Extending Transit: Completing New York State's First and Last Mile

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Extending Transit:
Completing New York State's First and Last Mile

Final Report

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Abstract

Bicycling has the potential to increase transit ridership by extending the reach of transit—providing a viable alternative to driving for transit customers within the 1- to 3-mile catchment area around a transit stop or station. In addition, bicycles represent a tool for transit agencies to reduce demand for automobile parking at major transit facilities by replacing car trips to transit for the first and last mile. This, in turn, can offset customers' greenhouse gas emissions (GHG) resulting from automobile commutes to and from transit facilities. While there is considerable anecdotal evidence across the country to support these outcomes, there is very little quantitative data available amongst individual transit agencies and across the entire industry. Using surveys—of both transit operators and customers—this study establishes New York State's first statewide data set on active first and last mile connections with transit and identifies a series of opportunities for agencies to facilitate more active connections with transit service. In addition to establishing this statewide data set, the study includes a deep dive into two of the existing transit programs via (1) exploring the concept of rural bike transit hubs in Tompkins County and (2) discussing the opportunities for micro-mobility connections with transit through the highly successful Capital District Transportation Authority's (CDTA), Capital District Physicians' Health Plan (CDPHP) Cycle! bikeshare program. And finally, the study ends by discussing a robust set of opportunities that frame innovative strategies to accelerate the public transit/bike connection throughout New York State.

Keywords

Bicycling, first and last mile, transit, micromobility, bikeshare, electric bikes, demand management, bike hubs, infrastructure

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Acronyms and Abbreviations

BC Transit	Broome County Transit
CDPHP	Capital District Physicians' Health Plan
CDTA	Capital District Transportation Authority
Centro	Central New York Regional Transportation Authority
DCPT	Dutchess County Public Transit
FTA	Federal Transit Administration
GHG	greenhouse gas emissions
MTA	Metropolitan Transportation Authority
NFTA	Niagara Frontier Transportation Authority
NICE	Nassau Inter-County Express
NYPTA	New York Public Transit Association
RTS	Regional Transit Service
STOA	Statewide Transit Operating Assistance
TCAT	Tompkins Consolidated Area Transit
UCAT	Ulster County Area Transit
UTRC	University Transportation Research Center

Executive Summary

ES.1 Overview

Bicycling has the potential to increase transit ridership by extending the reach of transit—providing a viable alternative to driving for transit customers within the 1- to 3-mile secondary catchment area around a transit stop or station. In addition to consumer benefits, bicycle linkages with transit represent a significant carbon mitigation tool by replacing car trips. Despite this potential, little data exists regarding both the current operational practices related to first and last mile connectivity among transit providers as well as consumer preferences related to bicycling. This study develops the State's first empirical data sets on both of these issues.

ES.2 Methodology

The project includes two surveys. One provided to transit operators aimed at collecting data on operational practices related to first and last mile transportation initiatives. The second survey—called the New York Cycling Census—was a consumer-focused survey designed to gauge attitudes and preferences that compel New Yorkers to bike. In addition to the survey, the research team partnered with Capital District Transportation Authority (CDTA) and the Tompkins Consolidated Area Transit (TCAT) to conduct in-depth field studies into different infrastructure and administrative initiatives to facilitate cycling.

ES.3 Survey Findings

Table ES-1. Consumer Insights and Transit Operations–Summary of Findings

Transit Operations	Consumer Insights (NYS Cycling Census)
• Only 30% of transit agencies have bike parking at major stops/stations; most do not track utilization. • Most bus agencies (78%) have exterior (bumper-mounted) bike racks on their buses; most agencies have them installed on the majority of their fleets. • Most agencies (81%) don't collect empirical data on bike boardings on their buses. • Most agencies (69%) allow folding bikes inside passenger spaces on buses. • 54% of agencies do not have a defined e-bike policy. Of the 46% of agencies that do have policies, 61% indicated that they do not allow e-bikes onboard their transit vehicles.	• Excluding those who don't typically bike, the two biggest barriers preventing respondents from cycling are a "lack of adequate bicycle parking at transit stops/stations" (31.7%) and "lack of accommodations for bicycles onboard transit vehicles" (30.1%). • 74% of respondents indicated that "secure access bike parking (lockers, cages, etc.)" would make the decision to connect with transit easier. • 65% of respondents indicated that they would be willing to pay a nominal fee to lock their bike inside a secure (locked, secure access) bike storage unit located at or near a local transit hub.

ES.4 Field Investigations

The agency field investigations examined two separate topics in partnership with the Capital District Transportation Authority (CDTA), and Tompkins Consolidated Area Transit (TCAT). See Table ES-2 for descriptions of the investigations.

Table ES-2. Extending Transit Field Study Overviews

The development of rural bike/bike hubs in Thompkins County to facilitate bicycle connections with transit in less dense areas throughout the region.	This field study examines the possibility of an improved and increased volume of transit customers biking to transit in rural regions outside of the city of Ithaca by transforming bus stops into bike centers. For that goal, it is essential to evaluate and create different criteria to identify optimal locations that would optimize this objective. Twelve favorable bus stops scattered throughout Tompkins County were identified for potential bike hub locations. Factors such as the quantity of flag stops for each bin and bike suitability scores contributed to an overall view of ridership tendencies for the years 2019 and 2021 and facilitated the selection of these sites. These sites should be vetted by agency staff and customer stakeholders to further refine the list and identify priority locations for implementation. This data-driven identification of potential bike hubs, which is replicable in most other regions in NYS, offers an opportunity for successful bike-transit integration and optimistically aims to assist the rise of more bike-to-transit usage and the growth of the level of comfort for bike commuters in Tompkins County rural areas.
The impact of an operational subsidy for bikes onboard CDTA buses, and the regional CDPHP Cycle! bikeshare system transit and bikeshare ridership.	An operations subsidy for bikes onboard CDTA's fixed-route service buses would have very little impact on the agency's overall operating budget but could provide resources for small-scale interventions to facilitate cycling to and from transit. This might include low-cost infrastructure such as bike racks, and/or promotional materials such as a more robust website and marketing campaigns targeting safe cycling practices. Bike trips linked with bus transit do, however, present a significant and demonstrated carbon emission mitigation tool for the Capital Region. In contrast, an operations subsidy applied to bikeshare vehicles and ridership on CDTA's bikeshare system would have a very significant impact on the program's operations. Given the carbon emission mitigation potential of bikeshare trips, an operational subsidy would have a tremendous impact on the system's service delivery and growth, enabling the fleet to upgrade, expand, and diversify in terms of mode choice (e-bike, e-scooter, adaptive vehicles, etc.).

ES.5 Opportunities

Based on the findings of the surveys and field investigations, this study identifies a series of opportunities for transit agencies to facilitate active first- and last-mile connections. These include:

- Building more bike parking at transit facilities.
- Encourage active connections for customers with resources and incentives.
- Build better data systems around bicycling at transit stops.
- Embrace and accommodate e-bike mobility.
- Integrate biking and walking into agency-wide GHG reduction goals.
- Instituting an operational subsidy for bikes onboard buses and bikeshare.

1 Extending Transit (Preface)

Bicycling has the potential to increase transit ridership by extending the reach of transit—providing a viable alternative to driving for transit customers within the 1- to 3-mile secondary catchment area around a transit stop or station.[1] Electric bikes (e-bikes) can extend this range even further by reducing physical barriers to biking such as hills, distance, and exertion. In addition, bicycles represent a tool for transit agencies to reduce demand for automobile parking at major transit facilities[2] by replacing car trips to transit for the first and last mile. This in turn, can offset customers' greenhouse gas emissions (GHG) resulting from automobile travel to and from transit facilities.

There are many strategies for integrating bicycling with transit to optimize customer mobility. These include strategically placed secure bike parking and free bike racks at transit facilities; bikeshare docks and/or drop off zones located proximate to major transit facilities; farecard interoperability between bike share systems and transit; prioritized on-road bicycle facilities (bike lanes, wayfinding signage and maps), leading to transit stops and stations; and bicycle racks onboard transit vehicles.

While there is considerable anecdotal evidence across the country to support these strategies and subsequent outcomes, there is little quantitative data available amongst individual transit agencies, across the entire industry, and in particular, New York State. For example, most agencies—especially those operating within more rural geographies—do not have formal information systems in place to track and evaluate key performance indicators for bicycle integration with transit, including factors such as:

- Bicycle rack utilization onboard transit vehicles (both quantity and geocoding).
- Fixed bicycle parking utilization.
- Transit station arrival mode share.
- Offset automobile trips and subsequent GHG reductions.
- Customer satisfaction with first- and last-mile travel alternatives.

This lack of data is the result of several factors including inconsistency of data collection methodologies, competing priorities for bus operators (who typically bear the burden of tracking on-bus bike rack utilization) and institutional biases toward transit operations. In the absence of data, it is difficult for transit agencies to analyze, plan for, and prioritize investments to enhance bicycle integration solutions— especially in the context of competing operational and funding priorities within individual agencies.

1.1 New York State Transit Landscape

New York State is home to more than 130 transit systems which collectively save 1.3 billion gallons of gasoline per year.[3] With a few exceptions most of New York's Transit systems primarily focus on fixed- route bus transit with complimentary on-demand and paratransit services. According to the American Public Transportation Association, seven agencies are considered "large" with more than 2 million boardings per year prior to Covid-19. Table 1 includes these agencies as well as those with ridership at or above 1 million rides per year.

Table 1. Large NYS Transit Agencies Based on 2021 Ridership

Agency	Service Area	2021 Ridership[a]
Capital District Transportation Authority (CDTA)	Capital Region	9,906,386
Broome County Transit (BC Transit)	Broome County	994,060
Tompkins County Area Transit (TCAT)	Tompkins County	2,111,241
Metropolitan Transportation Authority (MTA)	NYC Metro	1,891,280,135
Regional Transit Service (RTS)	Rochester Metro	7,468,759
Central New York Regional Transportation Authority (Centro)	Syracuse; Oswego; Auburn; Rome; Utica	3,252,204
The Bee-Line System	Westchester County	16,641,649
Nassau Inter-County Express (NICE Bus)	Nassau County	15,437,486
Suffolk County Transit	Suffolk County	2,675,053
Transport of Rockland	Rockland County	1,305,190
Niagara Frontier Transportation Authority (NFTA)	Buffalo Metro	11,319,227

[a] Ridership" is defined by the National Transit Database (NTD) as the number of passengers who board public transportation vehicles unlinked to passenger trips.

In addition to these large systems, many of New York State's counties manage their own transit systems, such as Ulster County Area Transit (UCAT), Transit Orange, Dutchess County Public Transit (DCPT), St. Lawrence County Public Transit, and others.

This investigation focuses on transit systems with fixed-route bus services. Not surprisingly, The Metropolitan Transportation Authority (MTA) is an outlier in terms of ridership, geographic reach, and assets. The agency includes two commuter railroads—Long Island Rail Road and Metro North Railroad—along with an extensive network of local and express buses, one of the largest subway systems in the world, and nine toll-bearing bridges and tunnels. In January of 2023, the MTA released "Extending Transit's Reach," the agency's first ever strategic action plan for bicycles, pedestrians, and other micro-mobility options. In addition to a detailed analysis of transit customer patterns and operations practices, the document lays out a strategic framework for facilitating first and last mile connections. As a result of this recent planning exercise, and the unparalleled scale of the agency compared to other systems in NYS, the MTA has generally been excluded from the first and last mile transit operations data collection and analysis for the purposes of this project. The New York Cycling Census data, gathered concurrently with the operations data from public transit agencies across the State, focused on transit customer preferences as it relates to first and last mile connections but does, however, include insights gleaned from MTA customers.

2 Purpose and Vision

Every transit customer is a pedestrian at some point along their journey. Whether walking from home to the bus, or even navigating to a train platform from a park & ride, this mode is an essential part of any trip involving public transit. Beyond the transit walkshed,[4] biking and shared micro-mobility have tremendous potential to extend the reach of transit systems. Biking provides greater access to people without cars, particularly in rural areas where transit is less dense. Providing easier access to more people has the potential to increase transit ridership. This is more important than ever in light of the Covid-19 pandemic, and its impact on ridership.

In 2020, transit providers across the country experienced dramatic drops in ridership as stay-at-home orders took effect and saw only essential workers using transit systems. Ridership in some cities across the country was as low as 10 to 40% of pre-pandemic levels.[5] While transit ridership began a slow recovery following the onset of the pandemic in 2020—aided by the distribution of vaccines—by 2022 national estimates indicated ridership at approximately 62% of pre-pandemic levels.[6]

The 2020 legalization of e-bikes in New York State and subsequent growth can extend the reach of transit even further. The purpose of this research study is to establish the first data set illustrating the current status of bicycle and transit integration throughout the State. Beyond establishing and analyzing this unprecedented data set, the study aims to:

- Understand the current practice for bike/transit Integration in NYS.
- Understand barriers and motivators for active mobility and transit amongst transit customers.
- Investigate the environmental benefits of integrating active transportation and public transit.
- Identify transit operations strategies to enhance active first and last mile connectivity.

3 Project Methodology

Urban Cycling Solutions developed and distributed an operations-focused survey to transit agencies across New York State in the spring of 2022. This survey contained 31 questions focused on data collection strategies, and existing policies related to details related to bicycle integration. Specifically, the survey asked agencies to describe data collection methodologies, bicycle parking strategies, and general policies related to bicycle onboard transit. The survey was distributed with assistance from the New York Public Transit Association (NYPTA), and direct outreach to transit providers. A total of 43 agencies responded to the survey out of approximately 118 listed in the New York State Department of Transportation's directory of New York Public Transit Agencies.[7] The results were analyzed to create an aggregated statewide data set on operational practices.

Figure 1. Project Methodology Flowchart

To understand transit customer insights, Urban Cycling Solutions developed the New York Cycling Census. This online survey included 28 questions on a variety of topics pertaining to bicycling preferences, barriers, skill-level and inclinations, as well as demographic details from respondents. The survey was distributed statewide to more than 150 distinct entities including metropolitan planning organizations (MPOs), government agencies at the State, county, and local levels; tourism and economic development agencies; bike retailers; bike clubs; grassroots community bike shops; people of color, environmental justice and green groups across the State. In total, the survey received a very strong response, with 13,740 participants across all 62 counties. Following the completion of the survey in the summer of 2022, Urban Cycling Solutions partnered with the University Transportation Research Center (UTRC) at the City University of New York to assist with the analysis of the results.

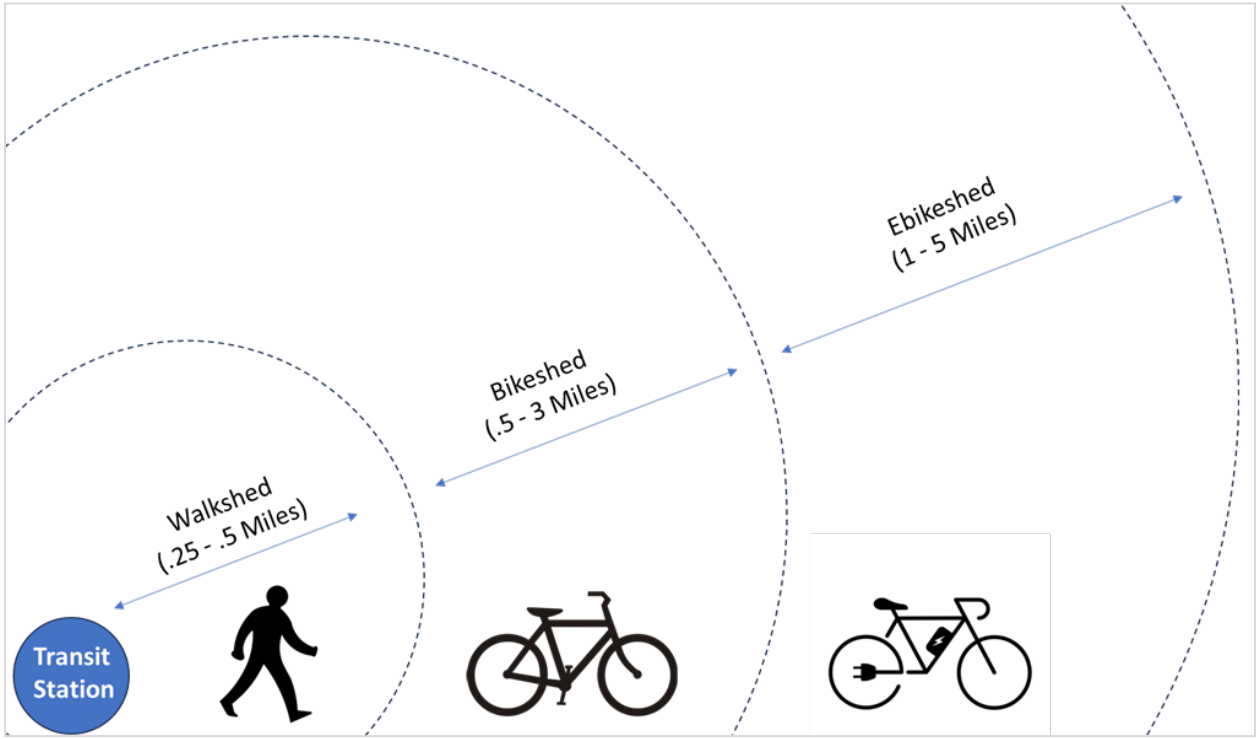
Urban Cycling Solutions used the data from both transit and Cycling Census surveys to identify opportunities for transit operators to improve active first and last mile connections. These include policy, infrastructure, and performance management tactics for agencies to consider.

In addition to the agency recommendations, Urban Cycling Solutions performed two field studies using operations data directly from specific transit providers. These field studies examine the feasibility of real-world initiatives at NYS transit agencies to specifically facilitate cycling. The research team worked with the Thompkins Area Consolidated Transit (TCAT) to investigate the potential of rural Bike hubs to facilitate biking in less dense geographies. Urban Cycling Solutions also worked with the Capital District Transportation Authority (CDTA) to explore the cost implications of various bicycle integration strategies and the impact of a hypothetical and innovative public subsidy.

4 Defining the First and Last Mile

In the context of public transportation systems, the "first and last mile" is terminology that refers to the distance between an origin point (such as home, employment center, or other community destination) and a transit stop or station. The actual distance of a first and/or last mile varies by transportation mode. The typical distance that people are willing to walk—a "walkshed"—or bike—a "bikeshed"—to and from a transit stop or station varies by agency, mode (bus, subway, commuter rail, etc.), and local station-area context. Research suggests that the ideal walking distance for transit commuters is 5 minutes which can range from a quarter to half mile from the station or stop. This is reflected in Federal Transit Administration's (FTA) policy, which establishes the transit catchment area for pedestrians at a half mile. The catchment area for bicycles is larger with FTA recommending a bikeshed of up to 3 miles.

Figure 2. Walk, Bike and E-Bike-Shed from Transit Stations



Micro-mobility—specifically shared and privately owned electric bikes (e-bikes) and electric scooters—add another dimension to the first and last mile by reducing physical barriers which may impede riding a conventional pedal-operated bicycle. A 2020 study in Norway found that people who buy an e-bike more than double their use of a bicycle for transportation-related reasons.[8] Additional studies further explore the potential impacts of e-bikes on transportation behavior. A 2017 study of e-bike consumer preferences in the Netherlands indicated that participants preferred e-bikes, because they allowed them to take advantage of the conventional benefits of cycling (such as exercise) while reducing barriers like longer travel time and physical exertion. In addition, this study noted that e-bike users were more inclined to choose longer, more comfortable routes, and this new mode is generally effective in changing perceptions of route distances that may have felt too long for a conventional pedal bike.[9] In the United States, a typical e-bike shed could be considered up to five miles.

5 Maximizing First- and Last-Mile Potential

Transit agencies can benefit greatly from enabling active—walking, biking, scooters, etc.—first and last mile connections as they bring myriad benefits both to consumers, transit agency operations, and communities throughout New York State. These include more equitable transit access and carbon emission reduction, a significant dimension with increasing urgency considering the growing impact of climate change.

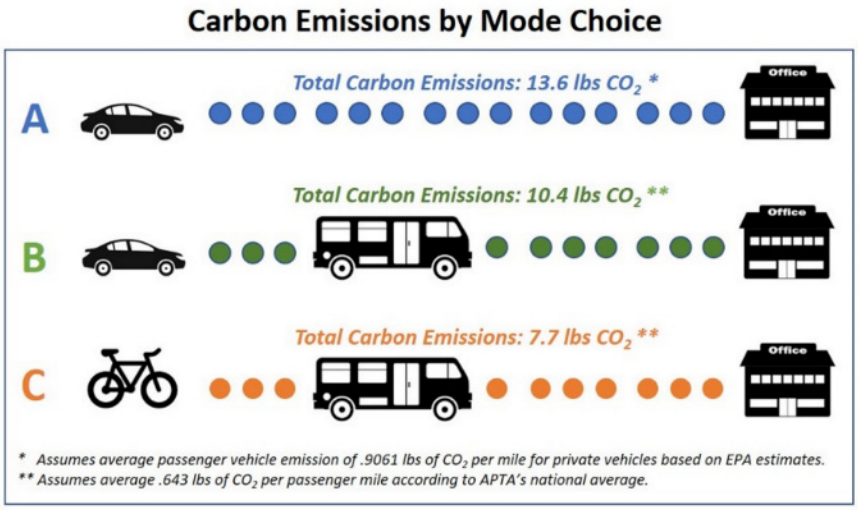
Transportation accounts for 28% of New York State's greenhouse gas emissions.[10] Car trips account for more than 65% of commuter trips in New York State, and an even higher percentage in rural areas. Combining bicycle trips with transit has the potential to reduce transportation-related greenhouse gas emissions by:

- Offsetting existing transit customer commute emissions by reducing car trips for the first and last mile to transit.
- Enabling existing car-only commuters to utilize transit by making stops and stations more accessible without the use of an automobile.

Based on the scenarios described in the figure below, combining bicycle trips with transit reduces carbon emissions by 43% compared to driving alone, and 26% compared with driving to transit. Policies, infrastructure, and education programs that facilitate bicycle integration with transit have the potential to yield significant decreases in daily commute emissions among both existing transit customers as well as commuters who would take transit if biking to transit were easier. Part of this study will include an investigation into commuter emission reductions resulting from current bicycle and transit integration activities as well as project emission mitigation in an optimal usage scenario.

Figure 3. Carbon Emissions by Mode Choice

In this diagram three subjects (A, B, and C) each travel 15 miles to work from the same neighborhood via different modes. Subject A drives the complete 15 miles; subject B drives 3 miles to the nearest bus station; and subject C bikes 3 miles to the nearest bus station. In these scenarios, subject C produces the least amount of carbon emissions.



In addition to these environmental benefits, bicycling extends the reach of transit beyond walking distance, without the need and expense of an automobile. This, in turn, provides easier access for more and new users to a wider array of public services, commercial destinations, and local/regional job opportunities.

6 Bike/Transit Integration in New York State

6.1 What Does Bike/Transit Integration Look Like in New York State?

A limited amount of data exists that specifically addresses bicycle trips to transit. There is currently no statewide database that provides consistent statistics related to the volume and frequency of cycling trips to bus transit systems across the State. Data availability varies by region and is often focused on specific trails or corridors as opposed to macroscopic measures like municipal-wide bike mode share. Similarly, there is no consistent set of statewide operational standards for transit agencies to facilitate bicycling. A statewide survey was developed to understand how individual transit agencies across the State are working to accommodate customers that arrive to transit via bicycle and other active modes. This survey contained 31 questions focused on transit operations and programs aimed at first and last mile connectivity. Regional transit agencies responded to this survey, and a list of these questions is available in appendix A. With the exception of the Metropolitan Transportation Authority, respondents included all of the other agencies considered "large"—those with more than two million boardings per year— including Capital District Transportation Authority (CDTA), Niagara Frontier Metro (NFTA), Tompkins County Area Transit (TCAT), Regional Transit Service (RTS), and Central New York Regional Transportation Authority (Centro). Major findings include:

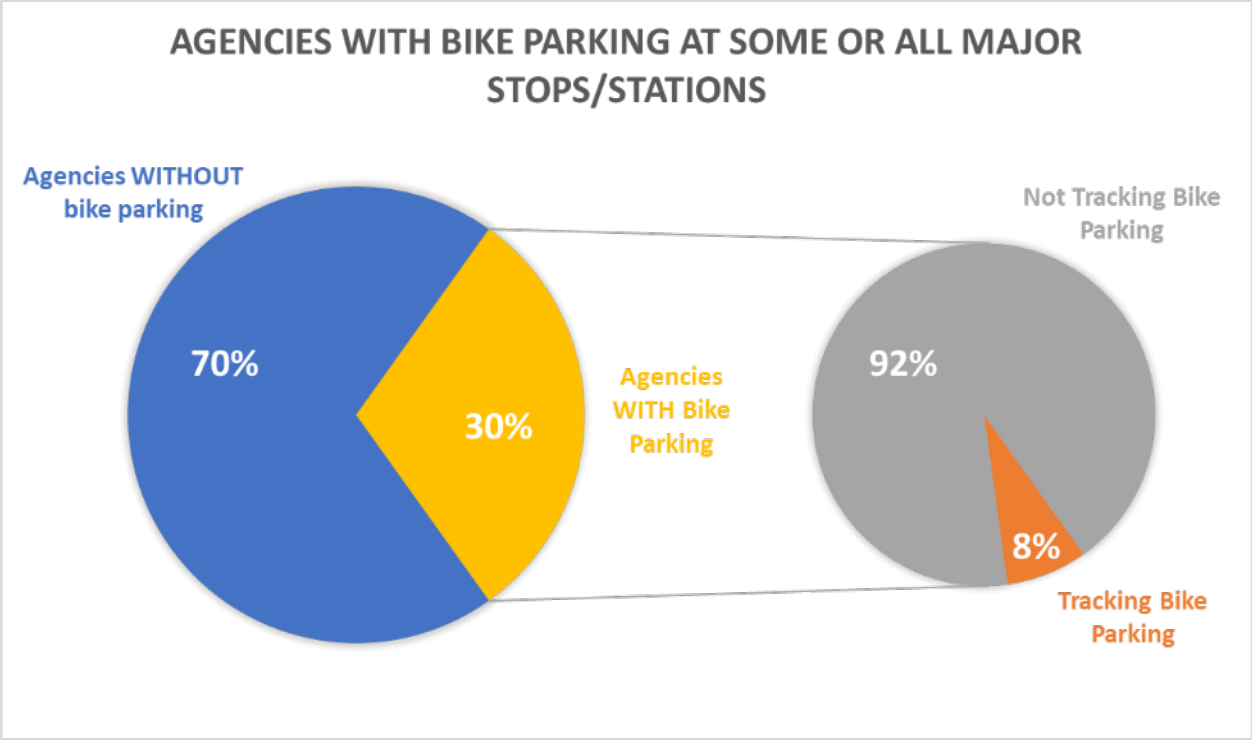
- Most transit agencies do not have bike parking at some, or all of their major transit stops. Where present, bike parking utilization typically is not actively tracked.
- Most transit agencies in New York State have exterior-mounted bike racks onboard the majority of their bus fleets. The few agencies that actively track utilization of these racks do so using manual tallies from bus operators.
- Most agencies allow folding bikes inside buses in their fully folded position.
- More than half of agency respondents do not have a defined policy related to e-bikes.
- Most transit agencies do not offer incentives encouraging customers to bike to transit or have information available online to provide education and trip planning resources.
- More than half of responding agencies indicated that they had collaborated with municipal partners to facilitate bicycling to transit.

6.2 Transit Operations Survey Findings

6.2.1 Bike Parking

Bike parking at transit stops and stations is not prioritized by agencies in New York State. The majority of transit agency respondents (70%) indicated that they do NOT have bike parking at some or all of their major stops or stations. Of the 13 agencies that indicated that they do have bike parking, only one indicated that they were actively tracking bike parking volumes.

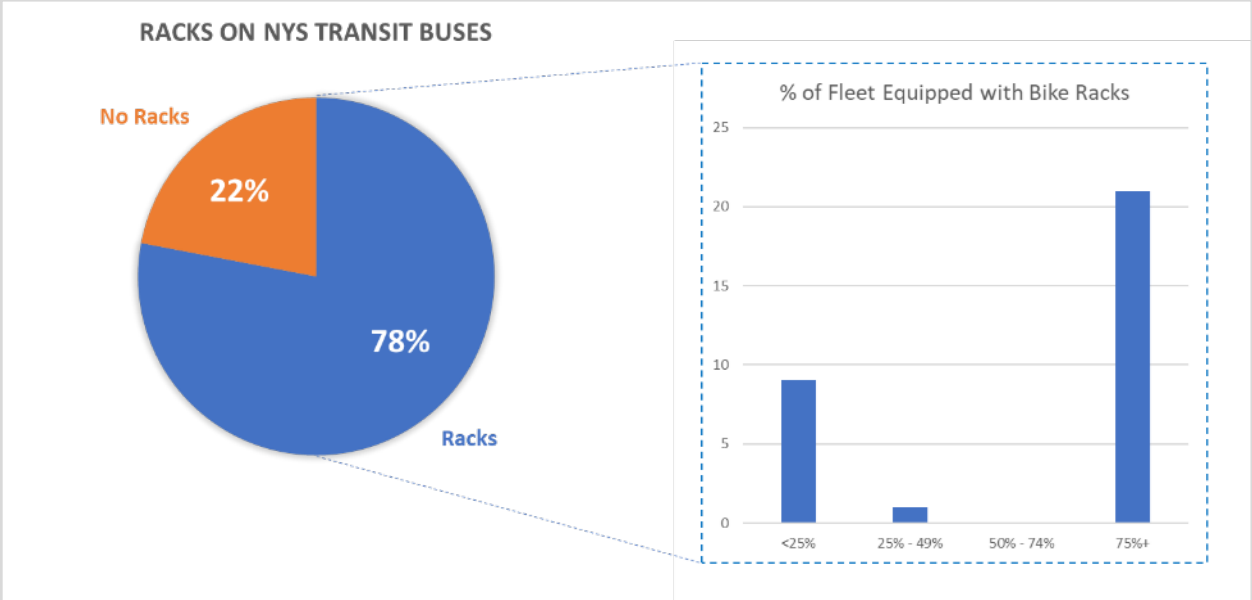
Figure 4. Statewide Bike Parking Availability and Management at Transit Facilities



6.2.2 Bike Racks on Buses

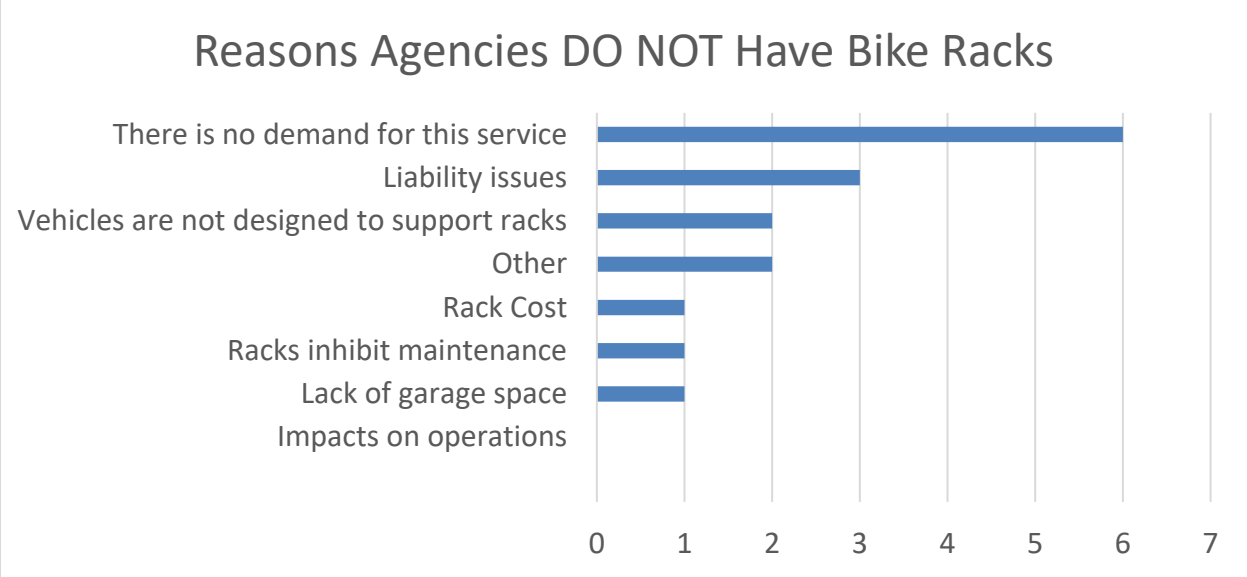
Exterior bike racks on buses are an important tool for facilitating multimodal transit connections as they enable customers to overcome geographic barriers (bridges exclusive to cars, hills, etc.) and unexpected weather conditions. The importance of bike racks on buses is underscored by the limited amount of bike parking at transit facilities as previously mentioned. The majority of responding agencies (78%) indicated that the majority—75% or more—of their bus fleets were equipped with bike racks. While most racks accommodate two bicycles, some models can accommodate up to three at a time. The vast majority of buses among responding agencies are designed to accommodate up to two bikes at any given time.

Figure 5. NYS Transit Bus Fleets Equipped with Bike Racks



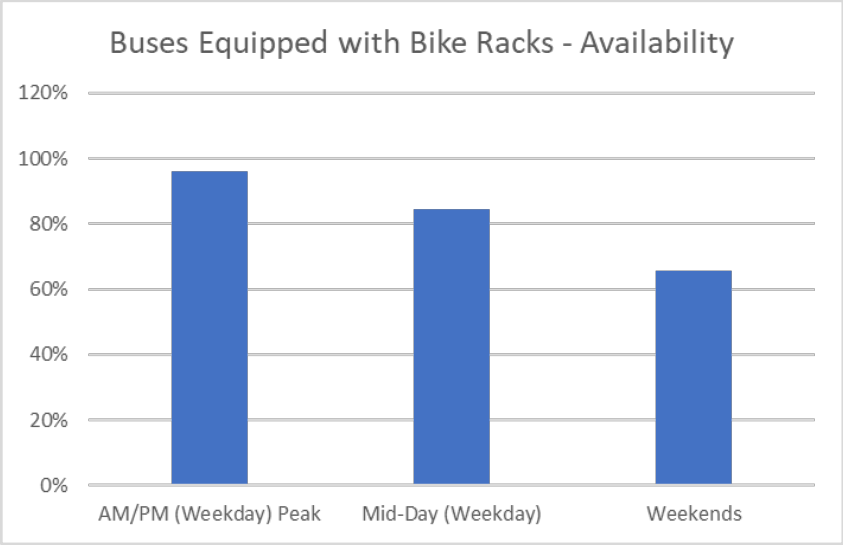
Agencies without exterior bike racks on their buses indicated that the main reason was a lack of demand for this service. Three agencies cited liability concerns—specifically, customer bodily injury resulting from rack operation and standing in front of an operating transit vehicle as well as customer property damage—while two agencies indicated that their buses were not designed to support racks. Rack cost, impediments to maintenance, and lack of garage space are not major factors preventing agencies from installing racks on buses; however, one agency did specify that access to the engine compartment was a concern. No agencies indicated that bike racks would inhibit transit operations.

Figure 6. Barriers to Bike Rack Installation at Transit Facilities



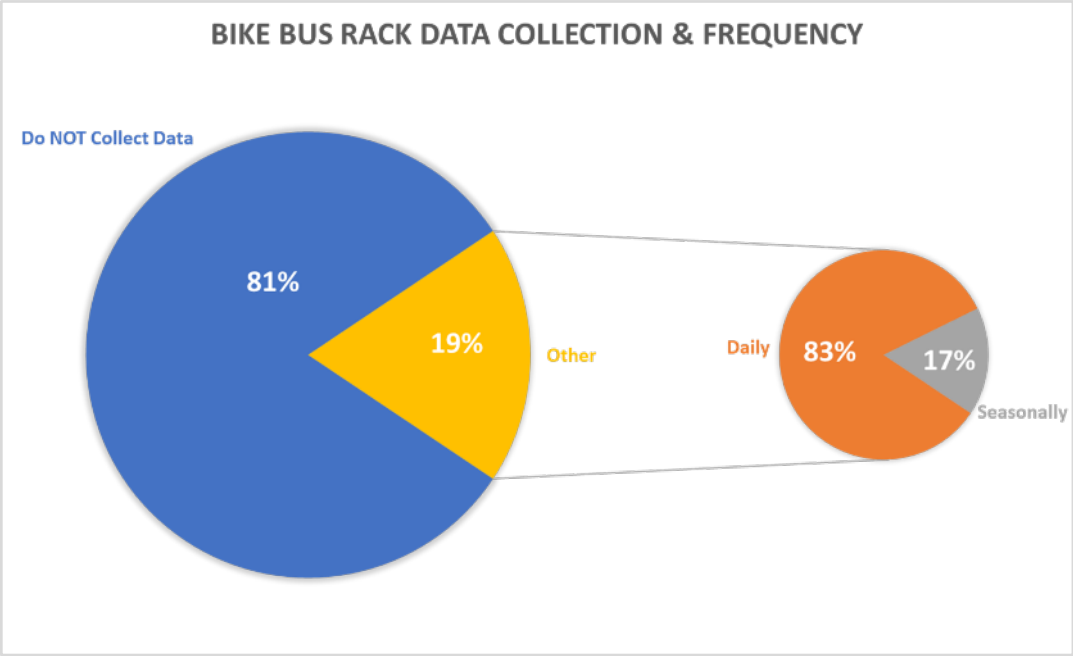
The availability of equipped buses is highest during a.m. and p.m. peak weekday travel times, and slightly lower during mid-day travel times. On weekends there is a slight drop in availability of buses with bike racks.

Figure 7. Exterior-Mounted Bike Rack Availability



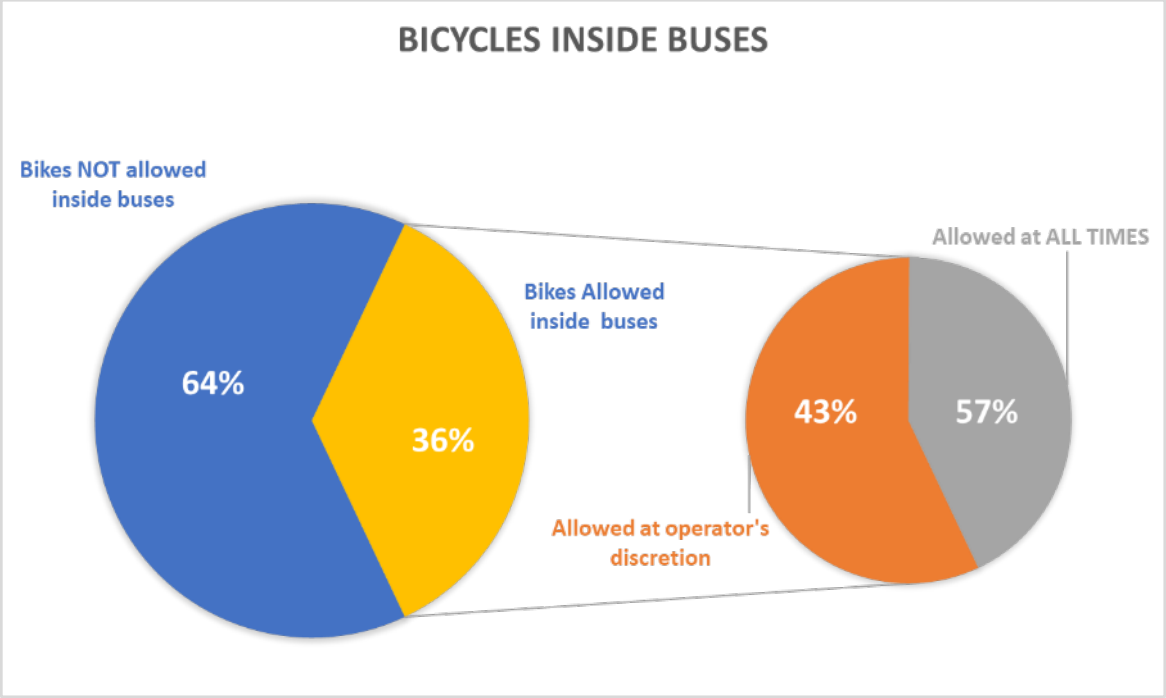
Despite the abundance of bike racks on transit buses in New York State, most agencies do not actively collect utilization data. Only six agencies (less than 20% of respondents) indicated that they monitor bike rack utilization. Of those six agencies that collect data, five agencies indicated that they collected data daily while one collected data seasonally. The majority of data was collected via manual tallies from bus operators. One agency indicated that they use their fare payment system to collect data—specifically, operators manually input each bike loading into the system, as customers board; customers are not charged an additional fee for utilizing the racks.

Figure 8. Bike Bus Rack Data Collection and Frequency



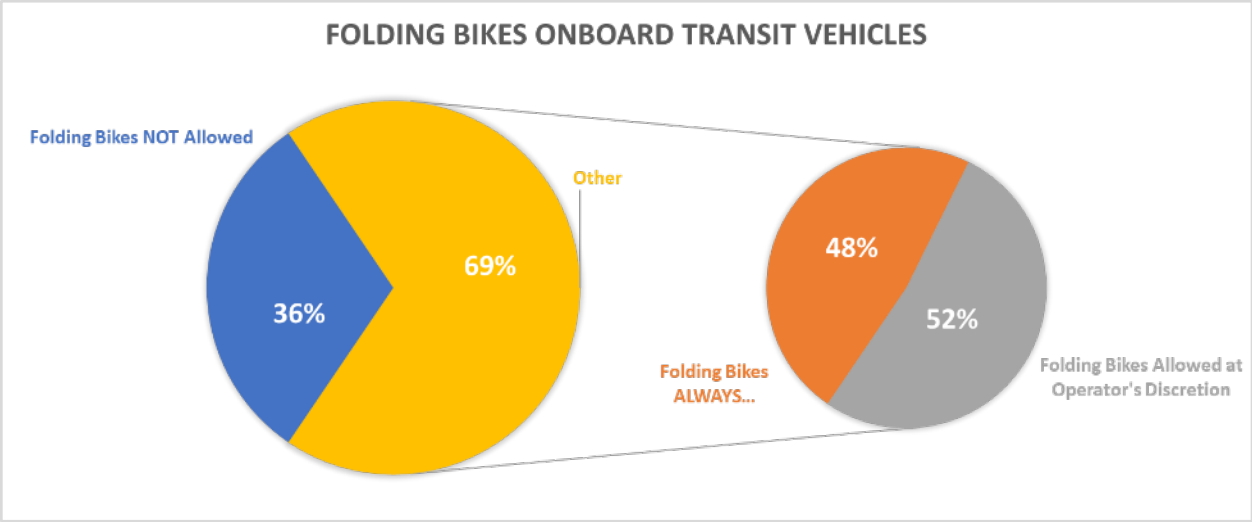
In alignment with other transit systems throughout the United States, the vast majority of transit agencies (64%) in New York State do not allow full-sized hybrid, road, or mountain bikes inside the bus. Thirty-six percent of agencies allow full-sized bikes inside the bus, with most of those agencies leaving it up to the discretion of the bus operator.

Figure 9. Bicycles Inside Transit Buses



Given their compact size, folding bikes are treated differently from regularly sized bikes onboard transit vehicles. The majority of agency respondents (69%) indicated that folding bikes were allowed onboard in their folded position and are essentially treated as luggage. Policies vary among agencies that allow folding bikes onboard, but roughly half allow folding bikes onboard at the operators' discretion, while the other half of respondents allows them at all times.

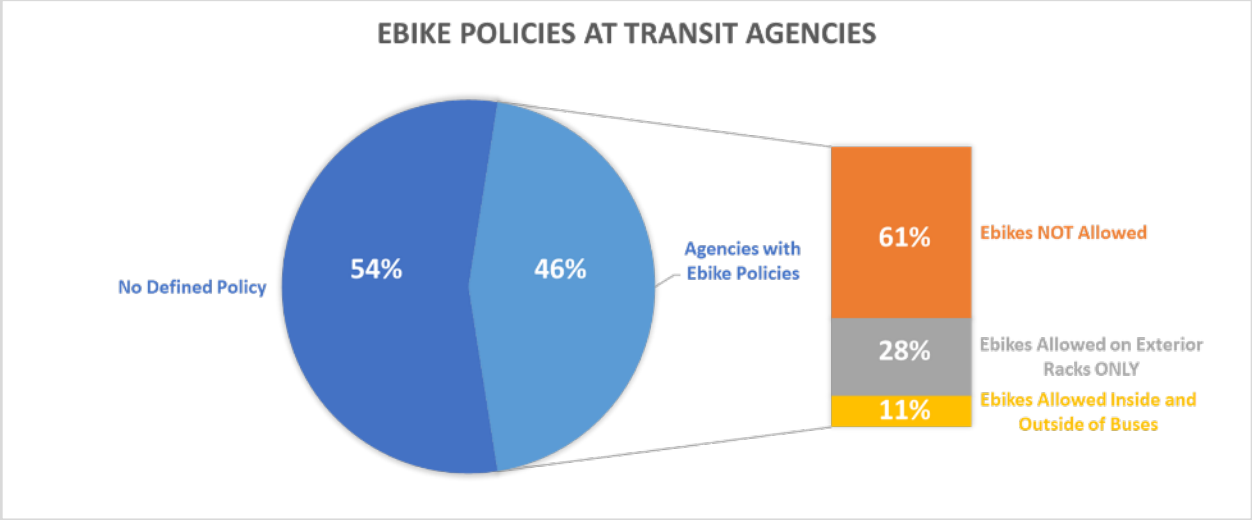
Figure 10. Folding Bikes Onboard Transit Vehicles



6.2.3 E-bike Accommodations

New York Vehicle and Traffic Law § 1242—the 2020 legislation legalized electric bikes statewide, but left regulation up to local jurisdictions. According to data from the 2022 New York Cycling Census, more than 50% of respondents indicated that they would likely bike more if they had access to an e-bike. Given the potential of e-bikes to boost bicycle ridership, and subsequent connections with transit, it is important for agencies to provide clear guidance on how e-bikes are defined and managed on and around transit. The majority of agency respondents (54%) indicated that they do not currently have a clearly defined policy for e-bikes onboard transit vehicles. Of the agencies that do have policies related to e-bikes, 61% of agencies do not allow e-bikes onboard transit vehicles at all. Battery safety was cited as a lead concern for this decision. The remaining agencies with policies that do allow e-bikes onboard have varying policies, with only 28% allowing e-bikes on the exterior bike racks, and 11% allowing them both on the exterior and interior.

Figure 11. Transit Agency E-bike Policy Adoption



6.2.4 Demand Management and Incentives

Only 12% of agencies provide any incentives to facilitate multimodal (non-car) connections with transit. These include cross-honoring fares from other transit agencies, and sponsorship of micro-mobility programs.

The majority of agency respondents indicate that their agencies have an online trip planning tool or application. Trip planners can encourage multimodal travel by incorporating additional modes. For example, including bikeshare parking and availability in trip planning applications enables transit customers to make easier multimodal decisions by seamlessly presenting information side by side with transit service information. While most responding agencies have trip planning tools, only 36% have any information available online related to bicycle access such as rules and policies, safety tips, and additional third-party resources. While some transit agencies outside the State have integrated transit fare payment with micro-mobility systems, no in-State agencies currently have the capability to allow customers to pay for multimodal trips through existing fare payment platforms.

6.2.5 Active Transportation Facilities and Collaboration

Transit agencies don't typically own the rights-of-way on which their vehicles operate, underscoring the importance of bike parking on transit property as a tool to promote and support customers who bike the first and last mile to transit (see section 8.1). Helping transit customers bike and walk to bus stops and stations requires coordination with local, county and State agencies. The majority of agency respondents (68%) indicated that they have collaborated with local municipalities, county governments, non-government organizations (NGO), or other entities to promote active first and last mile connectivity with fixed-route transit service. This collaboration takes many forms, including:

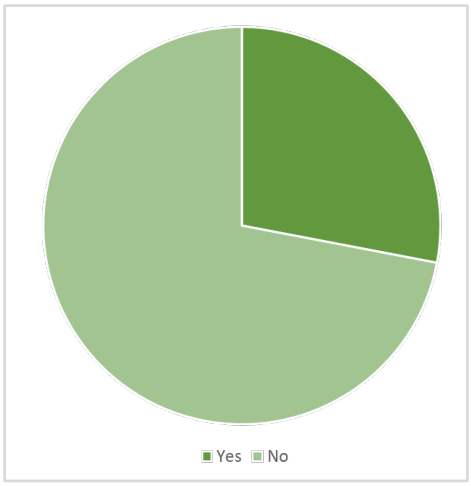
- Membership on city/county/town Active Transportation Plan Steering Committees.
- Joint grant applications for funding active transportation projects.
- Allowing micro-mobility parking collocation on transit property.

In addition to collaboration, 34% of agencies have invested in fixed active transportation facilities (trails, bike lanes, bike parking, etc.) to promote first and last mile connectivity and this includes easements for trails.

6.2.5.1 Other Transit Insights

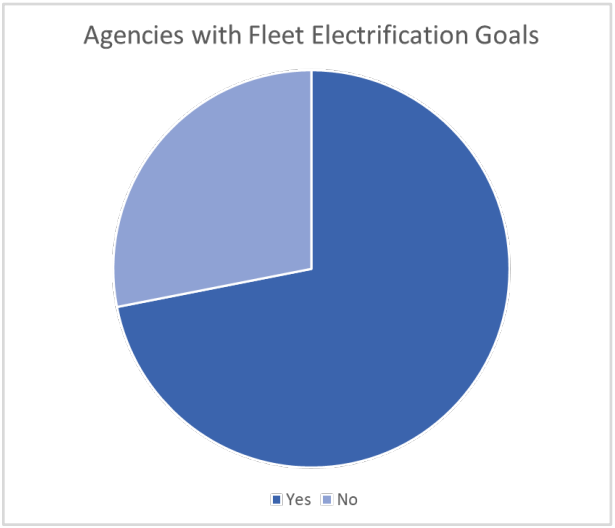
Only 15% of responding agencies have a greenhouse gas (GHG) reduction target.

Figure 12. NYS Transit Agencies with GHG Reduction Targets



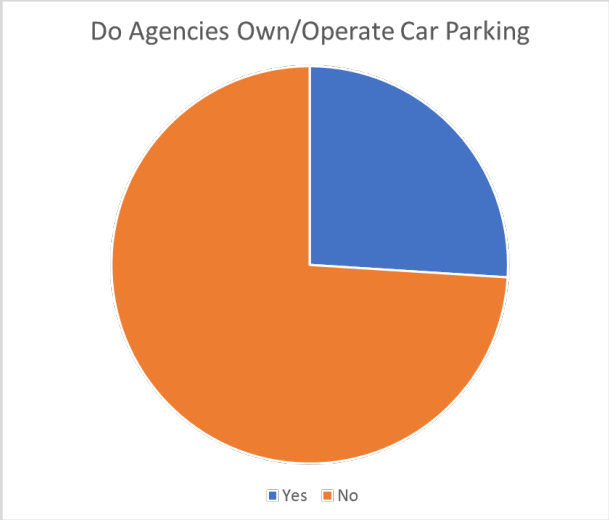
More agencies (28%) have fleet electrification goals. These are mostly driven by the Federal Transportation Administration Low or No Emission Grant program which "funding to State and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities." Between 2016 and 2023, this program has awarded $194,728,055 across nine agencies.[11]

Figure 13. Agencies with Fleet Electrification Goals



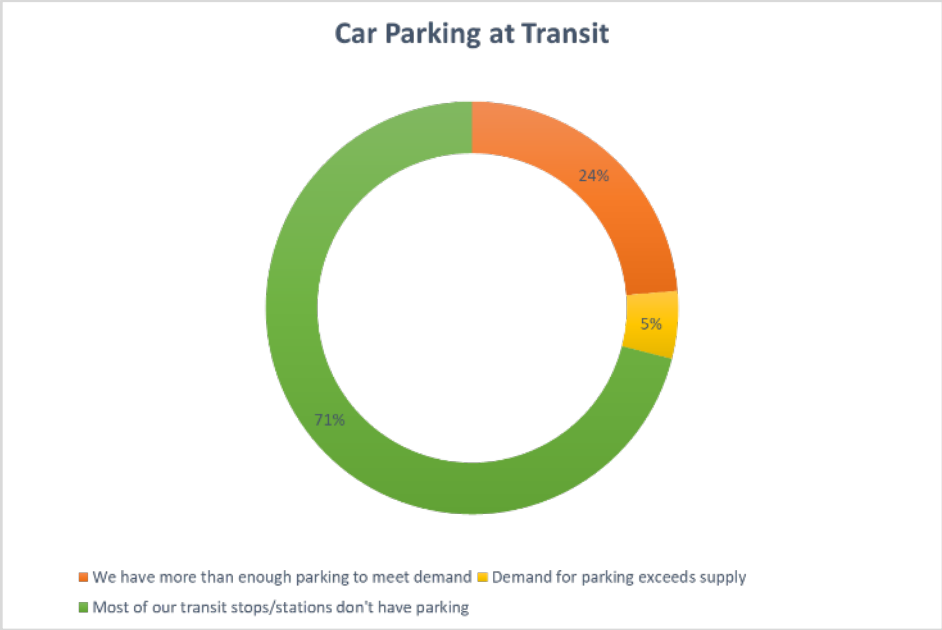
Twenty-six of the agencies own/operate car parking lots for transit customers.

Figure 14. Agencies Administering Automobile Parking for Customers



Agencies generally don't own or operate car parking systems; these are typically provided and maintained by local municipalities or county-governments depending on property ownership around the transit facility. More frequently it's the municipality or a private operation that owns and maintains parking lots and garages near transit.

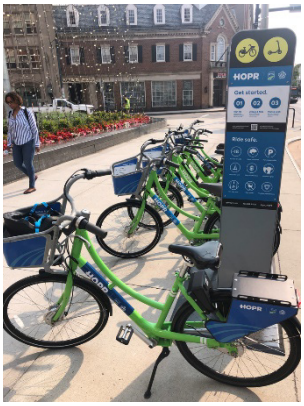
Figure 15. Car Parking at Transit



6.2.6 Other First- and Last-Mile Initiatives

In addition to this survey data, the Rochester Genesee Regional Transportation Authority (RGRTA) and the Central New York Regional Transportation Authority (Centro) provided additional details on initiatives aimed at enhancing regional first and last mile connections with transit. Both agencies indicated that they were exploring ways to integrate transit service with established or emerging micro-mobility systems as detailed below.

6.2.6.1 RGRTA | Bike/Scooter Sharing and Micro-Transit



In Rochester, NY—the largest market in the RGRTA service area—we have focused on two areas to help extend transit: bike- and scooter-sharing, and Micro-transit.

Since the program's inception in 2017 RGRTA has been an ongoing partner with the city on the community's bike-share system. Initially the agency sponsored six bike stations. In the first six years since the launch of the program, the bikeshare system averaged 30,000 rides per season. Anecdotal insights from customers, and an analysis of ridership data indicate that there is a huge appetite for this mobility option in the Rochester Metro Region, but access was restricted by a limited availability of shared vehicles. For the 2023 season, the city engaged a new vendor (Veo), bringing more vehicles, and a projected ridership of 10,000 rides per month.

In addition to supporting micro-mobility, RGRTA introduced RTS On Demand as a micro-transit option during the 2021 implementation of Reimagine RTS, the transit system redesign. While not typically included as part of active transportation plans, on demand micro-transit serves in part as a first and last mile solution for customers who need access to areas beyond the fixed-route network. Ridership in the seven on-demand zones is more than 50% higher than it was for the fixed-route service we provided in these areas prior to the redesign.

In order to facilitate seamless multimodal connections, RTS customers have the ability to plan and pay for RTS On Demand and the bike/scooter sharing program in the Transit app. Looking forward, a future goal would be to incorporate more active transportation options into the app. Additionally, RGRTA is currently working with the City of Rochester to support active transportation as a connection to public transit by installing more bus shelters and bus stop amenities.

6.2.6.2 Centro/Veo Partnership Expands E-bike/E-scooter Share in Local Municipalities

The demand for a bike/scooter share program throughout Central New York is high. To address the demand, Centro has contracted with Veo, the current provider of shared bike and scooter services in the City of Syracuse. Since entering the contract with Veo, Centro has initiated partnerships with specific municipalities across Onondaga County to expand this micro-mobility service. The first expansion phase, in 2023, allows current bike-share users to complete their journeys on one bike/scooter—rather than stopping at municipal boundary lines where City of Syracuse limits end. The expansion also includes the Onondaga Community College (OCC) campus, which means that individuals using Veo can travel from inside the city limits all the way to, and around, the OCC campus.

"We are excited to expand one of the most successful bike and scooter programs in the country to OCC," said Centro Chief Executive Officer, Brian Schultz.

Veo's bikes and scooters are not powered outside their coverage area, meaning users often have to leave the bike/scooter when they cross the city borders.

"We wanted to expand the service area to make it usable for more individuals," said Schultz. "The city could not legally expand beyond its borders, so we decided to partner with Veo to increase our community's mobility options."

Centro will continue to work with Veo and its community partners to deploy a dynamic fleet that will meet the overall demand of the community. In 2023, Centro anticipates an overall fleet of 1,000 bikes/scooters within Onondaga County, with further expansion of the program anticipated to additional Centro service locations in the future.

6.3 The Transit Customer Perspective

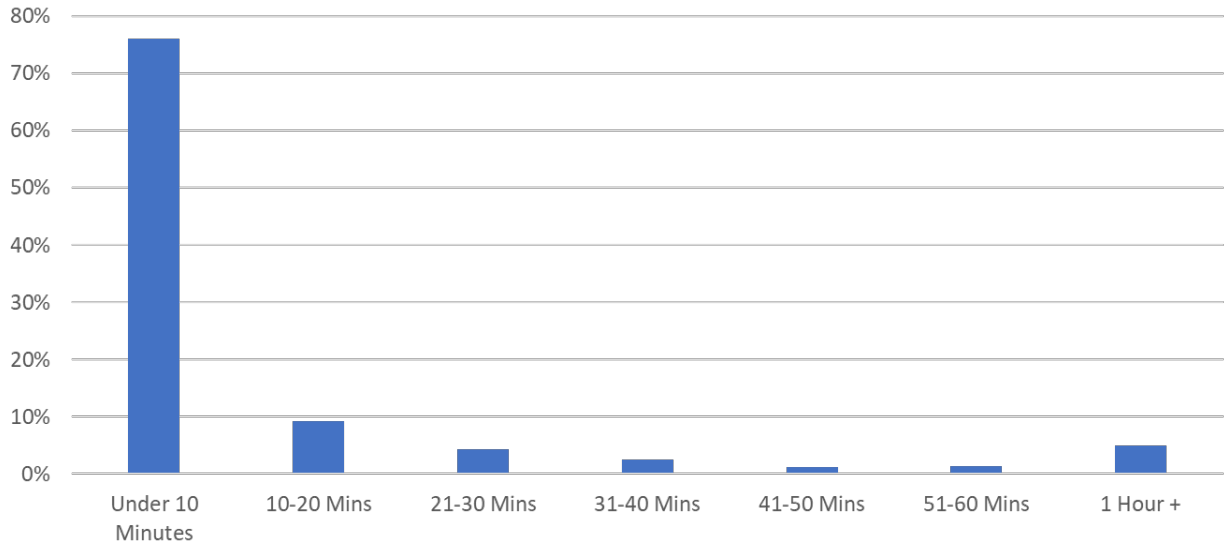
A large statewide survey, the first ever for the New York Cycling Census, was developed to better understand the perspective of transit customers who are currently or may be considering bike transportation to transit. The survey included 28 questions, including general questions on

cycling preferences, and eight questions specifically focused on integrating bicycling with transit. This survey received 13,740 responses across every county in New York State, providing a broad data set on transit conditions in different regions.

6.3.1 Respondent Snapshot

The majority of respondents (61.69%) consider themselves "enthused and confident riders"[12] who bike two to three times per week. While the data does have strong representation across gender and age groups, respondents skew toward higher-income individuals identifying as white. Most respondents (76%) estimated that it would take less than 10 minutes to bike to their nearest transit stop, while 10% indicated that they could bike to transit in 10–20 minutes.

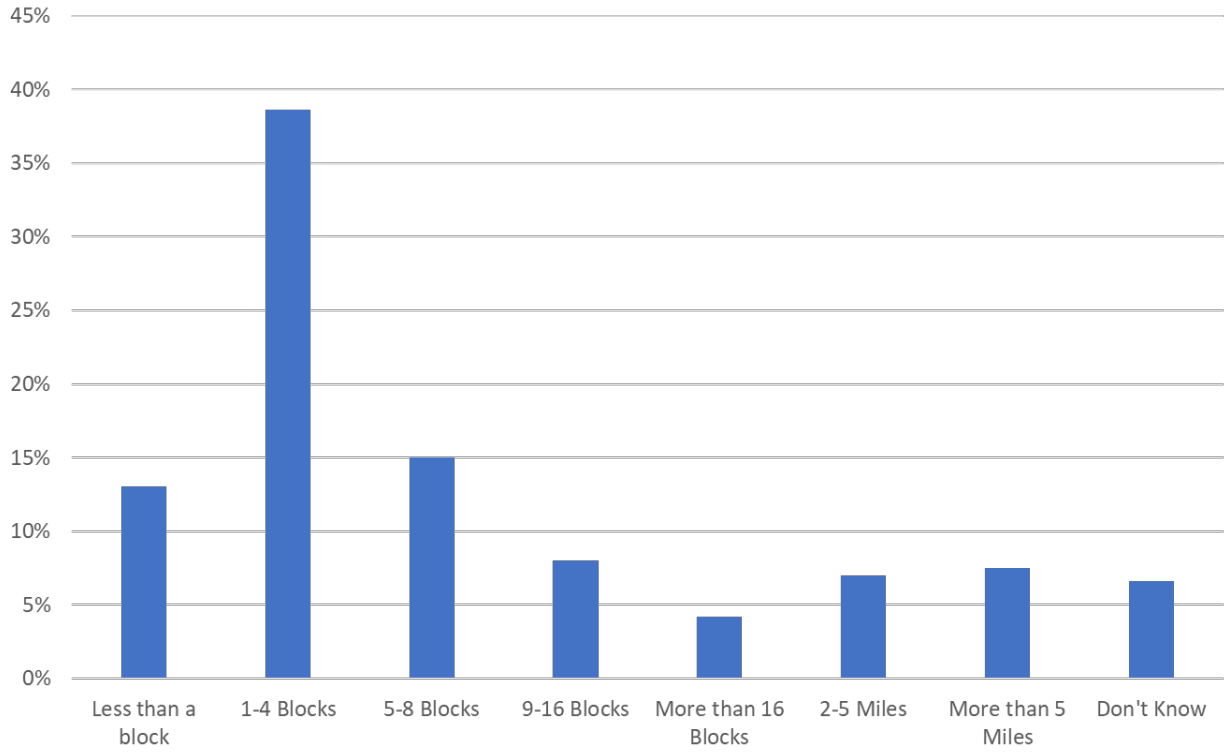
Figure 16. Perception of Travel Time on a Bike by Percentage of Respondents



More than half (66.7%) of respondents reported living within a half mile of their nearest transit stop, with 8% estimating that they live between one-half mile and a mile away from a transit stop.

One quarter (25.3%) of respondents reported living more than a mile away from transit.

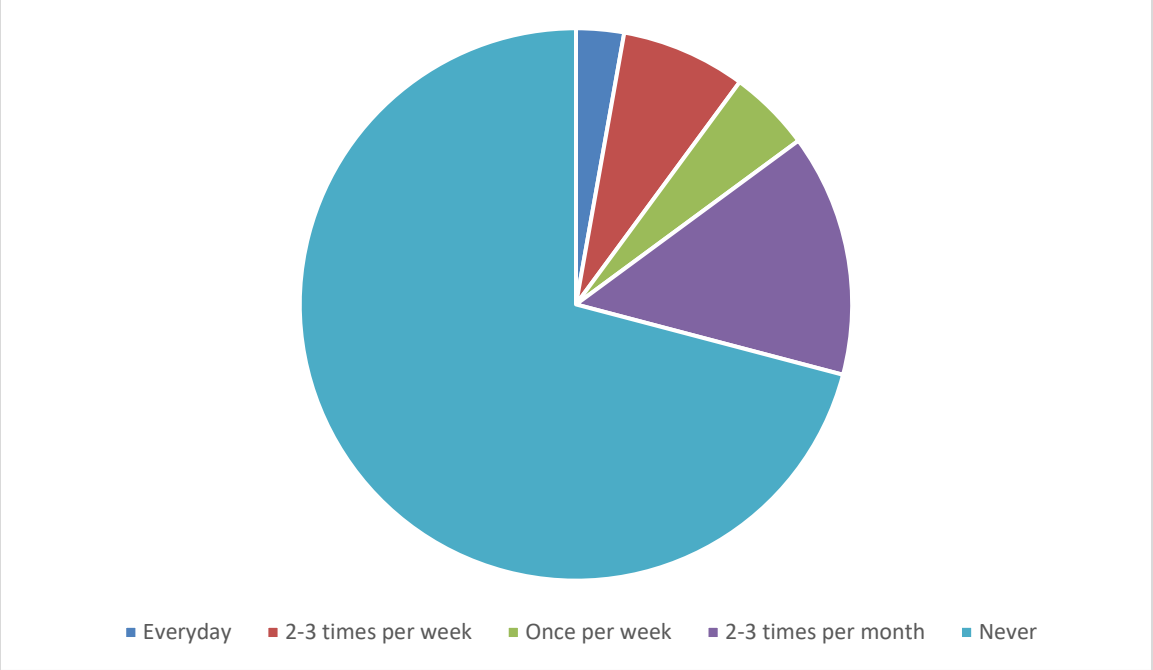
Figure 17. Distance from Transit by Percentage of Respondents



6.3.2 Frequency and Trip Purpose

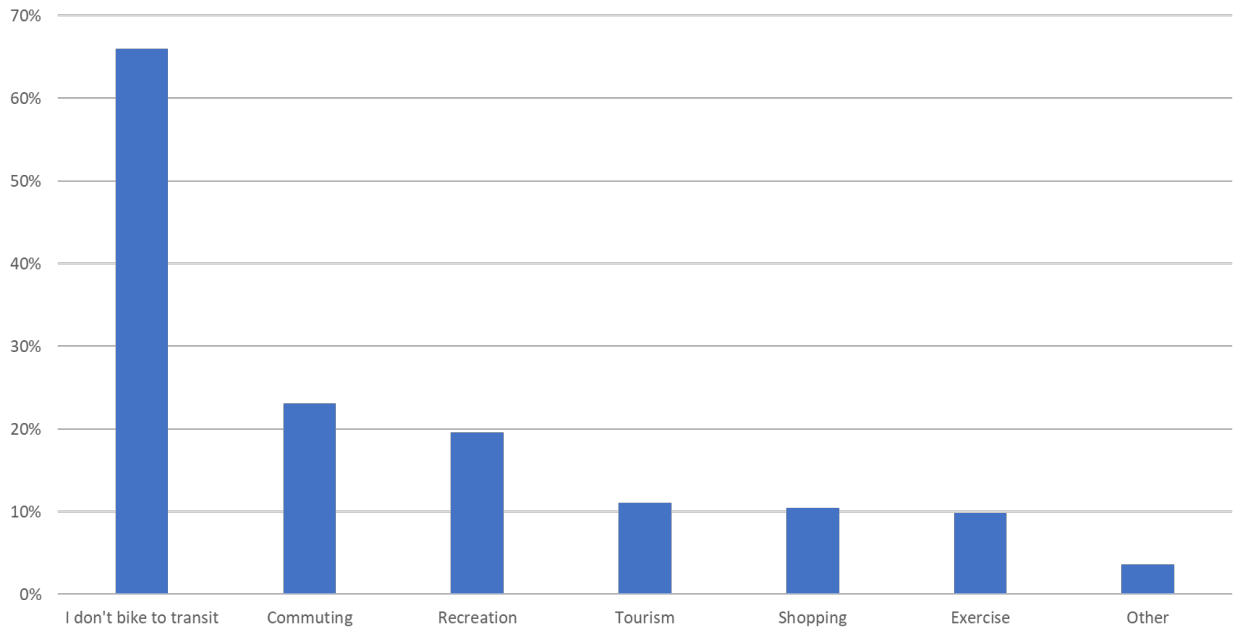
Despite this reported proximity, bicycling to transit is not pervasive among respondents. The majority (70.9%) of respondents indicated that they "Never" bike to transit, while 14.2% of respondents reported biking to transit two to three times per month, and 14.9% bike to transit more frequently.

Figure 18. Biking to Transit Frequency



For those that do bike to connect with transit, respondents indicated that "commuting" and "recreation" were the two main purposes for these multimodal trips, with 23.1% and 19.1% respectively.

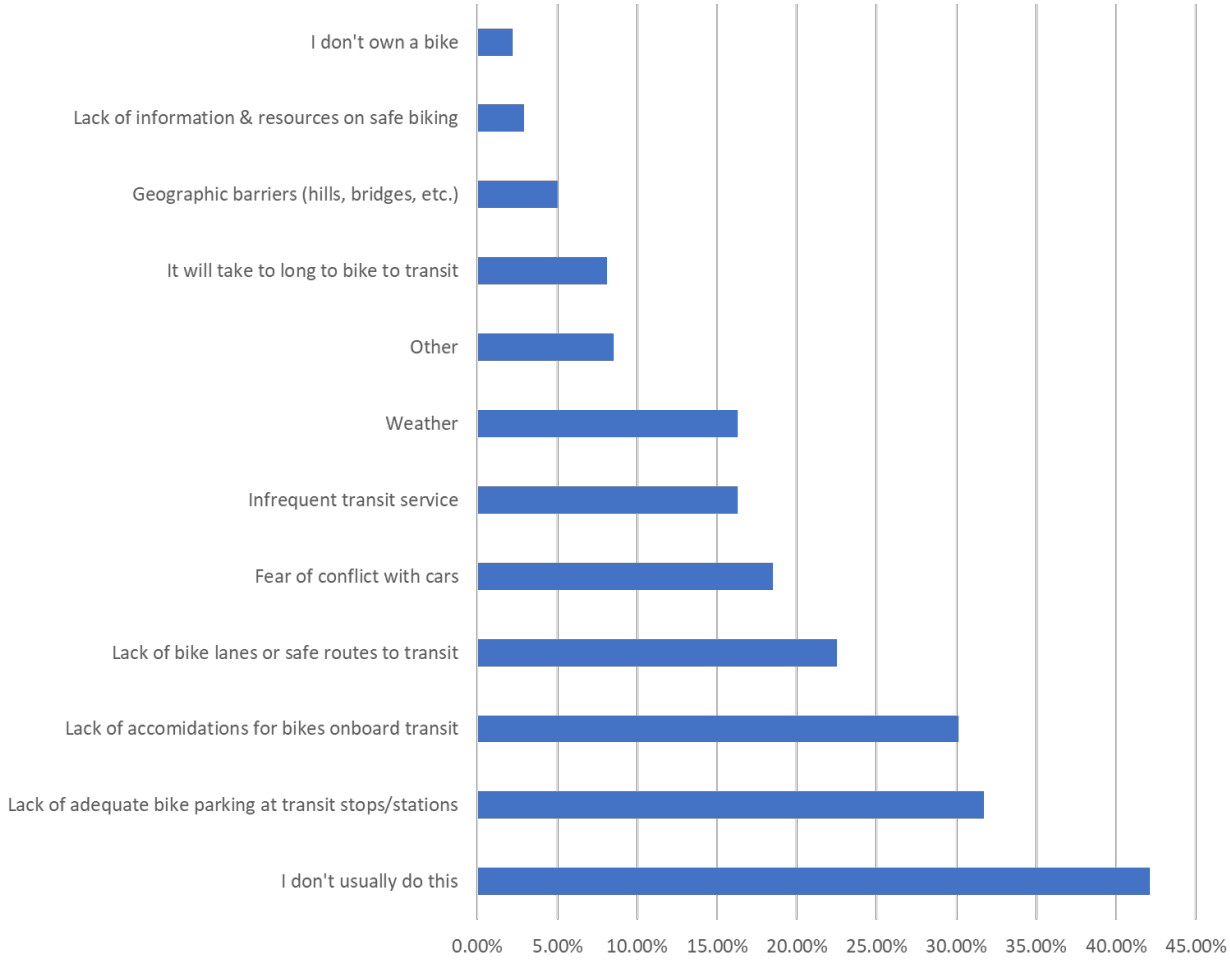
Figure 19. Reasons for Biking to Transit by Percentage of Respondents



6.3.3 Barriers to Bike Transit Integration

Excluding respondents who indicated that they don't typically bike to transit, the two biggest barriers preventing respondents from cycling are a "lack of adequate bicycle parking at transit stops/stations" and "lack of accommodations for bicycles onboard transit vehicles," garnering 31.7% and 30.1% of responses, respectively. Respondents indicating that "lack of safe routes to transit" was a barrier came to 22.5% while fear of conflicts with cars represented 18.5% of responses. "Weather" and "infrequent" transit service both individually garnered 16.3% of responses respectively.

Figure 20. Barriers to Biking to Transit by Percent of Respondents



6.3.4 Bike Rack Availability

While 30.1% of respondents indicated that lack of accommodations for bicycles onboard transit was a barrier to bicycling, the majority of transit systems in NYS have bike racks onboard buses to enable bikes to be mounted on the buses' exteriors (see section 6.2.2). This enables transit customers to bring their bikes on board buses without taking up passenger space inside the vehicle. Most of these racks can accommodate two bicycles at a time, which can create a barrier for some cyclists if they encounter a bus with both rack positions in use, and no electronic/mobile notification for subsequent bus rack availability. Despite this perceived risk, lack of bike-rack availability on buses does not appear to be an issue in New York State. Excluding those living in areas with transit systems that do not include bike racks on the majority of their bus fleets—such as New York City residents—nearly 82% of respondents indicated that they have never been unable to load their bikes on buses because of a lack of availability (full racks).

6.3.5 First- and Last-Mile Transit Amenities

Nearly three quarters (74%) of respondents indicated that "secure access bike parking (lockers, cages, etc.)" would make the decision to connect with transit easier. Underscoring this point, and highlighting an opportunity for innovation in the future, 65% of respondents indicated that they would be willing to pay a nominal fee to lock their bike inside a secure (locked, secure access) bike storage unit located at or near a local transit hub. Additionally, 52.4% of respondents report that "bike racks for free bike parking" would help facilitate their decision to connect their bike to transit. "Bike repair services" and "personal lockers for gear/clothing," respectively, received 29.5% and 28.4% of responses.

Figure 21. Desired Amenities by Percentage of Respondents

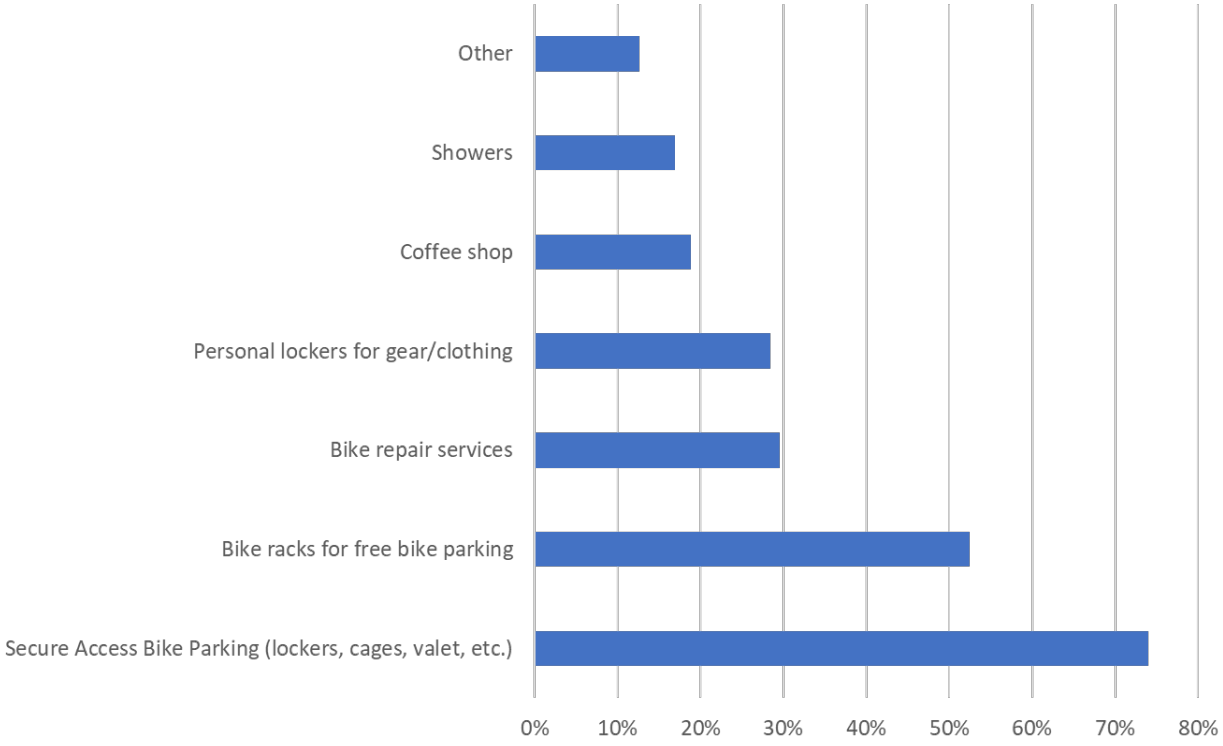
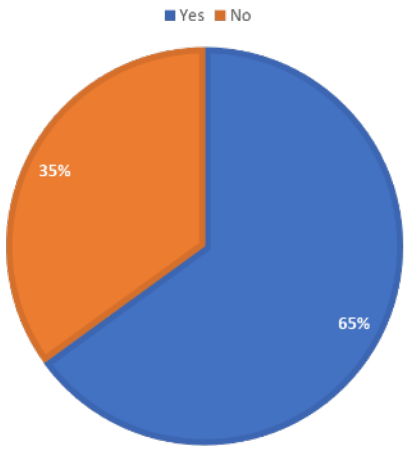


Figure 22. Customer Willingness to Pay for Secure Bike Parking



7 Field Investigations

In addition to the surveys in the previous section, this study included data development and analysis from two field investigations. These investigations leveraged agency-specific data to evaluate various opportunities for transit to maximize the potential of first- and last-mile connections for customers. The field investigations in this study explore two specific and separate operations and administrative issues for transit agencies related to bicycle integration. Beyond data from the transit survey detailed in section 6.2 these field investigations leveraged additional data obtained from TCAT to investigate rural bike access to transit, as well as financial and ridership data from CDTA to perform a cost analysis of operations subsidies for bike integration with transit service as summarized below:

1. **How can transit agencies facilitate bicycle connections for customers in more rural areas?** Many New York State transit agencies operate in less dense suburban or rural geographies. Even agencies serving major metropolitan regions extend their service to more sprawled areas with less population density and stop frequency. In addition to consolidating low-ridership volume stops, transit agencies can also serve as a conduit for bike tourism by leveraging a hub model for rural biking to connect transit customers with New York State's regional and State trail networks.[13]
2. **Can transit operations subsidies be applied to bicycle integration**? While small compared to expenses like rolling stock procurement, personnel, and other costs, facilitating bicycle connections with transit comes at a cost to agencies. Onboard bike racks, parking, and technology solutions all require capital for installation and ongoing maintenance.

7.1 Rural Bike Hubs

7.1.1 Tompkins Area Consolidated Transit Profile

Tompkins Area Consolidated Transit (TCAT) is the primary transit provider in Tompkins County with a fleet of roughly 55 clean diesel and battery-electric buses. In 2022 TCAT provided approximately 3 million rides equivalent to 1.5 million miles. In addition to fixed-route service TCAT also contracts with Gadabout Transportation to provide ADA Complementary Paratransit service.[14] The agency has a $19 million operating budget.

7.1.2 Field-Study Overview

The purpose of this field study is to encourage bike usage in rural areas by improving and allocating new bikes-to-transit integration. One of the ways of encouraging this integration is through improving existing rural bus stop locations that could accommodate newly constructed bike hubs outside of the city of Ithaca in Tompkins County. These facilities could provide amenities for bike users such as bike parking,

servicing, renting, etc., that could potentially encourage bike riders, in addition to regular bus riders, to use transit in their travels and, in turn, potentially increase or improve service areas around these hubs. To achieve this, establishing criteria for site selections is essential in order to maximize the capability for bicycling-to-transit ridership (for instance, considering bike suitability of nearby roads and bus ridership in the area). Based on these factors, sites were selected for potential bike hub locations. Along with the selection a prospective design and cost estimate was prepared.

7.1.3 Field-Study Methodology

The identification of rural bike hub locations requires the analysis of various data sets including:

- Bus flag stops on routes: 20, 21, 37, 40, 43, 52 and 67.
- The bike suitability map developed by Ithaca-Tompkins County Transportation Council (ITCTC)—the regional MPO—which illustrate which roadways are more likely to support cycling.
- Low-income household locations.
- Existing multi-use bike trail locations.

These data sets were consolidated into the maps below for further analysis.

Figure 23. Transit Bus Stops in Relation to Low-Income Housing

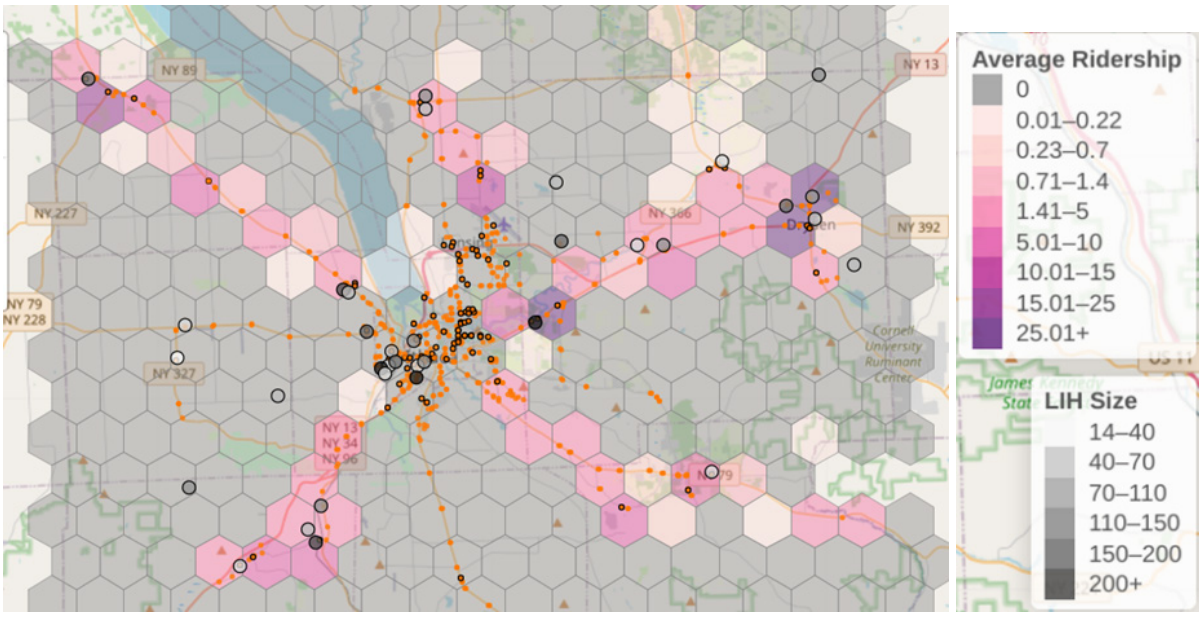
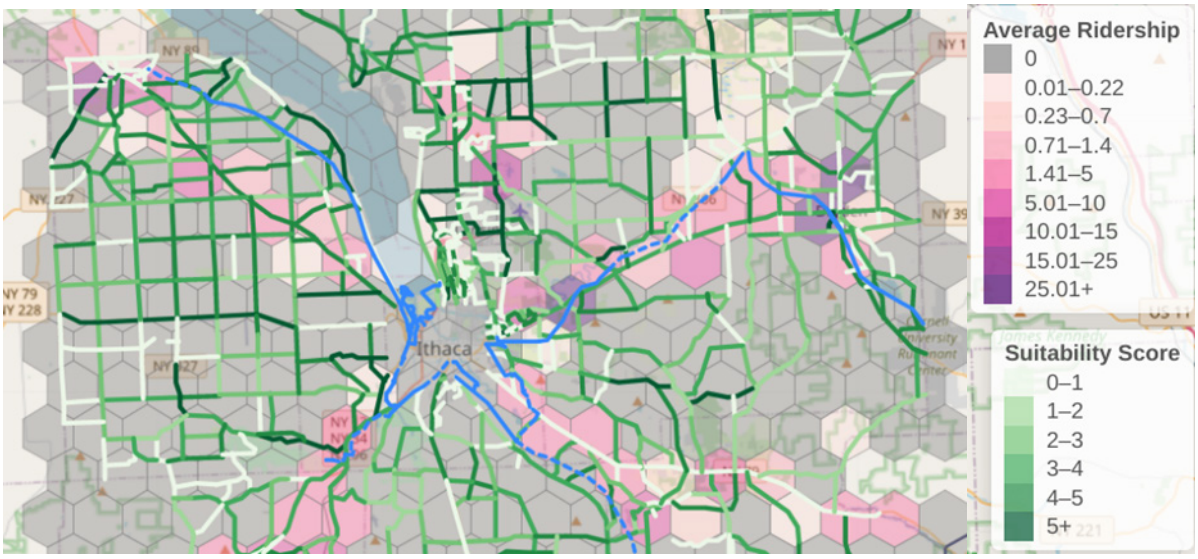


Figure 24. Bike Suitability in Relation to Transit Ridership



7.1.4 Hex Binning Flag Stops

In order to identify probable bus stops candidates for bike hubs, the research team needed to group together arbitrary bus flag stops and associate them with the nearest station. For this study, flag stops were clustered in hexagonal containers symmetrically gridded covering the entire Tompkins County. This kind of tessellation or tiling is called “hex binning,” and can be applied to any agency using flag stops in rural areas to aggregate boardings.

There are many reasons for using hexes. Hexagonal tiling is the most efficient way of dividing a surface into regions of equal sizes with the least total perimeter. It is also a popular way of representing a density map. For our intents, it has the properties to accurately cluster flag-stop locations and help identify bus ridership hotspots. Moreover, it serves as a tidy heat map illustration.

Different hexagonal heights were experimented for this grouping. Smaller hex areas gave greater spatial resolution for the density of ridership for a specific bus stop location in key bus routes prioritized by TCAT. However, for this investigation, having more evenly spaced potential bike hubs sites were preferred.

A typical “bike-shed” encompasses a 1- to 3-mile radius from a transit stop. A study indicated that the distance between how far a bike rider can ride before getting on a bus is 1 mile. (For walking, the average walking distance to a bus stop is in the range of 0.25 to 0.5 miles.) A hexagon radius of 1 mile will be

able to capture bike riders who might integrate their commute with public transit. Thus, a hexagon height of 2 miles (1 mile radius) was chosen as the ideal distance for the binning.

Hexagonal tilings were generated using a relational database management system software RDBMS called PostgresQL over Tompkins County boundaries. A heatmap was generated by accumulating flag stops within each hexagon bin, and later pictured (see Figure23 and 24) on a web application containing this plot.

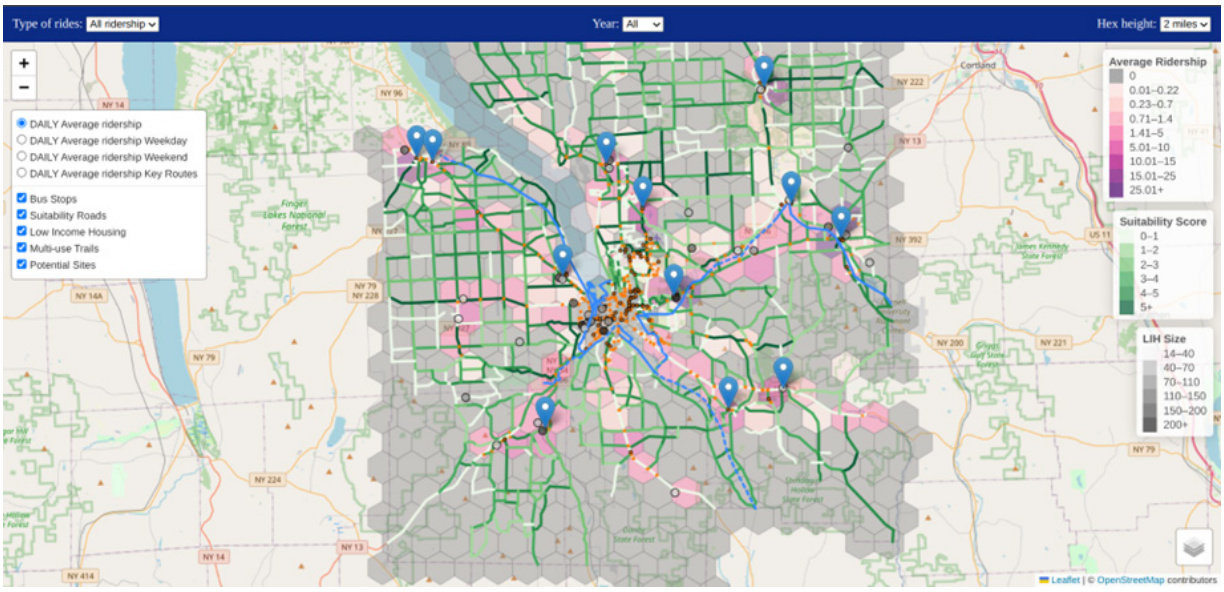
7.1.5 Identifying Potential Bike Hub Locations

There were many different factors to consider for choosing potential sites (in no specific order):

- Proximity to low-income housing.
- Proximity to multi-use bike trails.
- Average bus ridership in the area.
- Located on routes serving less densely populated areas including 20, 21, 37, 40, 43, 52 and 67.
- Bike suitability of nearby roads.
- Sheltered or unsheltered bus stops.
- If there are multiple potential locations per spatial (hexagonal) bin then a tie-break in favor of proximity to low-income housing and/or bike suitability of the road on which the bus stop is located.

Moreover, to smooth out the selection process, a dynamic interactive map plot was created. This map facilitated the discovery of bus stops in proximity to above-mentioned factors and allowed for swift exchange of information between TCAT, UCS, and the University Transportation Research Center at the City University of New York.

Figure 25. Proposed Rural Bike Hub Locations



All these criteria together contributed to designating potential bike hubs in rural areas of Tompkins County. However, the average bus ridership is one of the main factors in consideration as all bus riders have potential to use bike hubs with better bike-transit integration. Also, the higher the density of bus ridership, the more likely a potential bike hub will be successful.

The ridership data set provided contains 122 days of flag stops for different key routes that ranged from September to November of year 2019 and 2021. With this information, the average bus ridership was calculated by accumulating the number of flag stops for each individual hex bin and subsequently, divided by the number of dates for each to get the average.

Furthermore, calculations for subsets were also realized:

- Ridership for the number of days for year 2019 and 2021.
- Weekday ridership only for the year 2019, 2021, and total.
- Weekend ridership only for the year 2019, 2021, and total.

Another essential factor is to inquire if prospective bus stops incorporate shelters for riders. Stations possessing shelters are convenient to expand upon and incorporate bike hubs, since existing infrastructure requires less new construction. Therefore, stops with shelters are more highly regarded in choosing future bike hubs.

Additionally, another element taken into account is a study done by Ithaca-Tompkins County Transportation Council (ITCTC) on how suitable local roads in Tompkins are for riding bicycles. Suitability score ranges from 0 to 5 depending on the segments of the roads. The higher the number, the more suitable a particular road is for bike travel. This score would help determine if it is reasonable to provide services in areas that are not adequate for bikes to transit.

Likewise, installing bike centers in places with close proximity to housing with low-income households as well as multi-use bike trails are desirable. Bike hubs close to these areas will be expected to see increased usage and noticeable improvement of quality of life for bike-to-transit commuters.

7.2 Recommended Bike Hub Locations

Based on these factors and available data, twelve sites were identified for potential bike hub locations. These include:

Table 2. Optimal Rural Bike Hub Locations

ID	Station Name	Routes	Bike suit score >= 3	Trail <1 mi	LIH <1 mi	Shelter	Owner
2542	Overlook Apts	21	Yes	No	Yes	Yes	
2620	Trumansburg Central School *	21	No	Maybe	No	Yes	TCAT
2631	Trumansburg Park and Ride	21	Yes	No	No	Yes	
3137	Lansing Town Hall *	37	No	No	Yes	Yes	TCAT
3762	Village Solars South	37	Yes	No	No	Yes	
4315	Railroad @ Cook (Freeville)	40,43	No	Yes	No	Yes	
4362	Main @ Railroad (Groton)	40,43	No	No	Yes	Yes	
4510	Dryden Rd @ Forest Home	40,43	Yes	No	Yes	Yes	
4718	Dryden Village Main @ Library	40,43	Yes	Yes	Yes	Yes	
5759	Caroline Town Hall *	52	No	No	Yes	Yes	
5785	Brooktondale Store	52	No	No	No	Yes	
6532	Newfield Depot @ Valley Manor	67	No	No	Yes	Yes	TCAT

7.3 Rural Bike Hub Design and Cost

In order to maximize their effectiveness in attracting ridership, and facilitating bicycle connectivity, rural bike hubs need to serve a variety of functions. Specifically, these hubs need to provide locations to park bikes while supporting ridership with specific amenities and provide a sense of safety and security. An ideal rural bike hub would include:

- **Concrete Pad:** Bus pads are durable—typically concrete areas of the existing roadway surface at bus stops. These pads provide a consistent, hardened surface less prone to asphalt distortion and enable the secure installation of shelters, bus signs, and bike parking. Concrete pads also add visibility and increase bus shelter accessibility for pedestrians.
- **Bike Parking:** A group of 4 U racks can provide bike parking for up to 8 bikes. U racks are optimal because they enable parking for two bikes (one on each side) with multiple points of contact between the rack and the bike frame.
- **Canopy:** Provides weather protection for parked bicycles and gives the impression of safety.
- **Covered Shelter:** Once a bike is parked, transit customers require a waiting area for the bus, preferably with weather protection and seating that is not encumbered by parked bicycles.
- **Repair Station:** The Fixit Bike Repair Station is a metal stand that can be bolted down to pavements or other hard surfaces, and which includes all the basic tools necessary to carry out simple bike repairs and maintenance, such as changing a flat tire or adjusting brakes and derailleurs.

Figure 26. Curbside Bike Fix-it Station in Binghamton, NY

Table 3. Bike Hub Element Cost

Element	Quantity	Unit Cost	Total Cost
U-Rack	4	$200	$800
Bus Shelter	1	$5,500	$5,500
Bike Canopy	1	$4,000	$4,000
Repair Tree	1	$1,200	$1,200
8'x24' Concrete Slab	192 sqft	$28/sqft	$5,372
		Total	**16,872.00**

7.3.6 Case Study | Franklin County Bike/Bus Hubs

In collaboration with Paul Smith's College and the North Country Healthy Heart Network, the Franklin County Highway Department initiated a pilot program to design bus shelters with Living Green roofs and bike amenities.

The Town of Malone, NY has a 17% poverty rate, making public transit an important mobility option for many residents. Those living outside the Central Business District or major arterial roadways with limited or no access to a car may have difficulty accessing transit stops. The inclusion of bike racks in the design of these shelters was aimed at addressing this issue and to advance the overall "green design" approach with a more environmentally friendly structure that supports reduction car use where possible.

7.4 Field Study Review and Next Steps

This field study aims to bring the possibility of an improved and increased volume of transit customers biking to transit in rural regions outside of the city of Ithaca by transforming bus stops into bike centers. For that goal, it is essential to evaluate and create different criteria to identify optimal locations that would optimize this objective.

Twelve favorable bus stops scattered throughout Tompkins County were identified for potential bike hub locations. Factors such as the quantity of flag stops for each bin and bike suitability scores contributed to an overall view of ridership tendencies for the year 2019 and 2021 and facilitated the selection of these sites. These sites should be vetted by agency staff and customer stakeholders to further refine this list and identify priority locations for implementation.

This data-driven identification of potential bike hubs, which is replicable in most other regions in NYS, offers an opportunity for successful bike-transit integration and optimistically aims to assist the rise of more bike-to-transit usage and the growth of the level of comfort for bike commuters in Tompkins County rural areas.

7.5 Exploring Operational Subsidies for Bikes with Transit

7.5.1 CDTA Profile

The Capital District Transportation Authority (CDTA) is a multi-modal transportation provider serving Albany, Rensselaer, Saratoga, and Schenectady counties with fixed-route bus services, as well as a transportation demand management program including vanpool, carpool, and incentive-based ride sharing.[15] The agency operates a fleet of 300 vehicles across 55 routes including 241 fixed-route vehicles—71 of which are hybrid electric, 31 paratransit vehicles, 22 shuttles, and 14 coach buses. According to data from the agency operations survey (see section 6.2), approximately 92% of the agency's fleet is equipped with exterior mounted bike racks with a maximum capacity of two bikes per bus. In 2021, CDTA facilitated 9,841,472 trips, the vast majority of which were on fixed-route services, with an operating budget of $97,700,000 (an 8.3% increase from 2020). Of those trips, CDTA tallied 40,556 bike boardings in 2021.

In addition to bus transit, CDTA operates a bike share system known as CDPHP Cycle! Launching in 2017, the system doubled in size by 2020. In 2022, the system grew even further, facilitating more than 80,000 rides.[16] In 2023, the system included e-bikes into their fleet offerings.[17] In 2021, the program's operating budget was $612,000–up from $571,000 in 2020 and 2019 following a program expansion. A portion of the program is funded via sponsorship from Capital District Physicians' Health Plan (CDPHP).

7.5.2 Field Study Overview

The purpose of this field study is to explore the cost implications of various bicycle integration strategies on transit operations. In alignment with existing operations subsidies based on ridership and vehicular miles, this study will examine the feasibility and impact of a potential operation subsidy for bicycle integration strategies using New York's Statewide Transit Operating Assistance (STOA) funding formula as a model. The study also examines the climate change mitigation potential of bikes onboard CDTA buses as well as its CDPHP Cycle! micro-mobility program.

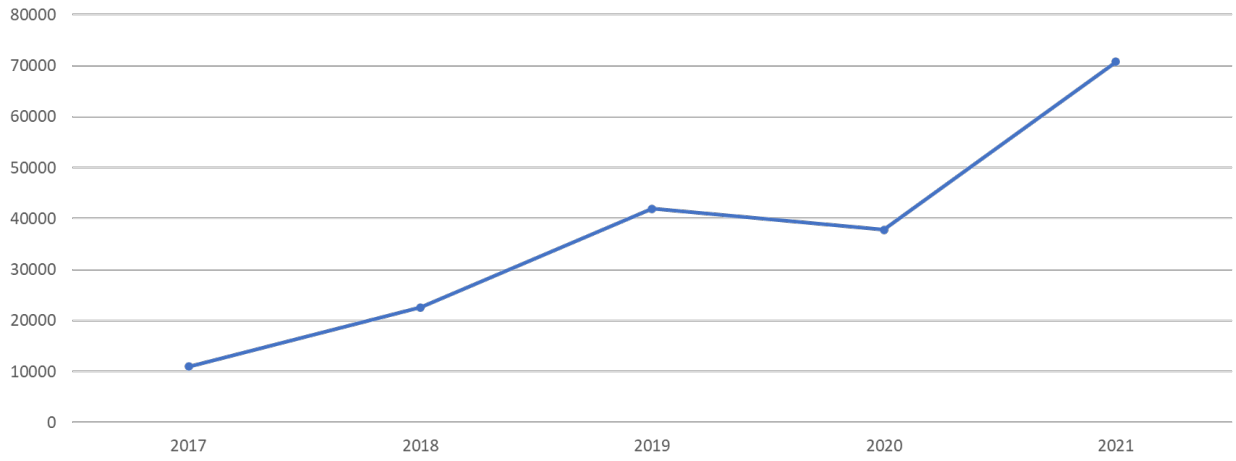
7.5.2.1 What is STOA?

Statewide Mass Transportation Operating Assistance (STOA) is an important funding stream for approximately 130 of New York State's transit systems, especially those in rural areas which tend to rely more heavily on public subsidies. According to the current funding formula, agencies are provided reimbursement based on quarterly ridership—at a rate of forty and a half cents ($0.405) per passenger and vehicular revenue miles—at a rate of sixty-nine cents ($0.69) per revenue mile. This study will use STOA as a model funding formula to analyze the cost of a subsidy for bicycles onboard transit buses in New York State.

7.5.3 Capital District Physicians' Health Plan (CDPHP) Cycle! Bikeshare Program Data

With the exception of a slight drop during 2020, ridership has grown steadily each year since the system's launch in 2017, in tandem with overall transit system growth throughout the region.

Figure 27. CDPHP Cycle! Ridership (2017–2021)



The CDPHP Cycle! program has considerable and tangible potential for carbon mitigation in the Capital Region. The mileage from these bikeshare trips represent real distances that could have otherwise been made via car. Per the chart below, between 2017 and 2021, the CDPHP Cycle! program facilitated 183,999 trips over 254,350 miles saving 365,400 pounds of carbon emissions. Per the Environmental Protection Agency's carbon equivalency calculator, this is equal to 18,650 gallons of gasoline, or 424,889 miles driven by an average gasoline-powered passenger vehicle.

Figure 28. Carbon Equivalency for CDPHP Cycle Trips 2017–2021

CDPHP Cycle's operating budget in 2019 and 2020 was $571,000 each year. In 2021 the bikeshare system's budget increased 7.2% to $612,000. This system is funded in part by sponsorship from CDPHP® a private health insurance provider. Per the table below, applying the same operational subsidies available for fixed-route transit to bikeshare would have a significant revenue impact on operations for CDTA's Cycle! Program. Using the data below, a subsidy based on the existing STOA formula would equate to nearly one quarter of the program's 2021 operating budget. This data suggests that a modest subsidy from this massive formula-driven federal funding source would play an even more significant role in the program's operating budget as the fleet and ridership continues to grow throughout the Capital Region.

Table 4. CDPHP Cycle Operations Subsidy Scenarios

Year	Bikeshare Mileage	Operations Costs	Bikeshare Ridership	Subsidy per passenger*	Subsidy per vehicle mile*	Total Subsidy	% of Operations Spending
2019	78,000	$571,000	41,000	$.405	$.69	$70,425.00	12.3%
2020	95,000	$571,000	37,784			$80,852.52	14.2%
2021	160,000	$612,000	70,718			$139,040.79	22.7%

* Uses the Statewide Transit Operating Assistance (STOA) funding formula as the basis for this analysis.[18]

7.5.3.1 Onboard Bike Rack Utilization and Subsidy Analysis

CDTA manually tracks the number of bikes that are brought onboard buses via their exterior-mounted racks. Bus operators are initially trained on the protocol for tabulating bicycle boardings during their onboarding and through intermittent refresher courses. The specific procedure involves operators hitting a button that tallies the bicycle boarding on their Operator Control Unit connected to the CDTA onboard farebox. With this data, it is possible to explore the impacts of bike boardings in relation to overall ridership, as well as the implications of extending existing operational subsidies to include bike boardings. The STOA formula provides operations subsidies per passenger and vehicle mileage. Since bike boardings have no impact on fixed-route vehicle mileage, this subsidy would not be applicable. It is however possible to examine bikes in the context of boardings. Specifically, this analysis looks at two subsidy scenarios:

- **Scenario 1: Full Passenger Subsidy**—In this scenario bike boardings are counted as whole separate boarding on the passenger vehicle. Using the STOA formula, under this scenario the agency would receive a full $.405 for each passenger boarding and an additional $.405 for each bike boarding.
- **Scenario 2: Partial Boarding Subsidy**—Because bike boardings are always accompanied with a passenger boarding (which is already accounted for in the existing passenger subsidy), the addition of a bicycle would only require a portion of a boarding subsidy. For the purpose of this analysis the partial subsidy for bike boardings is calculated at $.2025 or 50% of a passenger boarding under the STOA formula.

The table below outlines each of these scenarios and their impacts on the operations budget using CDTA ridership data from 2019 through 2021.

Table 5. CDTA Bike Boarding Operations Subsidy Scenarios

					Subsidy (Scenario 1)		**Subsidy (Scenario 2)**	
Year	Passenger Ridership	Bike boardings	% Boardings with Bikes	Bus Operations Costs	**Subsidy (Scenario 1)****	% of Operations Budget	**Subsidy (Scenario 2)****	% of Operations Budget
2019	15,686,219	57,644	0.37%	$86,100,000.00	**$23,345.82**	0.03%	**$11,672.91**	0.01%
2020	15,266,694	56,756	0.37%	$90,180,000.00	**$22,986.18**	0.03%	**$11,493.09**	0.01%
2021	9,841,472	40,556	0.41%	$97,700,000.00	**$16,425.18**	0.02%	**$8,212.59**	0.01%

* Uses the Statewide Transit Operating Assistance (STOA) funding formula as the basis for this analysis.

** Figures include additional funding only for bicycle boardings in either funding scenario. This does NOT include existing funding received for the passenger boarding.

Given the scale of CDTA's bus fleet and subsequent operations costs, both subsidy scenarios have little impact on the overall operations budget. This is not unsurprising given the low volume of bike boardings relative to overall ridership. Despite their low relative impact on the budget, these subsidies are not insignificant in relation to certain types of bike infrastructure—such as conventional bike racks, and/or incentives such as marketing materials, giveaways, or fare discounts. Despite the low impact of the bike, boardings represent a significant strategy for carbon mitigation. Per the chart below, assuming each bike boarding represents an average trip between 1 and 3 miles, the total amount of carbon emissions saved between 2019 and 2021 was equivalent to 317,790 miles driven by an average gasoline-powered passenger vehicle and 13,949 gallons of gasoline consumed.

Table 6. CDTA Bike Boarding Carbon Mitigation

Year	Bike boardings	Min Distance (1 Mile)	Min Carbon Offset (grams CO_2)*	Max Distance (3 Miles)	Max Carbon Offset (grams CO_2)*	Average Mileage	Average Carbon Reduction (grams CO_2)*
2019	57,644	57,644	23,057,600	172,932	69,172,800	**115,288**	**46,115,200**
2020	56,756	56,756	22,702,400	170,268	68,107,200	**113,512**	**45,404,800**
2021	40,556	40,556	16,222,400	121,668	48,667,200	**81,112**	**32,444,800**

* Assumes average vehicle emissions of 400 grams of CO_2 per mile per the EPA estimates.[19]

7.5.3.2 Conclusions

While an operations subsidy for bikes onboard CDTA's fixed-route service buses would have very little impact on the agency's overall operating budget, it would provide resources for small-scale interventions to facilitate cycling to and from transit. This might include low-cost infrastructure such as bike racks, and/or promotional materials such as a more robust website and marketing campaigns targeting safe cycling practices. Bike trips linked with bus transit do however present a significant, demonstrated carbon emission mitigation tool for the capital region, and align with CDTA's 2023 Climate Action Plan goals to increase transit use and implement sustainable features into new facility construction. Any effort by CDTA to encourage bicycling in tandem with transit service would provide significant environmental benefits by mitigating car trips.

In contrast, an operations subsidy applied to CDPHP Cycle's shared mobility vehicles and ridership on the bikeshare system would have a very significant impact on the program's operations. Given the demonstration carbon emission mitigation potential of bikeshare trips, an operational subsidy would have a tremendous impact on the system's service delivery and growth, enabling the fleet to upgrade, expand, and diversify in terms of mode choice (e-bike, e-scooter, adaptive vehicles, etc.). This can in turn reduce capital costs by reducing demand for car parking at transit facilities. In addition, the bikeshare program enables CDTA to plan a more efficient transit system by leveraging alternative (non-bus) modes of transportation to fill gaps on underperforming fixed routes.

8 Opportunities

8.1 Build More Bike Parking at Transit Facilities

Bike parking is the most impactful amenity transit agencies can deploy to facilitate bicycling to and from their transit stops/stations. More specifically, as described in Table 7, there are many different types of secure and free, open-air bike parking options as well as different operating models:

Table 7. Bike Parking Typologies

Bike Racks	Secure Bike Parking		
	Bike Lockers	**Bike Cages**	**Bike Garages/Valet Service**
Racks can be fixed to the ground or vertically integrated into the wall to save space. Bike racks can also be arranged as a "corral" in roadway spaces reserved for vehicular parking as pictured below. [20]  	Bike lockers are storage units that can fit a single bicycle inside. [21] 	Bike Cages are structures—either freestanding or integrated into an open space within a facility (such as an unused area underneath a stairwell).[22] 	Some of these facilities may be staffed with valet and provide bike repair services. [23] 

8.1.1 Case Study | Oonee Pod

Oonee is a Brooklyn-based startup that provides modular secure bike parking facilities. These unique shelters are designed to serve as both a safe place to store bicycles and unique public amenities with seating and green roofs. The company has also launched additional bike storage solutions, including a secure bike locker capable of storing six to 10 bikes.

8.2 Encourage Active Connections for Customers with Resources and Incentives

Providing essential infrastructure—mainly bike parking—at transit stops/stations as well as collaborating with local jurisdictions to design safe routes is an essential step in getting more transit customers to walk and/or bike to transit. These interventions require hard capital, and in some cases, ongoing operating costs. Beyond infrastructure, transit providers can regularly promote active connections with customers using a combination of marketing channels and monetary incentives. Initiatives like marketing campaigns, social media messaging, and web resource development are much lower cost than fixed infrastructure projects, while enabling electronic tracking via web analytics. These measures are also very effective in encouraging transit customers to bike by raising awareness regarding the benefits of cycling as well as available biking resources, infrastructure, and amenities.

As a baseline, agencies would benefit by maximizing the availability of information related to active first and last mile transportation on their websites. Having a central repository of information makes it easier for customers to explore options such as biking, walking, or using a scooter to get to transit.

In addition to these resources and incentives, transit agencies should work with municipalities to take advantage of New York State's recent Legislation (S.3897/A.8936-A). This new law provides increased funding for complete street projects—which includes transit stop accessibility.[24]

8.2.1 Case Study | NFTA's "Bikes on Metro" Web Page

NFTA maintains a web page dedicated to "Bikes on Metro" which includes all of the policies and assets the agency offers to facilitate bicycling. The website includes:

- A video and written instructions for loading and unloading bikes on buses using the exterior-mounted racks.

- Riding tips and best practices for locking bikes securely to a rack.
- A listing of all bike parking locations in the system including a description of the site, whether it's indoors, or the presence of a cover outdoors.

This information eliminates barriers for customers who want to bike by letting them know what to expect when they arrive at a given destination. It also minimizes fear for customers by explaining how to use bike racks on buses.

8.3 Build Better Data Systems Around Bicycling to and from Public Transportation

The lack of data and information on bicycle integration with transit systems is one of the biggest barriers to implementing strategies aimed at active first and last mile connections. As illustrated in section 6.2.2, there is very little quantitative data available on active connections with transit in New York State. Agencies across the State can capitalize on the myriad benefits of increased first and last mile transportation by better understanding existing patterns and managing performance over time. Transit agencies can take simple steps to integrate data collection into existing avenues. For example, including questions related to bicycling and walking into existing customer surveys can provide valuable insights to the agency, and solicit feedback on factors that would encourage customers to more strongly consider active first and last mile modes.

In addition to customer surveys, agencies can also integrate electronic data collection methods to provide a more accurate snapshot of bike amenity utilization. Perhaps most relevant to this study would be the use of electronic counters on exterior-mounted bike racks. Having racks that automatically count bike boardings would relieve the burden of manual tracking on bus operators and provide a more accurate indication of where these boardings are taking place. Many rack manufacturers have integrated this technology and created retrofit solutions that integrate directly with most existing automated passenger counting systems.[25]

8.4 Facilitating E-bike Mobility

Electric bike ridership and interest are growing all over New York State. According to the New York Cycling Census more than half of respondents indicated that they would likely ride more with an e-bike. Lack of knowledge about whether e-bikes are allowed can deter customers from using them for first and

last mile connections. All agencies in New York State should adopt and publicize clearly defined policies for e-bikes. Generally, agencies would benefit by maximizing the inclusion of these bikes wherever possible through “common sense” policies. Specifically, when it comes to e-bikes onboard buses, policies should:

- Align with local e-bike policies as it relates to various classes of e-bikes.
- Be defined by manufacturer-specified weight limitations on exterior bike racks.
- Prohibit riding on transit vehicles and inside station facilities (consistent with rules for a regular bike).

Many Transit agencies have chosen to prohibit e-bike battery charging on transit property to mitigate safety concerns. Agencies may consider mitigating these concerns with dedicated charging stations at safe areas of transit property, along with posted signage on using and charging legal e-bike batteries.

8.5 Integrate Biking and Walking into an Agency-Wide Greenhouse Gas Reduction Goals

Consumer reported data from the cycling census and agency data on bike boardings in relation to buses both indicate the strong carbon mitigation potential of bicycling in relation to transit. While very few agencies in NYS have a greenhouse gas emission goal—according to the transit operations survey results in section 6.2—for future climate change mitigation efforts, transit authorities should look beyond fleet measures focused on property, plant, and equipment (PP&E)[26] efficiency measures, and consider the broader benefit of their operations, specifically how customers are arriving at transit facilities. Decreasing the number of people driving to public transit can reduce an agency's overall footprint.

8.6 Instituting an Operational Subsidy for Bikes Onboard Buses and Bikeshare

Operations and maintenance-focused culture is pervasive at transit agencies of all scales in New York State and beyond, representing a significant barrier to bicycle integration. In keeping with existing subsidies for transit operations, applying similar funding formulas to first and last mile infrastructure would provide agencies with an operational incentive to invest in infrastructure, such as bike racks on buses, undercarriage bike storage for longer range buses, and bike parking at transit stations. In addition to new resources, this subsidy also represents an opportunity for transit agencies to consider micro-mobility as a new tool for addressing network gaps and bus routes with low ridership. In keeping with section 8.3, this strategy would require agencies to develop more robust information systems to track and evaluate bicycle integration on an ongoing basis beyond today’s anecdotal or

nonexistent data sets. This report provides a template for the types of data that would be required to enable such a subsidy, as well as other insights that can help hone public policy as it relates to micromobility as a complementary transit mode. Lastly, this strategy would encourage transit agencies to actively promote safe bicycle utilization among transit customers.

Since exterior-mounted bike rack capacity on buses is limited to two bikes per bus, there is a finite number of bikes that the fixed-route fleet can accommodate. Additional efforts should be made to investigate the viability of tracking the use of fixed-bike parking to enable data collection that could be applied toward a subsidy. This strategy would further encourage agencies to promote cycling the first and last mile while also mitigating potential overcrowding on bus racks.

9 Conclusion

This study revealed new insights into both the operational and policy measures transit agencies across New York State have in place to facilitate active first and last mile connectivity. Despite extremely limited utilization data on infrastructure such as bike parking and bus bike racks, survey data on transit operations reveals that many New York State transit agencies are actively engaged in efforts to support connections with transit. Likewise, there is clear demand for walking and biking transportation options.

There are clear gaps to be addressed. More consistent data collection will enable transit agencies to better plan for and support customers who wish to walk or bike to transit as well as enable transit agencies to share best practices across the State. In addition, while many transit operators report a lack of bike parking at transit stops and stations, user data from the New York Cycling Census indicates that one of the most powerful tools for facilitating bicycling within a transit authority's jurisdiction is bike parking. There is a specific appetite for secure bike storage options which provide customers with peace of mind when leaving their bike in a particular location for an extended period of time.

The climate mitigation potential of bicycling—especially in combination with transit—is undeniable. Both self-reported bike frequency data from the New York Cycling Census and micro-mobility utilization data illustrate the extensive amount of carbon emissions saved through the utilization of bicycling in lieu of car trips. The growth of e-bikes and micro-mobility across the State represents an opportunity to further expand access to bicycling for many transit customers by eliminating geographic and physical exertion barriers. Adopting clear policies in relation to e-bikes and e-scooters enables transit providers to address safety concerns related to batteries while providing clarity to transit customers. In addition to new policies and infrastructure, transit agencies can take proactive measures to facilitate seamless active first and last mile connections for transit customers using existing tools. Integrating micro-mobility availability into an agency's trip planning tool not only normalizes alternative modes but adds value to transit customer's mode choice decision-making process. Optimally, transit agencies can create an even more seamless connection for customers by working with micro-mobility operators to integrate fare payment on the same platform.

Bicycle connections with transit can also address equity in New York State's smaller towns and rural areas. Rural bike hubs—bus shelters with bike parking and other supportive amenities can not only serve to consolidate and formalize flag stop locations but can also provide a means for those with limited car access to bike-to-transit stops.

Beyond the scope of individual transit agencies, New York State could support bicycle connections with transit by expanding existing operations subsidies to include bike boardings on transit buses. This relatively small subsidy could incentivize transit agencies to invest in low-cost, high-value infrastructure to support bicycle connections such as bike parking. A further expansion of this subsidy to include micro-mobility systems—particularly those administered or sponsored by public authorities—would represent an unprecedented and innovative measure as well as provide a significant investment in the expansion of micro-mobility.

Appendix A. Agency Survey Questions

Block 2

The following survey is part of a unique opportunity for learning called "Extending Transit: Completing New York's First and Last Mile." The purpose of this study is to develop one of the first statewide datasets on bicycle integration with New York's public transit systems, and develop specific policy, infrastructure and performance management recommendations to encourage active first/last mile connections across the state. Your agency's responses to the following questions will help the research team understand operational challenges and opportunities to leverage bicycling, micromobility and other active modes to extend the reach of transit, and to increase equitable access. The survey should take approximately 10 minutes to complete, and will remain open until July 15, 2022.

The "Extending Transit" Study is administered by Urban Cycling Solutions and supported by the New York State Energy Research and Development Authority (NYSERDA). If you have any questions about this survey or the study, please contact info@urbancyclingsolutions.com.

Your agency's responses will NOT be made available to the public. *All data collected form this survey will be anonymized – with individual agency identifiers removed – to create a statewide dataset on transit policies and practices related to first and last mile connections. The research team may reach out to your agency for additional information for use in case studies. Any information on your agency's specific programs and operations methods will only be shared in the final report with the express approval and written consent of an agency's designated officer.*

Default Question Block

Name of Agency

Your Name (optional)

Your Title (optional)

Do you have designated parking for bicycles at some or all of your highest volume transit stops and stations?

- Yes
- No

Do you track the number of bicycles parked at your highest volume transit stations?

- Yes
- No

Do any of the buses in your fleet have exterior-mounted bike racks?

- Yes
- No

Approximately what percentage of your bus fleet is equipped

with these racks?

0 10 20 30 40 50 60 70 80 90 100

% of Fleet

How many bicycles can your bus-mounted bike racks accommodate?

- Maximum of two
- Maximum of three
- Other (please specify)

At what time of day do these buses with bike racks run (check all that apply)?

- AM/PM peak,
- Mid-day
- Weekends

Why does your agency not have exterior mounted racks for bicycles (select all that apply)?

- The racks are too expensive

- [ ] There is no demand for this service
- [ ] Our buses cannot support these bike racks
- [ ] These racks will inhibit our operations
- [ ] These will inhibit our maintenance procedures
- [ ] Our garages cannot accommodate the additional length of the vehicle with the rack attached
- [ ] Storing bikes on the front of operating buses presents liability issues for our agency
- [ ] Other (Please Specify)

How would exterior mounted bike racks inhibit your operations?

How will these racks inhibit your maintenance procedures?

Do you collect data on bus-mounted bike rack utilization?

- ○ Yes, we have a process for counting utilization of our bus-mounted bike racks
- ○ No we do not collect data on bike rack utilization on our buses

How frequently do you collect data on bus-mounted bike rack utilization?

- ○ Daily
- ○ Once per Quarter
- ○ Once per year
- ○ Other (please specify)

How do you collect data on bus bike rack utilization (select all that apply)?

- ☐ Manual bus operator tallies
- ☐ Automatic/digital counters
- ☐ Independent contractor counts
- ☐ Other (Please Specify)

Please describe how you collect data on bus bike rack utilization.

Do you ever allow standard sized bikes INSIDE your buses? *"Standard size" means any road, mountain or hybrid model that does not fold, and excludes Bakfiets, or other oversized cargo bikes.*

- Yes, standard sized bicycles are allowed onboard ANY TIME
- Yes, standard sized bicycles are allowed onboard but ONLY DURING NON PEAK HOURS
- Yes, standard sized bicycles are allowed onboard at the discretion of the bus operator
- No, we never allow standard-sized bikes onboard our buses

Do you ever allow **folding bikes** onboard your buses?

- Yes, folding bikes are always allowed onboard buses ANY TIME
- Yes, folding bikes are allowed onboard, but ONLY DURING NON PEAK HOURS
- Yes, folding bikes are allowed onboard, but only at the discretion of the bus operator
- No, folding bikes are not allowed onboard buses

Do you ever allow **electric** bikes onboard your buses?

- Yes, electric bikes are allowed on exterior racks but NOT inside the bus
- Yes, electric bikes are allowed on exterior racks AND inside the bus
- No electric bikes are not allowed on our buses
- We do not have a defined policy for this

Does your agency provide any incentives to facilitate multimodal (non-car) connections with transit?

- Yes (please specify)
- No

Does your agency have an online trip planning application/tool available for customers?

- Yes
- No

Does your agency have any information available online related to bicycle access including but not

limited to, rules and policies, safety tips, additional third party resources, etc.

- ○ Yes
- ○ No

Please provide a like to the webpage with this information.

Does your agency have a greenhouse gas emission reduction goal?

- ○ Yes (please specify)
- ○ No

Does your agency have a fleet electrification goal?

- ○ Yes (please Specify)
- ○ No

Are you willing to be contacted by the research team as a follow up to this survey?

- Yes
- No

Block 1

Does your agency own/operate automobile parking spaces/lots for transit customers?

- Yes
- No

What statement best describes automobile parking at your stops/stations?

- We have more than enough parking to accommodate demand
- Demand for parking exceeds supply
- Most of our transit stops/stations don't have parking

Has your agency ever collaborated with local municipalities, county governments, NGOs, or other entities to promote

active first/last mile connectivity with fixed-route transit service (excluding paratransit)?

- ○ Yes
- ○ No

Has your agency ever invested in fixed active transportation facilities (trails, bike lanes, bike parking, etc.) to promote first/last mile connectivity?

- ☐ Yes (Please specify)
- ☐ No

Please provide additional information, or links on any collaborative project/program/initiative related to active first/last mile connections.

Do you have any additional thoughts or perspectives related to active first and last mile connections with transit that you would like to share with the research team?

Endnotes

[1] A transit catchment area is defined as a transit stop/station's zone of influence; specifically as it relates to customers willingness to bike/bike to transit. https://todresources.org/wp-content/uploads/2016/06/is-a-half-mile-right.pdf

[2] According to a 2022 Central Business District Tolling Program Environmental Assessment of the ~400 commuter rail stations in the New York Metro region have parking lots and/or garages for transit customer use - whether agency, municipal, or privately owned/operated – are well-utilized at an average regional utilization ranging from 75-100% of "effective capacity." https://new.mta.info/document/92801

[3] New York Public Transit Association Website: https://nytransit.org/resources/public-transit-facts

[4] According to FHA's Pedestrian Safety Guide for Transit Agencies, most transit customers are willing to walk for five to ten minutes, or approximately ¼- to ½-mile to a transit stop. https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch4.cfm#:~:text=A.&text=Most%20people%20are%20willing%20to,stop%20 (see%20figure%20below).

[5] APTA Policy Brief " APTA Public Transportation Ridership Update" https://www.apta.com/wp-content/uploads/APTA-POLICY-BRIEF-Transit-Ridership-03.06.2023.pdf

[6] Congressional Research Service "Public Transportation Ridership: Implications of Recent Trends of Federal Policy" https://crsreports.congress.gov/product/pdf/R/R47302

[7] Many of the operators in this directory include small-scale local paratransit systems, as well as private operators such as Adirondack Trailways and Greyhound.

[8] Aslak Fyhri, Hanne Beate Sundfør, Do people who buy e-bikes cycle more?, Transportation Research Part D: Transport and Environment, Volume 86, 2020, 102422, ISSN 1361-9209, https://doi.org/10.1016/j.trd.2020.102422

[9] Paul A. Plazier, Gerd Weitkamp, Agnes E. van den Berg, "Cycling was never so easy!" An analysis of e-bike commuters' motives, travel behaviour and experiences using GPS-tracking and interviews, Journal of Transport Geography, Volume 65, 2017, Pages 25-34, ISSN 0966-6923, https://doi.org/10.1016/j.jtrangeo.2017.09.017

[10] Statewide Greenhouse Gas Emissions Report, NYSDEC, https://www.dec.ny.gov/energy/99223.html

[11] Low or No Emission Vehicle Program - 5339(c), FTA, https://www.transit.dot.gov/lowno

[12] Enthused and confident riders are people who are attracted to cycling by advances in local bicycle network development. They are comfortable sharing the roadway with automotive traffic, but they prefer to do so by operating in dedicated facilities such as bike lanes or multi-use trails. They appreciate bicycle lanes and bicycle boulevards.

[13] According to data from the New York Cycling Census, there is a strong interest in bicycle bicycle tourism in NYS. In addition, census respondents consistently rank trails highest in comparison to other infrastructure - such as bike lanes, bike parking, and wayfinding - in every region across NYS.

[14] TCAT Frequently Asked Questions, https://tcatbus.com/about/faq/

[15] CDTA Agency Overview, https://www.cdta.org/overview

[16] Another Record-Breaking Season for CDPHP Cycle!, CDTA, 2021, https://www.cdta.org/news/cdphp-cycle-hits-new-record

[17] What's All the Buzz About? CDPHP Cycle! Season 7 to Feature New Electric Bikes, CDPHP, May 2023, https://www.cdphp.com/newsroom/2023/05/cycle-season

[18] About STOA, NYSDOT, https://www.dot.ny.gov/divisions/policy-and-strategy/public-transportation/funding-sources/STOA

[19] Greenhouse Gas Emissions from a Typical Passenger Vehicle, US Environmental Protection Agency, https://www.epa.gov/greenvehicles/tailpipe-greenhouse-gas-emissions-typical-passenger-vehicle

[20] Cycle Safe Shelter, Image Credit: https://cyclesafe.com/bike-parking/bike-shelters/compact/

[21] Bike Locker, Photo Credit: https://sfbike.org/news/sleek-spacious-and-secure-new-bike-lockers/

[22] Bike Cages, https://www.handi-hut.com/products/bike-cages/

[23] Metro offerings during Bike Month, April 2021, https://thesource.metro.net/2021/04/30/metro-offerings-during-bike-month/

[24] Governor Hochul Signs Legislative Package to Support Pedestrians, Bikers and Transit Riders, December 2022, https://www.governor.ny.gov/news/governor-hochul-signs-legislative-package-support-pedestrians-bikers-and-transit-riders

[25] Sportworks Biek Counter, https://www.sportworks.com/product/bike-counter

[26] PP&E is a term used to describe tangible assets including buses, machinery, maintenance depots, offices and land.

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