over cabinets.

Overall, the program results were promising. Pilot program participants reduced at-home charging by 35%, and PopWheels users reported an 88% reduction in at-home charging. This high rate among PopWheels users may reflect the fact that Swobbee provides users with at-home chargers in addition to access to the swapping and charging cabinets (NYC DOT 2024b). Overall, participants also reported a 50% reduction in spare battery usage. When asked about continued use of similar services after the pilot, participants expressed strong willingness to pay for a monthly, unlimited subscription to maintain access.

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Appendix B. Intercept Survey Instrument and Survey Methodology

B.1 Intercept Survey Methodology

The team analyzed the multiple-choice questions in the intercept survey using a Multinomial Logit (MNL) model and a Machine Learning model, Random Forest with partial dependence plot (PDP), to understand correlations and feature importance. An MNL model is well-suited for categorical data and small samples (McFadden 1974), while the Random Forest model is nonlinear and can be used to explore hidden patterns.

An MNL model is a statistical method used to analyze discrete choices among three or more unordered alternatives (e.g., travel mode) based on random utility maximization theory. It predicts the choice probabilities among three or more unordered categories, such as the choice of travel mode. The model represents the utility of each alternative as a linear function of observable predictors and estimates coefficients that capture how these variables influence the probability of choosing one option relative to a designated baseline. The MNL model expresses the probability that individual n chooses alternative i (from choice set J) as:

$$P_{ni} = \frac{e^{U_{ni}}}{\sum_{j \in J} e^{U_{nj}}}$$

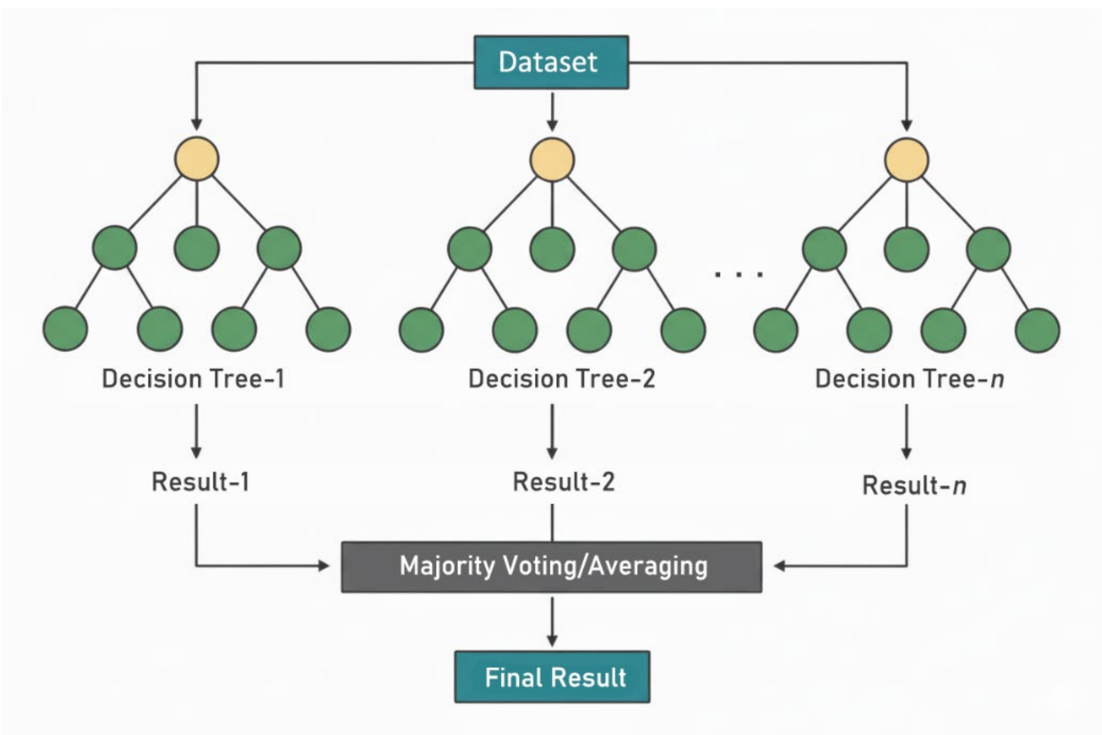
Where P_{ni} = probability that individual n chooses alternative i, $U_{ni} = \beta_n X_{ni}$ is systematic utility function of alternative i for individual n, X_{ni} is the vector of attributes, β_n is the vector of estimated parameters, the denominator, $\sum_{j \in J} e^{U_{nj}}$, is the sum of the systematic utilities of all available alternatives in the choice set.

As shown in Figure B-1, a Random Forest is a supervised machine learning method to produce predictions for classification and regression by constructing multiple decision trees during training and determining their outcomes by majority vote (classification) or averaging (regression) (Breiman 2001). This ensemble approach leverages bootstrap aggregating and random feature selection at each split to reduce variance and improve predictive stability and accuracy. However, Random Forest often suffers from its “black box” nature which refers to its shortcomings in understanding how the model arrived at a particular prediction. To address this gap, PDP was used, which visualizes the marginal effect of a single feature has on the predicted outcome of the Random Forest model by averaging the model's predictions over the distribution of the other features (Molnar 2025).

$$\hat{f}_S(x_S) = E_{x_C}\left[\hat{f}(x_S, X_C)\right] = \int \hat{f}(x_S, X_C)\,dP(X_C)$$

Partial dependence measures how selected features (*S*) affect a model's predictions by averaging over the influence of all other features (*C*). By marginalizing the model output across *C*, it isolates the relationship between features of interest and the predicted outcome while still accounting for interactions with the rest of the data. This helps to interpret the complex interactions and provides insights into the direction of feature's effect on the prediction.

Figure B-1. Conceptual Overview of Random Forest



The team analyzed the open-ended questions, which mostly focused on reasons for interest or lack thereof in the safe e-bike trade-in and battery swapping cabinet programs, using Natural Language Processing (NLP) with Latent Dirichlet Allocation (LDA), a Bayesian, unsupervised topic modeling method in NLP that uncovers hidden themes within large collections of text. When assigning topics to words, the LDA algorithm applies Gibbs sampling, which can be represented by the formula below:

$$p_G\left(s^{(t)}\middle|s^{(t-1)}\right) = p_M(s_n^{(t)}|s_{-n}^{(t-1)}, o)$$

Gibbs sampling is an algorithm designed for the continuous sampling of conditional distributions of variables (Geman and Geman 1984). It constructs a sequence of hidden states, known as a Markov chain, within the space of all possible variable assignments. In this process, movement from one state sequence to another can occur only by changing the state of a single position at a time. The probability distribution governing these transitions is represented in the equation above, where o is the observed sequence, s_{-n} represent all states aside from s_n. The equation above illustrates that the transition probability of the hidden state sequence corresponds to the conditional distribution of a label at a given position, given the rest of the sequence. This property allows the computation to be both efficient and fast. The NLP with LDA approach detects and summarizes the themes in the text data without the need for prelabeling, provides metrics for quality checks, and produces interpretable results suitable for visualization.

B.2 References

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Appendix C. Screenline Results

The team conducted screenline data collection at five locations on Thursday, October 24, and Friday, October 25, 2024, from 12:00 p.m. to 2:00 p.m., and 5:30 p.m. to 7:30 p.m. Teams assigned to each location recorded counts in 15-minute intervals, distinguishing between delivery and nondelivery workers and by micromobility mode: personal e-bike, rental-bike, stand-up scooter, moped, personal pedal bike, Citi Bike (electric and pedal), and other (e.g., cargo bike). In the tables below, "Others" includes those individuals whose delivery worker status the survey teams could not confirm with certainty.

Table C-1. Summary of Screenline Volumes by Day, Location, and Direction of Travel

Location, Direction of Travel	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
1. Ashland and DeKalb, Brooklyn: NB/SB	210	324	229	379	220	251	208	316
1. Ashland and DeKalb, Brooklyn: WB	79	157	155	226	90	124	185	163
2. 6th Ave and 38th St, Manhattan: NB	687	671	446	698	578	598	439	641
2. 6th Ave and 38th St, Manhattan: EB	252	234	148	131	175	189	146	161
3. 8th Ave and 50th St, Manhattan: NB	354	375	428	718	398	511	324	520
4. 11th St and 44th Dr, Queens: NB/SB	74	96	131	338	104	95	193	308
5. Queensboro Bridge EB/WB	210	310	468	1,153	163	314	517	825
Total	**1,866**	**2,167**	**2,005**	**3,643**	**1,728**	**2,082**	**2,012**	**2,934**

Table C-2. Screenline Volumes, Location 1, Ashland Place and DeKalb Avenue, Brooklyn: Northbound/Southbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	107	183	26	34	120	150	15	36
Rental E-bike	4	13	3	0	5	3	0	1
Moped	95	124	18	27	91	94	14	23
Pedal bike	3	4	70	133	3	3	85	102
Other bike	1	0	84	164	1	0	79	129
Scooter	0	0	28	21	0	1	15	25
Total	**210**	**324**	**229**	**379**	**220**	**251**	**208**	**316**

Table C-3. Screenline Volumes, Location 1, Ashland Place and DeKalb Avenue, Brooklyn: Westbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	24	64	27	15	34	65	29	9
Rental E-bike	1	4	0	0	2	2	0	0
Moped	48	89	22	12	52	56	16	20
Pedal bike	1	0	59	71	2	1	63	55
Other bike	5	0	38	101	0	0	64	70
Scooter	0	0	9	27	0	0	13	9
Total	**79**	**157**	**155**	**226**	**90**	**124**	**185**	**163**

Table C-4. Screenline Volumes, Location 2, 6th Avenue and 38th Street, Manhattan: Northbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	538	541	40	41	440	470	30	48
Rental E-bike	99	98	7	13	75	90	6	18
Moped	25	16	9	16	40	25	9	13
Pedal bike	13	5	105	159	7	4	101	104
Other bike	12	11	234	421	16	9	243	394
Scooter	0	0	51	48	0	0	50	64
Total	**687**	**671**	**446**	**698**	**578**	**598**	**439**	**641**

Table C-5. Screenline Volumes, Location 2, 6th Avenue and 38th Street, Manhattan: Eastbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	213	181	34	23	156	160	27	18
Rental E-bike	26	19	53	6	12	20	15	7
Moped	7	6	7	4	3	5	4	6
Pedal bike	1	5	24	16	1	2	19	19
Other bike	5	19	12	56	2	2	71	96
Scooter	0	4	18	26	1	0	10	15
Total	**252**	**234**	**148**	**131**	**175**	**189**	**146**	**161**

Table C-6. Screenline Volumes, Location 3, 8th Avenue and 50th Street, Manhattan: Northbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	292	317	150	147	332	412	63	65
Rental E-bike	38	39	28	35	40	74	18	17
Moped	16	16	15	14	20	22	10	9
Pedal bike	8	3	50	136	6	3	49	90
Other bike	0	0	139	347	0	0	146	296
Scooter	0	0	46	39	0	0	38	43
Total	**354**	**375**	**428**	**718**	**398**	**511**	**324**	**520**

Table C-7. Screenline Volumes, Location 4, 11th Street and 44th Drive, Queens: Northbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.	12:00 p.m.–2:00 p.m.	5:30 p.m.–7:30 p.m.
Personal E-bike	14	15	7	12	21	20	7	11
Rental E-bike	2	0	4	0	0	2	0	0
Moped	25	30	13	10	27	25	8	11
Pedal bike	0	1	23	59	1	2	36	39
Other bike	0	0	30	73	1	0	47	63
Scooter	0	1	6	17	0	0	12	10
Total	**41**	**47**	**83**	**171**	**50**	**49**	**110**	**134**

Table C-8. Screenline Volumes, Location 4, 11th Street and 44th Drive, Southbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.
Personal E-bike	13	24	1	10	21	13	6	14
Rental E-bike	0	0	0	0	0	3	0	0
Moped	18	24	10	12	33	28	4	11
Pedal bike	2	0	13	70	0	2	28	71
Other bike	0	0	18	62	0	0	38	67
Scooter	0	1	6	13	0	0	7	11
Total	**33**	**49**	**48**	**167**	**54**	**46**	**83**	**174**

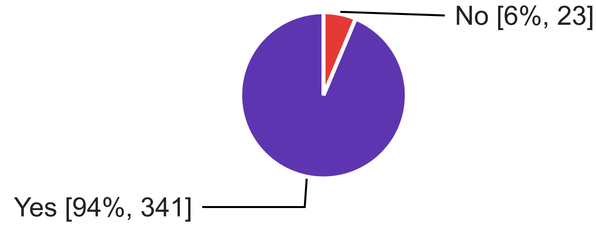
Table C-9. Screenline Volumes, Location 5, Queensboro Bridge Eastbound/Westbound

Vehicle Type	Thursday, 10/24/24				Friday, 10/25/24			
	Delivery Workers		Others		Delivery Workers		Others	
	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.	12:00 p.m.– 2:00 p.m.	5:30 p.m.– 7:30 p.m.
Personal E-bike	181	287	72	156	140	291	105	115
Rental E-bike	11	12	1	0	6	10	1	7
Moped	8	2	18	12	11	6	18	5
Pedal bike	6	7	168	441	5	6	184	290
Other bike	3	2	132	384	1	0	129	287
Scooter	1	0	77	160	0	1	80	121
Total	**210**	**310**	**468**	**1,153**	**163**	**314**	**517**	**825**

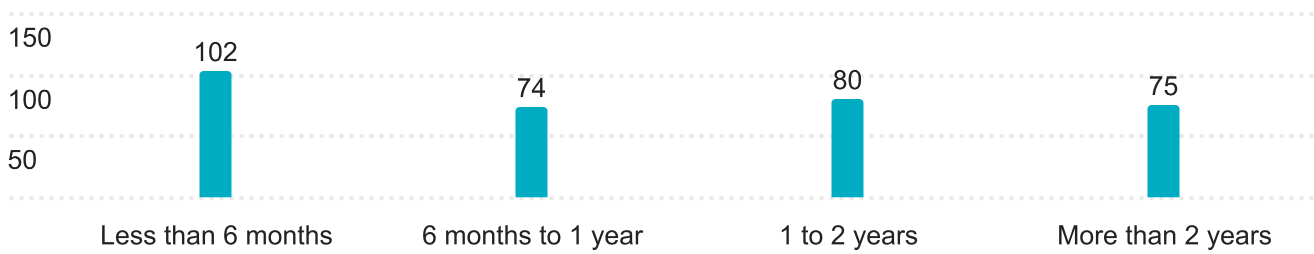
Appendix D. Intercept Survey Summary Results

Delivery Worker Survey Results

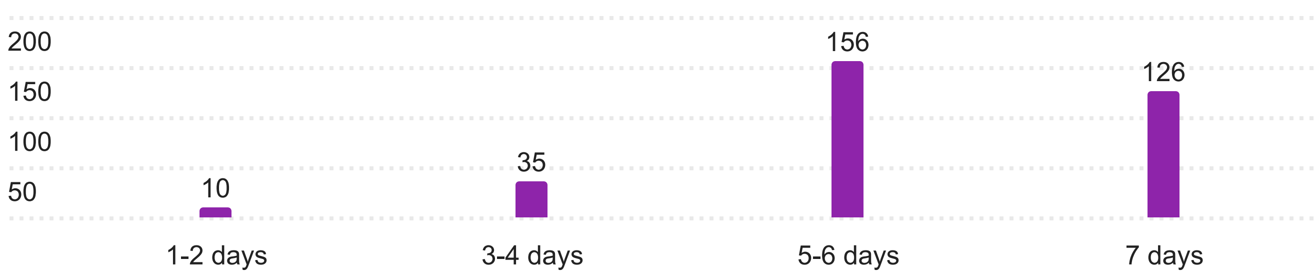
Are you a delivery worker in the five boroughs of New York City?



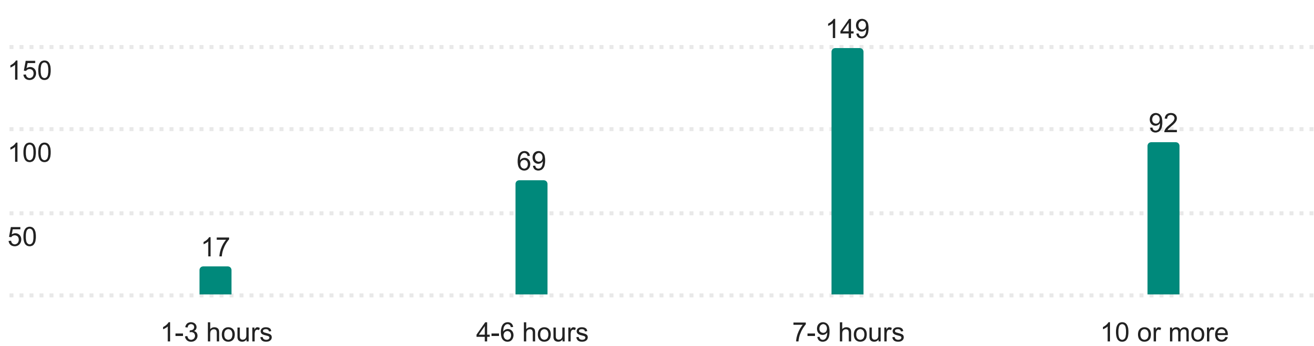
Q1 - How long have you worked making deliveries?



Q2 - How many days a week do you usually work making deliveries?



Q3 - Approximately how many hours do you work on deliveries per day?

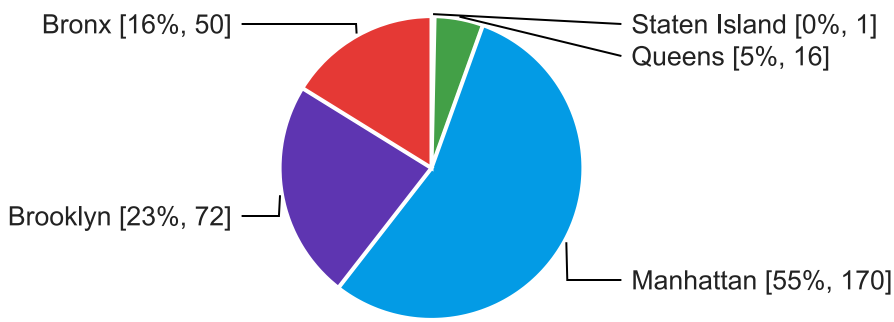


*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

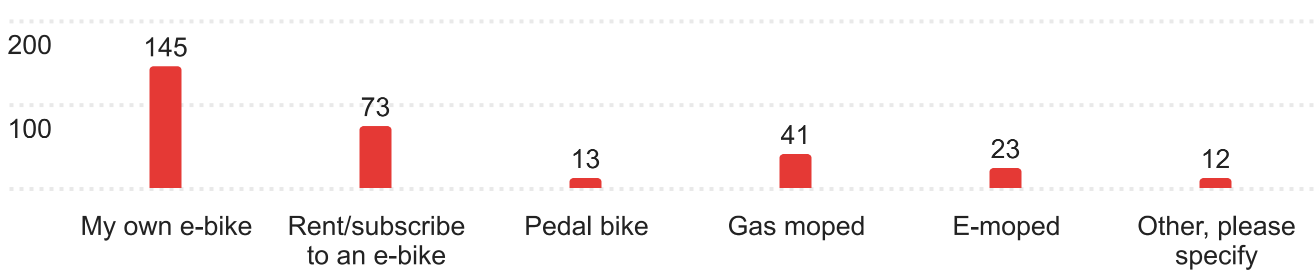
Delivery Worker Survey Results

Q4 - Which zip code do you currently live in?

Q5 - Which borough do you typically work in?



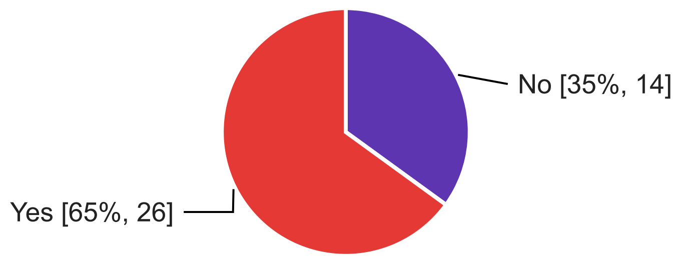
Q6 - What is your primary mode of transportation for deliveries?



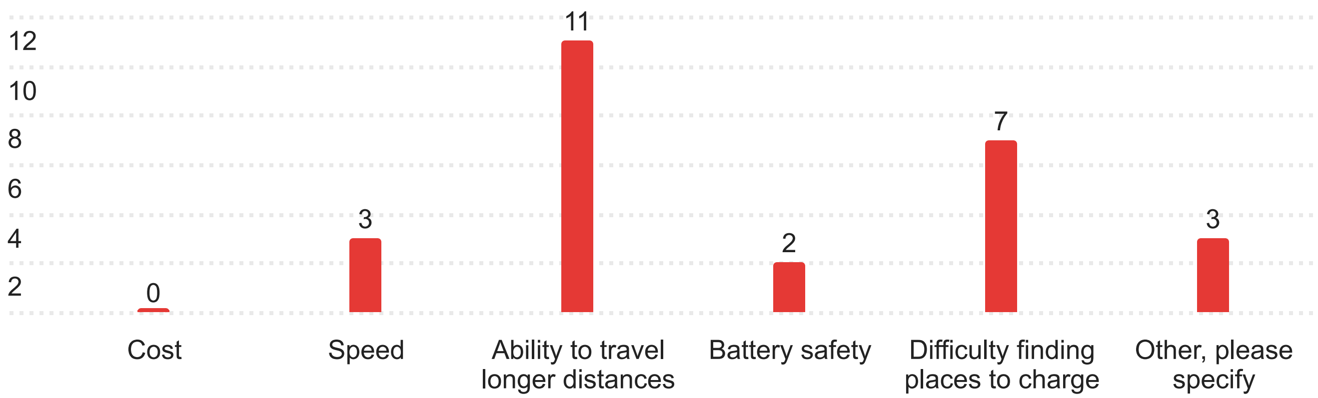
*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

Delivery Worker Survey Results

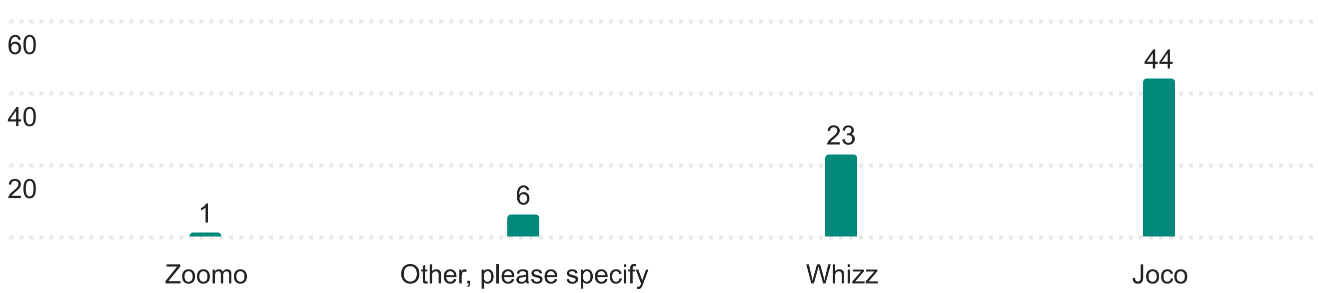
Q7 - Have you switched from an e-bike/scooter in the last three years?



Q7A - [If yes] Why did you switch?

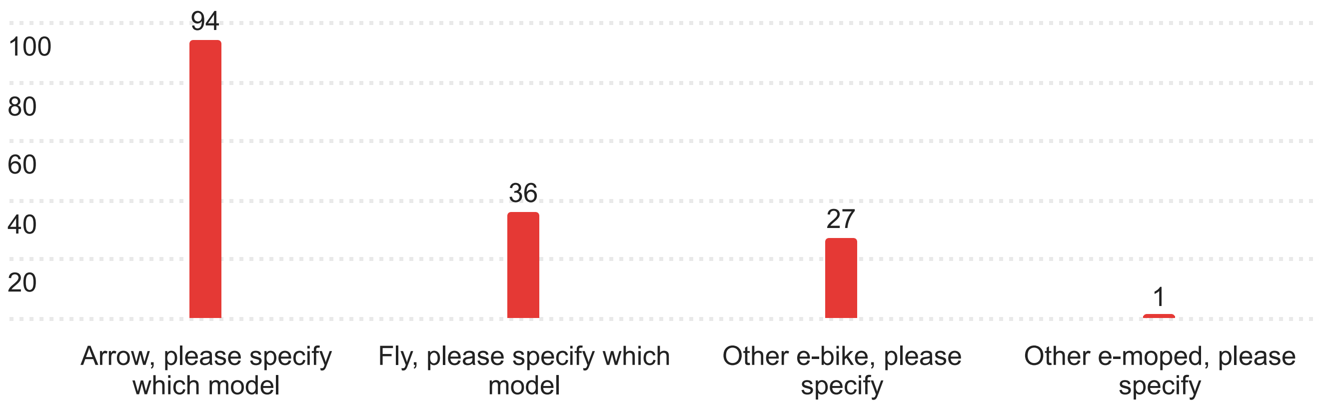


Q9 - [If you rent/subscribe] Which company do you use?

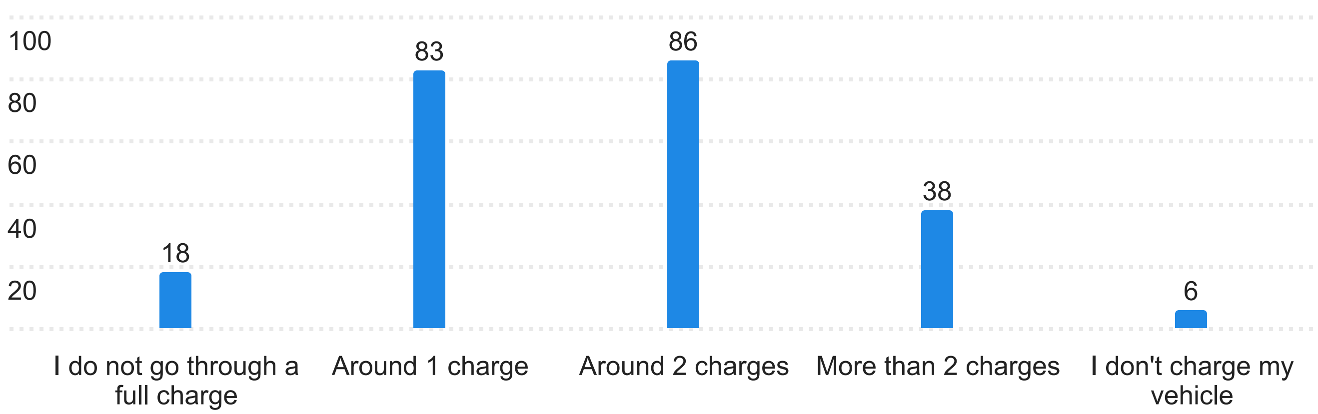


*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

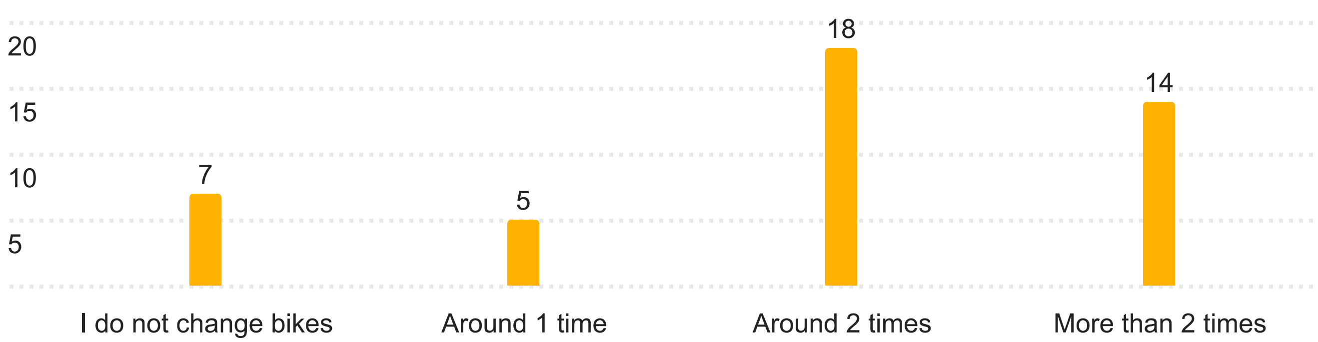
Q10 - [If e-bike or e-moped] Which model of e-bike or e- moped do you currently ride?



Q10A - How many full battery charges do you go through in a typical day?



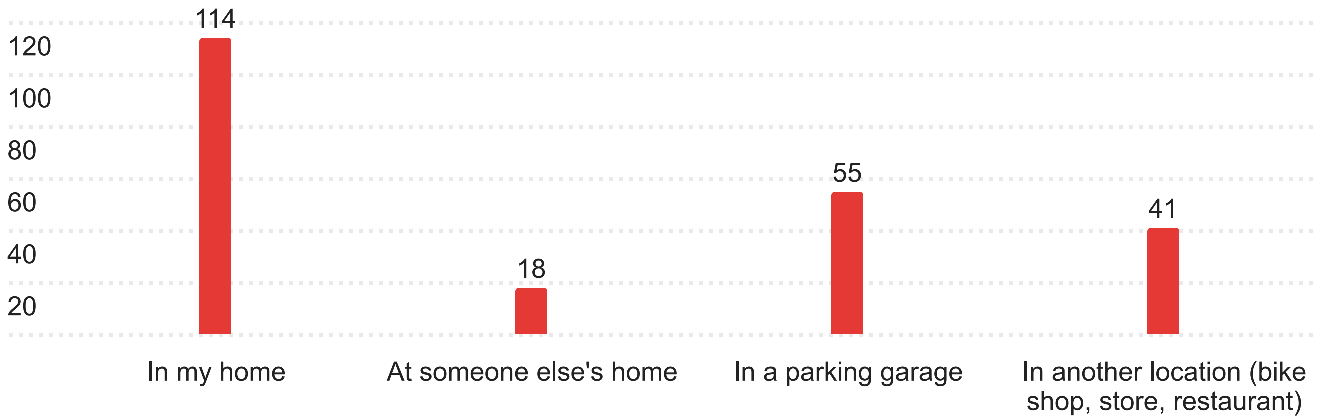
Q10B - How many bike changes do you go through in a typical day?



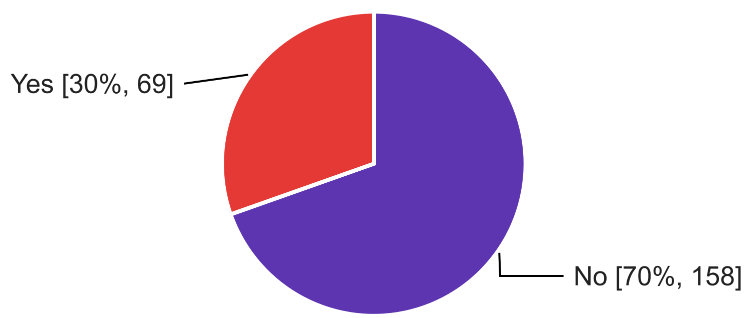
*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

Delivery Worker Survey Results

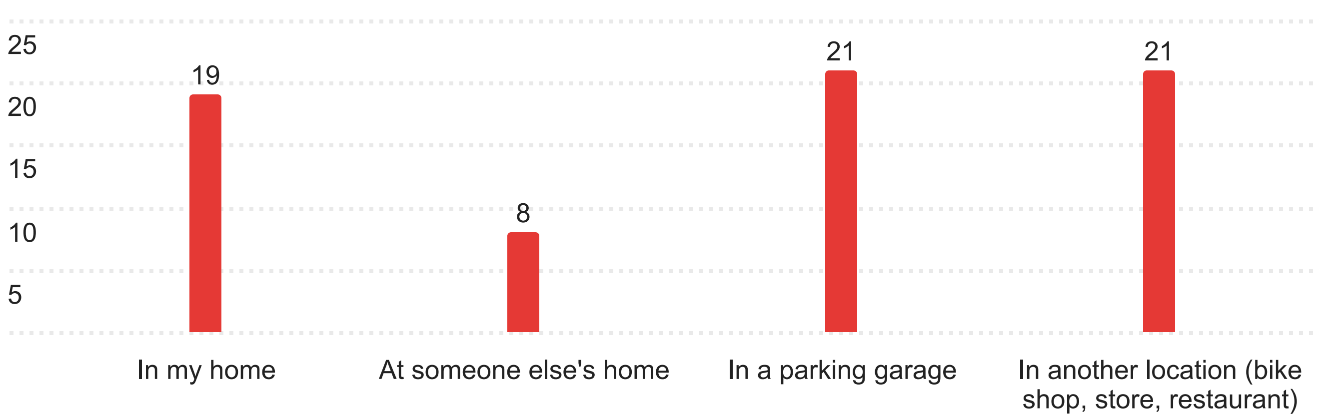
Q13 - Where do you primarily charge your battery during non-work hours?



Q14 - Do you charge during your work shift?



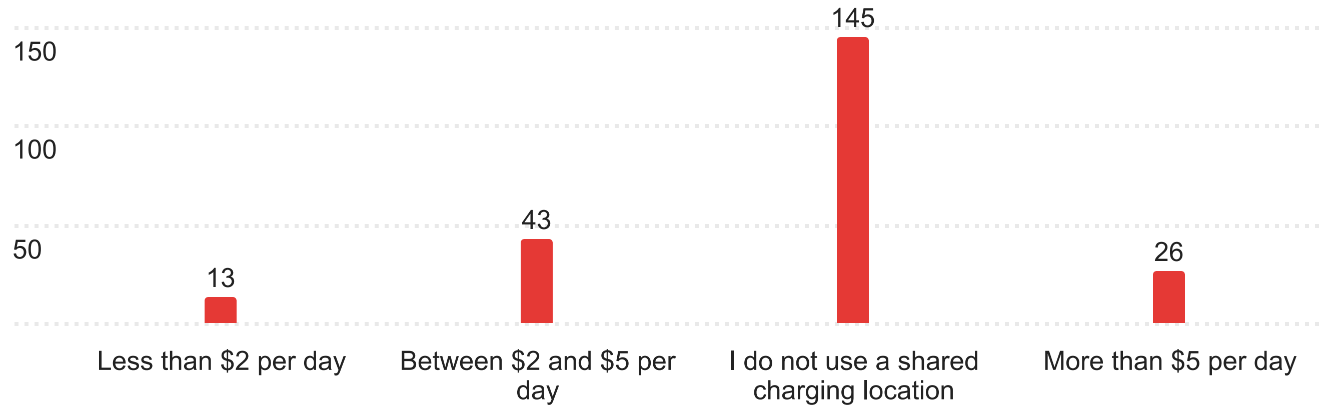
Q14A - [During your work shift] Where?



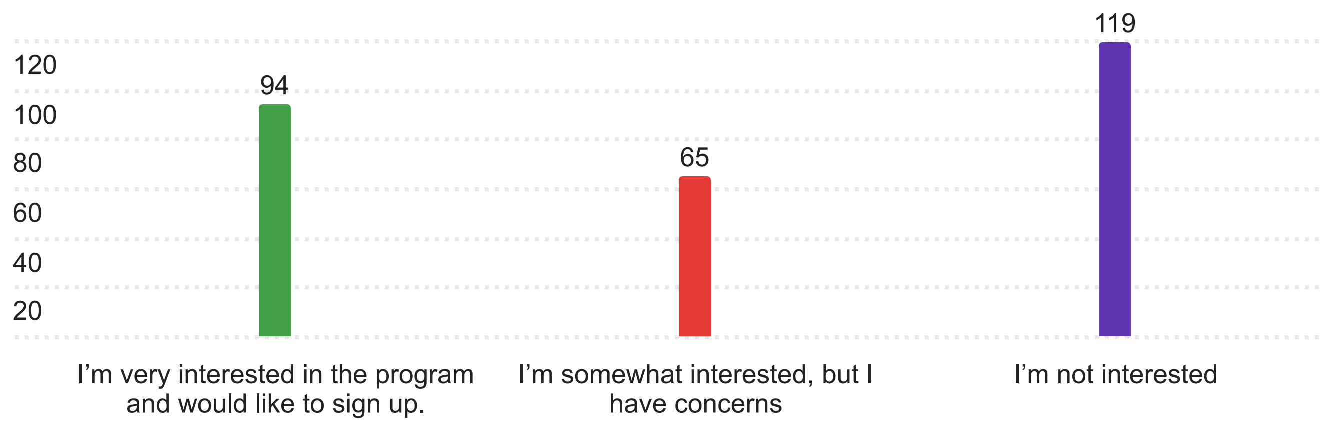
*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

Delivery Worker Survey Results

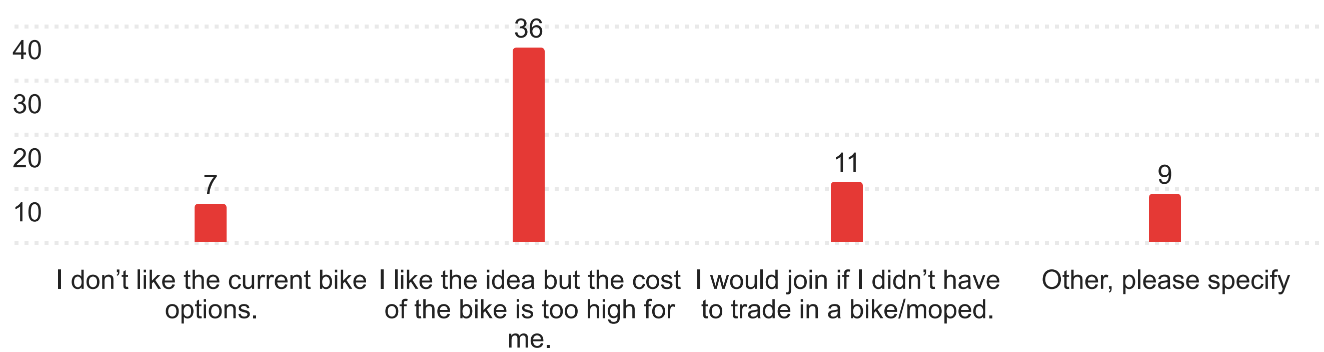
Q15 - If you use a shared charging location, how much do you pay?



Q17 - Are you interested in the E-bike Rebate/Trade-in Program?



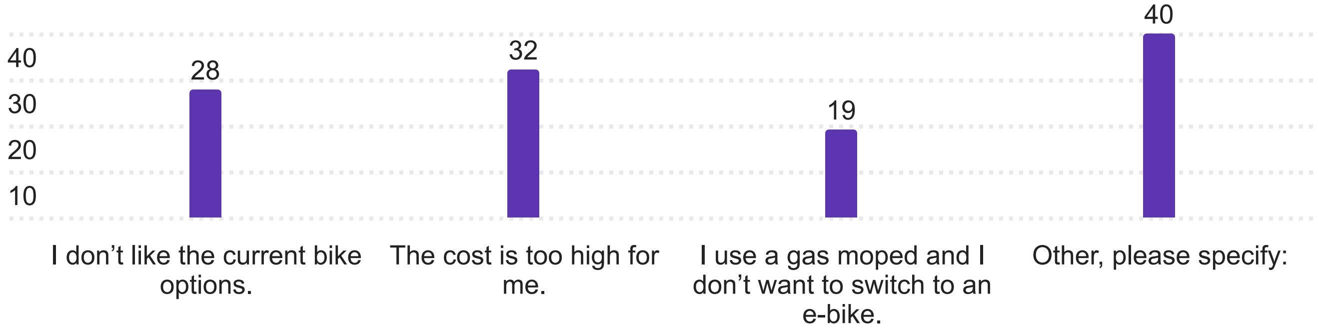
Q17A - Why are you only somewhat interested?



*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

Delivery Worker Survey Results

Q17B - Why are you NOT interested? (Select one) - Selected Choice



Q18 - Would you be interested in a battery swapping program for e-bikes or e-mopeds whereby you don't own your battery but instead subscribe to a battery rental service, and have access to a public battery locker?

*Some text field questions (e.g., "Other, please specify") are not visualized here for simplicity. Results represent raw data and may differ slightly as a result of data cleaning.

Appendix E. Life-Cycle Cost Analysis User Guide

User Guide

Life Cycle Cost Emulator - NYC Delivery Worker Data Collection and Research

LCCA Worksheet

The **LCCA** worksheet is used to calculate the life cycle costs of owning and operating the three popular transportation modes among food delivery workers in NYC during the analysis period. It contains the following sections: 1) Project Detail, 2) Analysis Options, 3) Initial Purchase Costs, 4) Recurring Costs, and 5) Cost Estimation.

Net Present Value (NPV) and Equivalent Uniform Annual Cost (EUAC)[1] were used to present the final life cycle cost of each alternative.

- **NPV**: The current value of a future stream of payments over the entire life of an investment, discounted to the present.
- **EUAC**: Another way to express life cycle cost results. EUAC converts the total cost of an alternative into equal yearly costs spread uniformly over the analysis period.

Whether NPV or EUAC is used, the resulting decision from the analysis will be the same.

This user guide provides a brief tutorial on the use of the spreadsheet-based tool. In general, cells highlighted in **green** represent input variables that may be modified by the user, cells highlighted in **blue** display output values, and cells in white contain either fixed values or values automatically calculated from other inputs; these do not require modification.

Project Detail

This section records the description of the project, including the analysis location and its purpose.

Project Detail	
Location:	NYC
Project purpose:	Life cycle cost estimation for the three popular modes among food delivery workers

Analysis Options

By default, the analysis is configured for a 5-year period with a 3% discount rate. Users may adjust both the analysis period and the discount rate within this section to suit their specific requirements.

Analysis Options:		
Alternatives:	Alt A:	Gas Moped
	Alt B:	E-moped
	Alt C:	UL-certified e-bike
Weeks per year:	52	
Analysis period (years):	5	
Discount rate (%):	3%	

[1] Life-Cycle Cost Analysis Primer, Office of Asset Management, U.S. DOT.

Initial Purchase Costs

This section is used to enter all one-time or initial purchase costs. The default configuration includes the cost of the initial device purchase, additional materials such as handlebar mittens and a helmet, and license and registration fees for the two moped modes.

Initial Purchase Costs						
Initial device purchase cost ($):	Alt A:	1,500	Alt B:	1,000	Alt C:	1,500
Additional material (e.g., handlebar mittens and helmet) purchase costs ($):	Alt A:	60	Alt B:	60	Alt C:	60
Registration fees ($):	Alt A:	64.25	Alt B:	64.25	Alt C:	n/a

Recurring Costs

The *Recurring Costs* section is divided into the following subsections: 1) routine annual maintenance costs, 2) annual insurance fee, 3) annual gas or electricity cost, 4) additional device purchase frequency, and 5) additional battery purchase frequency.

In the default analysis, it is assumed that delivery workers require maintenance twice per year for all three transportation modes. Insurance costs are included only for gas-powered mopeds and electric mopeds, in accordance with city and state regulations. Users may modify the values for routine annual maintenance and insurance in the subsequent section of the tool.

19	Recurring Costs						
20	Maintenance schedule (Every XX years):	Alt A:	1	Alt B:	1	Alt C:	1
21	Number of maintenance per year:	Alt A:	2	Alt B:	2	Alt C:	2
22	Number of maintenance activity in analysis period:	Alt A:	10	Alt B:	10	Alt C:	10
23	Annual maintenance fee ($):	Alt A:	400	Alt B:	300	Alt C:	250
24	Annual insurance fee ($):	Alt A:	75	Alt B:	75	Alt C:	n/a

When estimating the annual costs for fuel or battery recharging, device replacement frequency, and battery replacement frequency, the calculation process uses the annual travel distance for each alternative, as recorded in row 26 of the spreadsheet.

26	Estimated annual travel distance (miles):	Alt A:	10,000	Alt B:	10,000	Alt C:	10,000

Rows 28 through 33 estimate the annual cost for gas refill or battery recharge. The gas refill frequency is calculated by dividing the estimated annual travel distance by a reference fuel efficiency of 110 miles per gallon. The battery charging frequency for the two electric modes is based on the average value of full charges per working day, the number of working days per week, and the number of weeks per year. The energy consumption per charge is calculated by multiplying the voltage of the battery (72V for a typical e-moped, and 48V for a typical e-bike) by its capacity in Ah (20Ah for e-moped and 10Ah for e-bike), then dividing this product by 1000 to arrive at the unit of kWh, which is commonly used when estimating the cost of electricity.

28	Full charges per working day:	Alt A:	n/a	Alt B:	1.45	Alt C:	1.59
29	Working days per week:	Alt A:	n/a	Alt B:	5.5	Alt C:	5.71
30	Gallons of gas/ full battery charges per year:	Alt A:	90.9	Alt B:	414.7	Alt C:	472.1
31	Energy consumption per charge (kwh):	Alt A:	n/a	Alt B:	1.44	Alt C:	0.48
32	Price per gallon gas/ kwh electricity ($)	Alt A:	3.186	Alt B:	0.2567	Alt C:	0.2567
33	Annual gas refill/ battery recharge electricity cost ($):	Alt A:	289.6	Alt B:	153.3	Alt C:	58.2

To determine the number of devices and battery repurchases throughout the analysis period, we divide the lifespan mileage for each alternative by the annual distance estimate. Then, we calculate the lifespan of each alternative and identify the number of repurchases required and the year(s) in which they occur within the analysis period. Please note that changing the *lifespan distance* and the *annual travel distance* will affect the device repurchase estimates.

35	Device purchase cost ($):	Alt A:	1,500	Alt B:	1,000	Alt C:	1,500
36	Device lifespan distance limit (miles):	Alt A:	20,000	Alt B:	23,000	Alt C:	23,750
37	Device lifespan estimate (years):	Alt A:	2	Alt B:	3	Alt C:	3
38	Additional number of device purchase in analysis period	Alt A:	2	Alt B:	1	Alt C:	1
39	Purchase at year:	Alt A:	2, 4	Alt B:	3	Alt C:	3

Battery replacement is calculated separately for e-mopeds and e-bikes. For e-mopeds, the battery lifespan is assumed to be 25,000 miles of use based on the reference. For e-bikes, the lifespan is based on data from the NYC Department of Consumer and Worker Protection (DCWP) report, which found that surveyed workers replaced a battery every 1.74 years. After rounding these calculated lifespans to the nearest whole number, the spreadsheet determines the total number of additional batteries required and identifies the purchase year(s) for each electric alternative.

41	Battery purchase cost ($):	Alt A:	n/a	Alt B:	300	Alt C:	500
42	Battery lifespan estimate (years):	Alt A:	n/a	Alt B:	3	Alt C:	2
43	Additional number of battery purchase in analysis perio	Alt A:	n/a	Alt B:	1	Alt C:	2
44	Purchase at year:	Alt A:	n/a	Alt B:	3	Alt C:	2, 4

Cost Estimation

Cost estimation used in this worksheet follows the guidelines from the National Highway Cooperative Research Program (NCHRP) Report 483.[2] The NPV is calculated as the sum of four components: initial purchase costs (I), recurring annual costs (R), additional purchase costs (AP), and salvage value (SV).

The initial purchase costs are obtained by summing the items listed in the *Initial Purchase Costs* section described above. *Recurring annual costs* are determined by summing each component after applying the Equal Annual Events Equation (eq. 1) individually to the annual maintenance, insurance, and gas refill/battery recharge costs. In eq. 1, C represents the annual cost for each component, DR represents the discount rate, and N is the length of the analysis period.

[2] Hugh Hawk. *NCHRP Report 483: Bridge life-cycle cost analysis*. Vol. 483. Transportation Research Board, 2003.

$$PV = C\frac{(1+DR)^N-1}{DR(1+DR)^N} \text{ (eq. 1)}$$

We then apply the one-time future event equation (eq. 2) to the additional device and battery purchases, where C represents the cost of the device or battery, DR is the discount rate, and n is the year where the additional purchase occurs. The sum of the device and battery repurchase costs after applying eq. 2 represents the additional purchase costs.

$$PV = \frac{C}{(1+DR)^n} \text{ (eq. 2)}$$

To calculate the *salvage value (the estimated residual value of the device at the end of the analysis period)*, equation (eq. 3) is applied to each alternative, where C is the initial purchase cost for each device, DR is the discount rate, N is the analysis period, L is the lifespan of the device, and H is the number of repurchases occurred during the analysis period.

$$SV = -\frac{C}{(1+DR)^N} * \frac{L-(N-H*L)}{L} \text{ (eq. 3)}$$

47	**Cost Estimation**						
48	**Initial purchase costs ($):**	Alt A:	***1,624***	Alt B:	***1,124***	Alt C:	***1,560***
49	**Recurring annual costs ($):**						
50	(A) Annual Maintenance ($):	Alt A:	1,832	Alt B:	1,374	Alt C:	1,145
51	(B) Insurance ($):	Alt A:	343	Alt B:	343	Alt C:	0
52	(C) Gas refill/ battery recharge cost ($):	Alt A:	1,326	Alt B:	702	Alt C:	266
53	**Total recurring costs ($):**	Alt A:	***3,502***	Alt B:	***2,419***	Alt C:	***1,411***
54	**Additional purchase costs ($):**						
55	(A) Replace the device ($):	Alt A:	2,747	Alt B:	915	Alt C:	1,373
56	(B) Replace the battery ($):	Alt A:	0	Alt B:	275	Alt C:	916
57	**Total additional purchase costs ($):**	Alt A:	***2,747***	Alt B:	***1,190***	Alt C:	***2,288***
58	**Salvage Value ($):**	Alt A:	***-701***	Alt B:	***-323***	Alt C:	***-449***

NPV is then calculated for the analysis period using eq. 4. The equivalent uniform annual cost (EUAC) is also estimated to represent this NPV annually throughout the analysis period (eq. 5), where DR represents the discount rate, and N is the analysis period.

$$NPV = I + R + AP + SV \text{ (eq. 4)}$$

$$EUAC = NPV * DR * \frac{(1+DR)^N}{(1+DR)^N-1} \text{ (eq. 5)}$$

60	**Total Life Cycle Cost (LCC)**						
61	**Net present value (NPV):** The current value of a future stream of payments over the entire life of an investment discounted to the present. **Equivalent Uniform Annual Cost (EUAC):** The yearly costs of an alternative as if they occurred uniformly throughout the analysis period. *Note: Whether PV or EUAC is used, the decision supported by the analysis will be the same.						
62	**Total NPV ($):**	**Alt A:**	**$7,172**	**Alt B:**	**$4,410**	**Alt C:**	**$4,811**
63	**EUAC ($):**	**Alt A:**	**$1,566**	**Alt B:**	**$963**	**Alt C:**	**$1,051**
64	**% Difference (from Alt A)**	-	-	**Alt B:**	**-38.5%**	**Alt C:**	**-32.9%**

Emission Estimation Worksheet

In addition to calculating the life cycle cost for the three alternatives, the tool also estimates the carbon footprint per person over the analysis period. This calculation is performed in the

Emission_Estimate worksheet. The estimate is derived using the annual travel distance obtained from the analysis and the emissions rate values reported in the literature.

Emissions Estimate						
Emissions rate (g CO2/person-km)	Alt A:	90	Alt B:	21	Alt C:	15.5
Annual travel distance (mi):	Alt A:	10,000	Alt B:	10,000	Alt C:	10,000
Annual travel distance (km):	Alt A:	16093	Alt B:	16093	Alt C:	16093
Annual emissions (kg CO2/person):	Alt A:	**1448.4**	Alt B:	**338.0**	Alt C:	**249.4**
Analysis period total (kg CO2/person):	Alt A:	**7242.0**	Alt B:	**1689.8**	Alt C:	**1247.2**
% Difference (from Alt A)	-	-	Alt B:	**-76.7%**	Alt C:	**-82.8%**

This spreadsheet-based tool is developed as part of the NYC Delivery Worker Data Collection and Research project.

Updated by 8/13/2025

References:

This section provides the list of references for estimates used in the spreadsheet tool. Please note that, due to the limited availability of information on this topic, some estimates have been derived from a combination of published online articles and user-generated content.

One-time cost estimates are based on the information in the following table.

	Gas moped	**E-moped**	**UL-certified E-bike**
Device cost	•$1,500 - $3,500 on average for 50cc (Whizz 2024) •$600 - $1000 for 50cc (Amazon 2025)	$1,000 - $1,039 (Fly 2025) •Fly-10 UFO ~$1,039 •Fly-7~$1,000 •Fly 9 ~ $1,028 •2024 Fly UFO ~1,600 •$699-1,799 (local bike shop, Wilson's)	•Fly 11 pro $1,499 ($1,699 no discount) (Fly 2025) •$1,690 with $100 discount (Whizz 2025) •$2349/ $1635 uber eats (Zoomo 2025)
Additional items	$50 - $290 for a decent bike helmet (NYT 2025)	$10 - $50 for handlebar mittens (Amazon 2025)	
License and registration	$64.25 - $82.50 (depends on moped speed; higher speed, higher fee) (NYS DMV 2025)	$64.25 - $82.50 (depends on moped speed; higher speed, higher fee) (NYS DMV 2025)	N/A

*Note that Fly 10 and 7 are the most popular e-moped models based on our survey respondents. Arrow 10, Arrow 9, and Fly 11 are the most popular e-bike models based on our survey respondents, but Arrow Model 10 e-bike (and its stock battery) is not UL-certified, according to New York City's official E-Bike Trade-In Program, which explicitly lists Arrow Model9 and Model 10 e-bikes and their batteries as not certified.

Recurrent cost estimates were based on the information in the following table.

	Gas moped	E-moped	UL-certified E-bike
Additional battery	N/A	•$200 - $400 (Amazon 2025) •$559 (BTR powers 2025) (UL-certified)	•$500 (Whizz 2025) •$429 - $690 (Bigcat bikes 2025)
Additional charger	N/A	•$62 (Rev riders 2025)	•$49 (Whizz 2025) •$69 - $199 (Bigcat bikes 2025)
Annual maintenance	$200 - $600 (NYC mopeds 2025) **	$200 - $500 (Levy electric undated)	$150 - $500 (Whizz 2024)
Fuel refill/ battery charge	July 16 gas price AAA	April 2025 electricity cost	April 2025 electricity cost
Insurance	$75 - $144 per year (Progressive, Harley-Davidson 2025)	$75 - $144 per year (Progressive, Harley-Davidson 2025)	N/A

Device mileage estimates:

- Gas moped: A typical 50cc gas moped can last between 10,000 to 30,000 miles: based on multiple references, here are some examples (Ref1, Ref2, Ref3)
- E-moped estimates were based on Fly 10 UFO (one of the popular models selected by the survey respondents). The Fly 10 UFO could potentially cover 16,000 to 30,000 miles before its battery significantly loses capacity (300-500 charging cycles with a 60 V, 50 Ah lithium-ion). Here is an additional reference that highlights the life span of an e-moped/motocycle is around 2-3 years if heavily used for deliveries.
- E-bikes: 12,500–35,000 miles (Reference)

Emission rates:

- Gas mopeds have an emission rate of 90g CO_2/person-km (Reference)
- E-mopeds have an emission rate of 21g CO_2/person-km (Reference)
- E-bikes have an emission rate between 13g (Ref1) to 18g (Ref2) CO_2/person-km; for the estimation, we took the average value of 15.5g CO_2/person-km

Annual Distance Travelled Estimation:

The following information is NOT used in the cost estimation, but are presented here to provide additional references.

From the literature:

- Gas moped travel distance is estimated to be ~62 miles per day based on a 2024 report from RMI based on Mexico City data.

- Product information shows that an e-moped can travel around 55 miles per full charge, and our survey indicates an average of 1.45 charges per day.
- ECP trade-in program survey indicates that e-bike delivery workers in NYC travel an average of 20.25 miles per day based on responses from 180 participants.

	Gas moped	E-moped	UL-certified E-bike
Distance travelled per day	62 mi (RMI 2024)	55 mi per full charge (Kimo's bike 2025) * 1.45 full charges/day (our survey, 22 responses)	20.25 mi (ECP survey 2025)
# days working per week (from our survey)	5.92	5.5	5.71
Total distance estimate per year (52 weeks)	19,086 mi	22,806 mi	6,013 mi

From direct calculation based on speed:
*Lower and higher-end determined by 25 and 75 percentile, respectively
*Working hours multiplied by 70% of reported values; *assume 52 weeks
*Note that delivery workers may not always travel at the speeds listed due to city traffic

	Gas Moped	E-Moped	E-Bike
lower-end speed (mph)	20	20	15
lower-end working hours (hrs)	4.9	2.8	2.8
lower-end daily distance (miles)	98	56	42
lower-end working days	5	4	5
lower-end annual distance (miles)	**25,480**	**11,648**	**10,920**
higher-end speed (mph)	40	40	25
higher-end working hours (hrs)	7	7	5.6
higher-end daily distance (miles)	280	280	140
higher-end working days	7	7	7
higher-end annual distance (miles)	**10,1920**	**10,1920**	**50,960**
average speed (mph)	30	30	20
average working hours (hrs)	5.7	5.4	5.2
average daily distance (miles)	170.52	161.28	104.58
average working days	5.93	5.5	5.71
average annual distance (miles)	**52,582**	**46,126**	**31,052**

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