

Designing Public Transit at the Margins

How rethinking public transit in Boston to support the travel patterns of transit-reliant women could transform public transportation for the better

by

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Submitted to the Department of Urban Studies and Planning
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ABSTRACT

Boston's public transportation network, the MBTA, is a "hub-and-spokes" system: rail lines radiate out to the suburbs from a few central downtown stations, and traveling between the "spokes" often requires taking multiple buses or traveling all the way inbound in order to transfer. Particularly on the bus and Commuter Rail systems, off-peak service is limited. For those who live in the suburbs and commute to the city during rush hour, this setup works relatively well. However, many women that depend on public transportation face unique difficulties. Women are more likely to make care-related and household-sustaining trips such as grocery runs and dropping off and picking up children from school, to make multiple trips in a row (trip-chaining), and to feel unsafe on public transit. Understanding the limitations that transit-reliant women face can help to build a more comprehensive public transit system that supports all types of trips and improves public transportation for everyone, following the theory of "designing from the margins. Using data from a survey I conducted of almost 200 women in the Boston area, I examine some of the issues and obstacles that these women face when using public transit, suggest some design guidelines for new transit infrastructure, and imagine how the MBTA could change to accommodate the travel patterns of the women surveyed.

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“If you design for people at the margins, you automatically get the people in the middle.”

-- MIT DUSP Professor Caesar McDowell

¹ [The Boston Globe](#)

INTRODUCTION

As the threat of climate change-related disaster grows larger, special attention is being paid towards how the transportation sector--one of the largest producers of greenhouse gas emissions--can be “decarbonized” and lessen its environmental impact. In the U.S. in particular, the prevalent use of personal, single-occupant vehicles has been singled out as a significant contributor to the problem. Sprawling cities and suburbs, limited public transit service, and a disproportionate amount of capital directed towards supporting a car-oriented lifestyle have all made it almost necessary to own a personal vehicle in many American cities. In fact, 90% of Americans who did not work at home drove to work, and out of the people who drove, 89% drove alone². Although taking public transit is not uncommon in major metropolitan areas like New York City (over 30% take public transit to work) or San Francisco (17% do)³, in many other cities, public transit is very limited, underfunded, and reserved only for the people who have no choice but to take it. In a culture where owning a car means freedom, a dramatic increase in mobility, and a decrease in travel time, riding the bus is something one typically “graduates” from as soon as one has the means. Those who cannot drive, whether because they cannot afford a car, because of a disability, or for whatever reason, are left out of many employment, educational, and recreational opportunities.

Increased greenhouse gas emissions and inequality are not the only issues that car-oriented societies present. Extreme congestion is slowing down cities, leading to long commutes, frustrated drivers, and a loss of economic productivity. The “peak period” for vehicle travel within I-95 in the Boston area now spans 14 hours, meaning that severe traffic is almost

² American Community Survey 2017 5-YR Estimates Table B08301

³ <https://www.citylab.com/transportation/2019/01/commuting-to-work-data-car-public-transit-bike/580507/>

unavoidable⁴. Safety is also a major concern; over the course of 2016, 37,806 people were killed in car crashes in the United States. Car crashes remain the leading cause of death of American teenagers⁵. Encouraging a switch from driving to more sustainable and spatially-efficient modes of transportation, such as public transit, walking, and biking, would improve many of these issues by reducing carbon emissions, transporting more people in less space, and offering affordable mobility options. However, due to the current, limited state of public transit in the U.S., this is not remotely feasible.

Even cities with relatively expansive public transit systems such as Boston follow an out-of-date “hub-and-spoke” model that only truly works well for commuters wanting to get in and out of the city during the weekday rush hour. In other words, the subway and commuter rail lines of the MBTA, Greater Boston’s public transit network, radiate outwards from the center city towards the suburbs. They operate infrequently or not at all during off-peak hours, and offer no easy way to traversing from one line to another without traveling all the way into the city and then traveling all the way back out. A proposed “Circle Line” that could potentially alleviate some of these concerns by connecting the “spokes” of the system together has been in the works with little progress for years⁶. As a result, commuting anywhere except from certain parts of suburbia to the center city and anytime except during classic workday rush hours is quite challenging--not to mention any other types of non-commute trips one wishes to take. Other, non-commute travel responsibilities, shifts outside of peak hours, intra-city or intra-suburbia commutes, and many other realities of traveling make public transit very difficult to rely on.

⁴ <https://www.wbur.org/news/2019/08/08/traffic-massachusetts-report>

⁵ <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603>

⁶ <https://web.archive.org/web/20110722105736/https://www.commentmgr.com/projects/1169/docs/URnews0105c.pdf>

Women in particular tend to have travel patterns that vary from the types of trips supported by public transportation. Although more women are part of the workforce than ever before, in opposite-sex partnerships they are still usually expected to perform a majority of the household responsibilities, such as running errands, buying groceries, and taking children to school and extracurricular activities. This in turn makes women more likely to “trip-chain”, or link trips together: one example could be leaving from work and stopping at the supermarket and at the daycare center on the way home (McGuckin and Murakami, 1999). Low frequencies of buses and trains, poor off-peak service, and the need to make many modal transfers make trip-chaining confusing, time-consuming, and frustrating on public transportation. As women are likely to do more of the “caregiving” work in a family, such as spending time with young children or taking care of an elderly parent, they are more likely to face corresponding accessibility issues posed by public transit, such as struggling to take a stroller up a flight of stairs in the subway⁷. Women in general also tend to report feeling more vulnerable and unsafe⁸ on public transit vehicles and stations, and high incidents of harassment only validate these fears. Despite these challenges, many women must and do rely on public transit, and face unique obstacles while navigating a transportation network that seems to have left them out of the conversation.

Public transit-reliant women are, of course, not the only people who face severe limitations on public transportation. Almost everyone, even those with convenient public transit access, encounter obstacles in some form or another that might not have occurred when driving. (It is important to note that convenience is by no means inherent to driving, but instead a result of the car-oriented cities that have been created with public transit as, in many cases, little more

⁷ <http://genderedinnovations.stanford.edu/case-studies/transportation.html#tabs-2>

⁸ Ibid.

than an afterthought.) However, the combination of challenges that they encounter--and the resulting unusual ways that they must use public transportation networks built for purposes different than their own--provide very useful insights into how public transit could be altered to make it as convenient as driving. The questions that I'm interested in studying, therefore, consist of the following: *What would a transportation system designed for public transit-reliant women look like? Could this make public transportation more attractive and accessible for everyone?*

This premise follows the idea of designing “from the margins”, where instead of designing for the “middle”: the average--or perceived to be average--citizen, design should start at the margins and work towards the middle. MIT Professor Ceasar McDowell explains this as “If you design for people at the margins, you automatically get the people in the middle. People at the margins are living with the failures of society⁹.” One example of this phenomenon he gives is the history of curb cuts in the U.S., which were at first created for disabled WWII veterans in wheelchairs. However, they ended up helping not just wheelchair users, but people pushing strollers or pulling suitcases, elderly people who have trouble with stairs, cyclists, and many more people who weren't part of the original conversation. If curb cuts suddenly disappeared tomorrow, many more people besides wheelchair users would find themselves inconvenienced. This design concept is growing in popularity with the establishment of projects such as “8 80 Cities”, a group with the vision that “if everything we do in our public spaces is great for an 8 year old and an 80 year old, then it will be great for all people¹⁰”. Instead of designing cities for the supposedly “average” person, designing for the needs of the very young and very old could make cities safer, more accessible, and even more enjoyable and attractive places to live.

⁹ <https://www.goldininstitute.org/news/24-goldin-news/829-senior-advisor-dr-ceasar-mcdowell-speaks-on-ethics-design-and-democracy>

¹⁰ <https://www.880cities.org/>

The same could hold for designing public transportation as well: making off-peak or intra-suburb travel easier, providing buses with space for strollers or shopping bags, improving safety at bus stops, and other potential changes that could improve the commutes of transit-reliant women would also improve the experiences of many others, potentially making them more likely to use public transportation. For example, making it easier for someone to take a stroller on the train by improving accessibility could make traveling easier for people coming from the airport with suitcases or for wheelchair users. Expanding intra-suburban transit wouldn't just make it easier for transit-reliant women to make multiple stops on the way home from work, it could make high schoolers living in the suburbs that are too young for a license less dependent on their parents to shuttle them around. In this case, designing for the margins could, in a seemingly contradictory way, reduce the stigma of public transit as something that you "graduate" from as soon as you are able to, and could in turn reduce carbon emissions, congestion, and mobility inequity.

Cities around the world are starting to examine how women can be better included in the city design process, and very often, public transportation is one of the central topics. In Barcelona, planners have recognized that not only do women travel on foot and on public transportation more often than men, they make more trips as well. Cars are heavily prioritized, though, as they are in most cities--60% of public space in Barcelona is dedicated for either parked or moving cars¹¹. The mayor has undertaken a project of redistributing this public space with the creation of "superblocks" where car access is limited, in order to provide equal access to public space for everyone, not just those who drive. In Vienna, a transportation survey found a similar result: women have more varied, complicated, and often-changing commutes. This was

¹¹<https://www.theguardian.com/cities/2016/may/17/superblocks-rescue-barcelona-spain-plan-give-streets-back-residents>

apparent even when filling out the survey, as women took much longer to describe their travel patterns while men were more likely to just have to explain their daily round-trip work commutes¹². In line with the theory of designing for the margins, many of the new ideas were well-received across the population. The “superblocks” were safer for children, more pleasant for the elderly, and supportive of those with disabilities due to widened, smoother sidewalks and frequent public spaces with benches providing places to stop and rest if necessary. With this thesis, I hope to be able to apply these tactics to suggest more inclusive public transit within Greater Boston that can not only give a voice to those marginalized by limited mobility options, but to further illustrate how planning for the most marginalized can support everyone in the middle as well.

¹² <https://www.citylab.com/transportation/2013/09/how-design-city-women/6739/>

LITERATURE REVIEW

Mobility and Inequality

Decades of heavy subsidization of highway construction, gasoline, and car ownership have led to the creation of a transportation network so auto-centric that Americans who do not own cars are considered “transit-disadvantaged”. Public transit infrastructure has both evolved and, later, been built to reflect this reliance on personal vehicles: trolley lines have slowly disappeared from cities around the country, and public transportation typically reflects the needs of commuters who commute at peak hours during the weekdays (Blumenberg and Manville, 2004). This rise of sprawling cities and of the necessity of owning a personal vehicle created inequalities for those who do not own cars or who cannot drive. Although suburbanization and homeownership were encouraged and subsidized for white people, black people were often excluded from the suburbs (cite). Primarily black neighborhoods were “redlined” and became disinvested, resulting in what would later be called the “spatial mismatch hypothesis”: residents of post-white-flight inner-city communities became disadvantaged as more and more jobs were moved to suburban areas, making employment difficult to reach without a personal vehicle (Kain, 1968). While many scholars agree with the spatial mismatch hypothesis, the theory is still controversial (Blumenberg, 2007). Sanchez et. al. compares the American spatial mismatch theory to the British tactic of addressing “social exclusion”, a much broader approach which seeks to, among other things, improve access to education, training, and other tools that grant access to a wider portion of the job market (Sanchez et. al., 2004). Blumenberg and Manville suggested that the real issue might be more of a modal mismatch, citing how access to employment increases dramatically depending on whether or not one has access to a car: in Monterey Park, Los Angeles, a commuter can reach 70 times as many jobs with a car in thirty

minutes as they could on public transportation with the same timeframe (Blumenberg and Manville, 2004). In fact, owning a personal vehicle has been shown to “all but eliminate” differences in employment between white and black Americans, truly demonstrating the inequities that result from a lack of mobility and the extent to which cities have been built around the personal vehicle. Beyond employment, the availability of public transportation has been shown to influence the level of social exclusion that a person experiences (Hine and Mitchell). This is particularly true for elderly people, who might not be able to drive and who would otherwise remain trapped and isolated within their homes (Hough, Cao, Handy). Furthermore, traveling on public transportation often takes far longer than the same trip would in a car, due to the limitations of public transit systems and the heavy prioritization of space and resources given to automobile travel (Wekerle and Rutherford). This can leave less time in the day for other activities and limit the jobs, services, and social opportunities that one has access to.

Auto-centric cities create issues and limitations even for families and individuals who can afford to own a car. Duany et. al. studied what they called the “victims of sprawl” and identified many classes of people who suffer as a result of suburbanization (Duany et. al., 2010). “Cul-de-sac kids” have little-to-no freedom well throughout their teenage years as they are reliant on others to drive them around--they cannot get to school, play sports, visit friends, or any of the other activities typically associated with childhood and freedom without having a parent drive them as suburbia often lacks walkable streets and heavily separates uses. Their parents, typically their mothers, must then sacrifice most of their free time dropping off and picking up their children from various activities. The elderly, many of whom no longer qualify for a driver’s license due to health reasons, have no choice but to either be completely dependent on a family member or caretaker for mobility or move to a retirement community.

Gender Differences in Travel and Public Transit Use

The travel needs of women have often been overlooked in the design of transportation networks, in particular public transportation. Feminist scholars have theorized that transportation systems, including highway networks, hub-and-spoke-style public transportation, and the auto-centricity of suburbs, have been primarily designed for men's needs, leaving many women confined to their homes and limiting their freedom of mobility (Wajcman, 1991). Many researchers have studied the differences in travel patterns between men and women to examine the extent of this disparity. First, women are more likely to "trip-chain"--make multiple stops on the way to the final destination--than men (Gordon et. al, 1989; McGuckin and Murakami, 1999; Goddard et. al., 2006). This could include dropping off children on the way to work, picking up groceries on the way home, or other "chained" trips. Unless public transit infrastructure is particularly comprehensive, this can be very challenging to do without a car: for example, timing connections becomes much more challenging, and if service is infrequent, making stops can drastically increase the length of one's commute. Women tend to trip-chain more because, even if they are in a heterosexual partnership where both partners work, they are still more likely to bear the responsibility of "household-sustaining" trips such as running errands and taking children to school, activities, and appointments (McGuckin and Murakami, 1999). This is often referred to as the "dual-worker role" or the "second shift" that women in opposite-sex partnerships are expected to carry out due to an unequal division of household labor (Wekerle and Rutherford, 1987). In addition, women have been found to have shorter commutes and live closer to home, but are likely to make more trips than men. Some explanations for this include the need to spend less time traveling in order to maximize the time spent at home or completing

other household tasks (Michelson, 1983). Many women also feel pressure to be at home when the rest of the family leaves and to be there when they return (Dobbs, 2005). This can limit the number of jobs that women have access to, and can make public transportation a non-option if it takes longer than driving. Women are also more likely to use public transportation, particularly single mothers; in fact, Wekerle and Rutherford found that the higher the percentage contribution to household income that a woman makes, the fewer cars a household has. They also found that women commute on slower modes and spend more money per mile than men do. In Boston, this theory stands: 35.8% of women in Suffolk County, which includes all of Boston Proper as well as Winthrop, Chelsea, and Revere, take public transportation to work, compared to 31.9% of men. Of those who take public transit, 44.6% of Suffolk County women primarily take the bus compared to 38.6% of men, meaning that women are more likely to take slower modes (i.e. the bus instead of the subway)¹³.

When a family does have access to a personal vehicle, women are more likely to be “second in line” for the car and can only use it when others aren’t (Dobbs, 2005; McGuckin and Murakami, 1999). This further implies that mobility obstacles that women face are not just related to income or spatial mismatch, but on pervasive gender roles and expectations. A study done on students, staff, and faculty at Ohio State University found that women typically have more dynamic and variable commutes than men do, making it difficult to rely on fixed and infrequent public transportation service (Namgung and Akar, 2014). The complexity of many trips carried out by women is a factor that often comes up in studies about women’s travel patterns, as well as the time pressures and additional accessibility constraints such as transporting children or groceries, and is often cited as a reason for why women face many challenges while using public transportation (Dobbs, 2005). With a transportation network where public transit

¹³ American Community Survey 2018 5-YR Estimates Table S0804

operates on fixed, limited routes built almost entirely for commuting but roads for personal vehicles are far-reaching, complex travel routes involving trip-chaining are often far easier to carry out in a personal vehicle. In addition, women find personal safety and “guaranteed rides” to be very important. One concern that many people, particularly women with children, have with relying on public transportation is that, in the case of an emergency, there is no way to get home or to the site of the issue quickly as any commuter trains and buses run very infrequently during the day. Guaranteed ride home programs offer a free car ride home to commuters who regularly use other modes besides driving alone. This points to a major issue with the lack of mid-day or otherwise off-peak service that can particularly disadvantage those who have childcare or caretaker roles. Furthermore, low-income and low-educated women face issues with a lack of frequent all-day service more than others, as they are more likely to work “non-standard hours” (Presser and Cox, 1997). Commuting to and from a night shift on public transportation might be impossible as many transit systems do not have late-night or early-morning service; if they do, service is much more infrequent and usually means long wait times.

Another major mobility limitation that women face is personal safety. One study done in Turkey showed that although women use public transportation more frequently, they avoid using public spaces, particularly at night (Deniz, 2016). Many of the women interviewed expressed that they limited where and when they traveled out of fear of harassment and assault. Importantly, these concerns are not unfounded—a third of respondents face harassment on public transportation at least weekly. These limitations on mobility can be viewed as an issue of equity, as women are prevented from accessing spaces or traveling at certain times. Dobbs studied similar issues in the United Kingdom, bringing up the concept of “no-go” areas, or places where women avoided traveling out of fear (Dobbs, 2005). Certain designs of bus stops, subway

stations, or other transit nodes such as poor lighting or prevalent blind spots could contribute to increased feelings of vulnerability.

Both Dobbs and Blumenberg et. al. have studied how private transportation can have positive impacts on women, low-income people, and other disadvantaged groups. Although many different public transit-related programs have been put in place to support low-income people, such as supporting reverse commutes to get residents of the inner city into the suburbs and on-demand transit to better reflect the dynamic needs of commuters, they have not been very successful. Similarly, Dobbs wrote that access to private transport can have many positive effects on the lives of women due to the many safety concerns that women face on public transportation and the increase in employment options that owning a car provides. Both authors recognize that the solution is not just to provide all disadvantaged people with vehicles, as they can also be significant financial burdens and can contribute to larger problems of congestion and pollution. However, preventing transit-reliant people from gaining access to private transportation under the guise of protecting the environment and curbing congestion is both ineffective and inequitable when wealthier people drive far more. Instead of limiting access to private transportation for disadvantaged and transit-reliant populations, transportation improvements could be more widespread and aimed at making public transit a viable travel method for all, not just something that one “graduates” from as soon as possible.

One useful way to study some of the aforementioned complexities of how women, particularly transit-reliant women, commute is to use “self-mapping”. One Canadian study used this technique to examine how transportation can foster social exclusion, and asked low-income, mostly transit-reliant women to map their “individual space” (McCray and Brais, 2007). Instead of modeling decisions based on the concept of utility, which suggests complete rationality and

awareness of all options, the authors chose an approach based on “personal preferences and present circumstances” to better reflect the reality of travel choices. Respondents mapped places that they regularly travel to as well as places they wanted to travel to but could not due to safety concerns, absence of public transit, cost limitations, etc. The authors congregating these nodes and routes using GIS to visualize the heavily traveled corridors as well as the parts of the city that were unreachable for many of the surveyed women. Similarly, Mei-Po Kwan developed a “space-time accessibility measure” to understand where a person can travel in a day given their space and time constraints through a three-dimensional depiction of an individual’s daily trips (Kwan, 1999). The study found that women tend to have lower levels of “access to urban opportunities” given their unique travel constraints. This process of mapping commonly used corridors as well as places that are difficult, unsafe, or impossible to access given time or cost constraints and the limitations of public transportation is a valuable way of examining how public transit-reliant women navigate daily travel responsibilities.

Designing a non-Sexist City

With her 1980 work “What Would a Non-Sexist City Be Like?”, Dolores Hayden proposes a similar question to my own on a larger, broader scale. In her discussion on the idealized American family home, she states, “How does a conventional home serve the employed woman and her family? Badly” (Hayden, 1980). The home is separate from any communal or community facilities, and not by accident--zoning law often enforces the separation of residential areas from any other uses. This in turn makes it difficult for both a stay-at-home mother to socialize and interact with the community while taking care of her children and for the working mother to find convenient care for her children while she is at work. Recategorizing what are typically thought of as “women’s problems” from being private and within-the-home to

be problems of inequality and market inefficiency that affect everyone can legitimize these issues. This approach reiterates the need to frame a study based on uplifting marginalized groups as non-specific to that group in particular and as public, far-reaching issues that would affect general society positively if resolved.

BACKGROUND

Like many other older American cities, Boston was transformed in the late 1800s with the arrival of the streetcar. Up until then, most of the urban population was concentrated in the small peninsula that was 19th-century Boston. Commuters were limited by how far they could walk, so it was essential that residences and businesses be located within walking distance. However, when streetcar routes--some of which still exist today, in the form of the MBTA Green Line--were built, radiating from the center city into the then-countryside, the middle and upper classes had the opportunity to live outside the main business district. Current urban planning theory supported a radial city design where residents lived in suburban outer rings and commuted into the city, and the importance of access to nature was being advocated for by prominent architects like Frederick Law Olmsted. In addition, the center city was becoming increasingly dense with the arrival of immigrants fleeing the Irish Potato Famine, prompting those who could afford it to leave in search of more space. In his book *Modeling the Streetcar Suburbs*, Sam Bass Warner described the resulting “rings” of both income and lot sizes that radiated out from the city. While the upper and middle classes settled in large houses along the streetcar lines and commuted back and forth from downtown, lower-income residents stayed in the dense city center.

Although Boston has changed since the turn of the 20th century in many ways, the MBTA still resembles the streetcar system of a century ago. The subway and Commuter Rail lines diverge from a few central stations, and crosstown service is limited to bus routes with no right-of-way. This setup poses issues for those who need to make intracity or inter-suburb trips, or those who need to make multiple stops in a single trip that is not aligned with a subway route.

In order to understand the ways transit-reliant women use the MBTA, I analyzed data from the 2015-2017 MBTA Systemwide Passenger Survey and from the MBTA 2010 Bus Performance Metrics. I began by comparing the fifteen routes with the lowest percentage of women passengers with the fifteen routes with the highest percentage, as well as the fifteen routes with the lowest percentage of passengers from zero-vehicle households with the fifteen with the highest. As there are approximately 150 MBTA bus routes represented in the survey, these two categories can be thought of to represent the top and bottom 10%.

Then, I compared these routes on a number of different standards. Routes with high percentages of women and passengers from 0-vehicle households (0VHs) had lower percentages of home-based work trips, which are trips from home to work or from work to home. However, these same routes have higher percentages of non-home-based trips, or trips that neither start nor end at home--in concurrence with previous studies on women’s travel patterns, which showed that women are more likely to trip-chain. Similarly, both the passengers on routes with high percentages of women and 0VHs are more likely to take the trip in question 6-7 days per week, implying that these riders are more likely to use the system during off-peak times (during at least one weekend day).

Demographics of High/Low % Women/0VH MBTA Bus Routes

	Low % Women	High % Women	P-value (two-tailed t-test)	Significance
Trip purpose: Home-based work	0.78	0.72	0.11	
Trip purpose: Non-home-based	0.09	0.12	0.16	
Trip frequency: 6-7 days a week	0.08	0.15	0.03	**
Trip frequency: 5 days a week	0.60	0.57	0.36	

	Low % 0V	High % 0V	P-value	Significance

Trip purpose: Home-based work	0.89	0.66	2.67E-09	***
Trip purpose: Non-home-based	0.04	0.15	0.001	***
Trip frequency: 6-7 days a week	0.03	0.17	1.81E-08	***
Trip frequency: 5 days a week	0.70	0.50	3.37E-08	***

97% of both the passengers on routes with high percentages of women and passengers from OVHs walk or cycle to their first MBTA service, compared with 88% and 87% of routes with low percentages of women and riders from OVHs, respectively. As shown in the above table, high % women/OVH routes are typically local routes that run within Boston neighborhoods, particularly Dorchester and East Boston, while the other routes are primarily express routes to downtown Boston or to outer rapid transit stations. In addition, the passengers on high % women routes are more likely to come from OVHs, and the high % OVH routes are more likely to be women.

Demographics (cont.)

	Low % Women	High % Women	P-value	Significance
Access to first MBTA service: Walked or bicycled	0.88	0.97	0.02	**
Access to first MBTA service: Drove alone	0.06	0.01	0.09	*
Usable household vehicles: 0	0.27	0.42	0.02	**

	Low % OV	High % OV	P-value	Significance
Access to first MBTA service: Walked or bicycled	0.89	0.97	0.04	**
Access to first MBTA service: Drove alone	0.07	0.004	0.02	**
Gender: Woman	0.56	0.66	0.002	***

Routes with Highest/Lowest % Women Ridership



Figure 1: This map and all following maps were created by myself using QGIS and layers from MassGIS. Most of the high % routes are concentrated within the city or within neighborhoods, while routes with fewer women tend to be express routes running from the suburbs to downtown or to rapid transit endpoints.

Routes with Highest/Lowest % 0-Vehicle Household Ridership

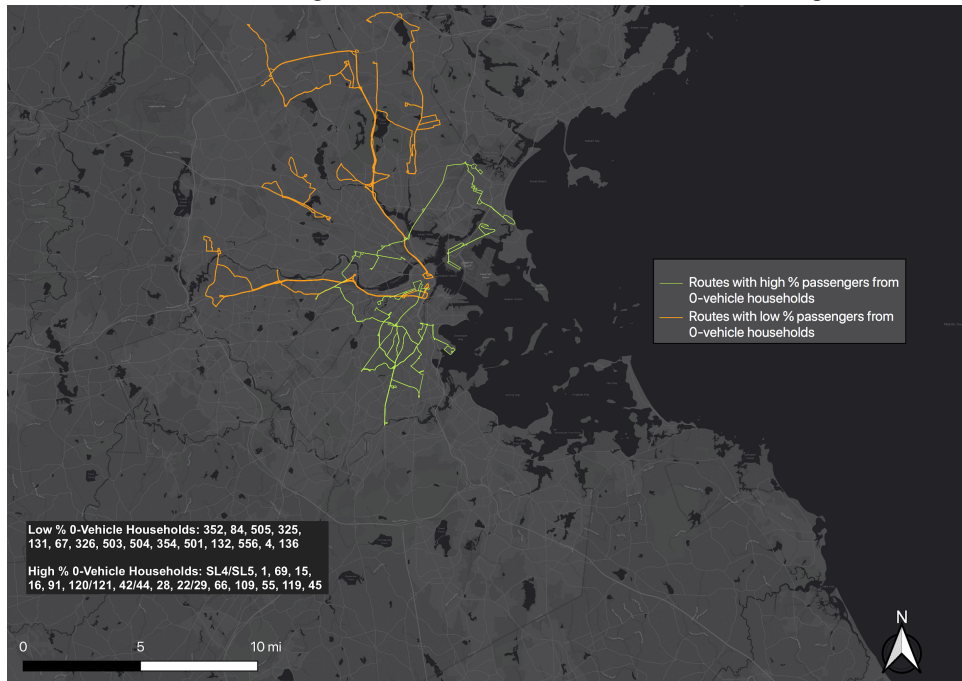


Figure 2: Most of the high % routes are located in Dorchester, East Boston, or Everett, which are communities with substantial minority and immigrant populations. Routes with few passengers from OVHs tend to be in wealthier towns such as Newton, Arlington, and Reading.

Demographics (cont.)

	Low % Women	High % Women	P-value	Significance
Low-income classification: Yes	0.28	0.44	0.04	**
Minority classification: Yes	0.35	0.57	0.02	**
Cost per passenger	\$3.01	\$1.65	0.02	**
Overcrowding¹⁴	0.6	0.13	0.01	**
Express or local¹⁵	0.27	0	0.04	**

	Low % 0V	High % 0V	P-value	Significance
Low-income classification: Yes	0.11	0.52	8.39E-08	***
Minority classification: Yes	0.20	0.59	8.99E-05	***
Cost per passenger	\$3.63	\$1.05	4.60E-06	***
Overcrowding	0.8	0.2	0.003	***
Express or local	0.6	0	0.0004	***

* P-value <0.1

** P-value <0.05

*** P-value <0.01

While these comparisons are not a stand-in for determining trends of the travel patterns of public-transit-reliant women in Boston, they do provide some insight into the characteristics of bus routes more likely to be used by this group. Overall, they are more likely to be traveling more than 5 days a week and for non-work purposes, more likely to be low-income and non-white, and more likely to travel on overcrowded routes that stop frequently.

The purpose of this thesis is not so much meant to suggest that transit-reliant women are the only ones who struggle with the limitations of the MBTA. On the contrary, relying on public

¹⁴ Routes are assigned either a passing score (1) or a failing score (0).

¹⁵ Express buses are given the value 1 and local buses are given the value 0.

transportation can be challenging for anyone, even for those with uncomplicated travel patterns. A person who would be easily able to commute to downtown from their home in the suburbs on the Commuter Rail might choose to drive in case they need to pick up their child from school in an emergency, as the Commuter Rail runs only every 2 hours during off-peak times. Someone who could take an express bus to work might drive instead because they want to pick up groceries after work and don't want to have to go all the way home to get the car--and it would be difficult to carry a whole family's grocery load on a bus. Traveling at off-peak times, trip-chaining, and making certain types of non-work trips that are typically intra-city or inter-suburb are challenging on a hub-and-spokes and commute-oriented transit system like Boston's. Because transit-reliant women are more likely to make these types of trips, as shown by both local data and by literature on the subject, they offer a unique perspective. Understanding the issues they face and the changes that could be made to improve their experiences on public transportation could improve the system for all.

METHODOLOGY

The purpose of this survey was to gather data from women in the Boston area who rely primarily on public transportation on what their travel patterns are, what limitations they face, and what changes they would make to the MBTA to improve their experience. From there, I planned to extrapolate general “design guidelines” for public transportation as well as both major and minor changes that could be made to the system.

I wanted to find a diverse pool of participants, so I distributed the survey in a variety of different groups. First, I contacted a few local community centers and asked if I could post flyers promoting the survey on their bulletin boards. Then, I posted in an MBTA-related Facebook group made up of mostly younger Boston-area MBTA riders. The majority of the responses came after I asked DUSP Academic Programs Manager Ellen Rushman to distribute the survey to MIT undergraduate and graduate administrators, who in turn distributed the link to MIT staff. From there, one respondent reposted the survey in a few local childcare Facebook groups she was in, and another sent it out to the MIT Working Group for Support Staff. In the end, I had received 198 responses from women across Greater Boston.

The survey was separated into three sections: first, a few background questions; second, a “trip diary” for a typical day; last, a few open-ended questions.

Part 1

1. What is your gender?
2. Do you own or have access to a car?
 - a. Yes: I have my own car
 - b. Yes: I have to share it, but it’s available most of the time
 - c. Yes: I have to share it, and someone else is usually using it or has priority
 - d. No, but I regularly use a carsharing service like Zipcar
 - e. No
 - f. Other (please specify)

Although I had asked for only women who relied on public transportation, a few men and people who did not use public transportation filled out the survey as well. These questions helped eliminate these responses, although I did not exclude all car-owners from the analysis--instead, I went through the trip diaries on a case-by-case basis and kept the respondents that indicated very minimal use of their cars.

Part 2

Describe the trips you make on a typical day.

Trip n:

1. Start Location
2. End Location
3. Travel Mode
4. Time spent
5. Would you like to add another trip?
 - a. Yes
 - b. No, this is the last trip of the day.

This part of the survey was useful for connecting the long-form answers to specific areas of the city and to understand the prevalence of trip-chaining and non-commute travel.

Part 3

1. Which portions of your trips feel slow, frustrating, or stressful? Why?
2. Which areas of the city do you feel are challenging to access on public transportation?
3. Are there any times during your travel where you feel concerned for your safety? Why?
4. If you could redesign the MBTA, what would you change to make your trips easier?
5. If you have any other comments, share them here.

For each question, I quantified the results by classifying each response by topic. For example, for the first question, the response “Commute home on 9 bus, always so much traffic and packed bus” would fall under the categories “Traffic” and “Overcrowding”. I used charts to visualize the prevalence of responses relating to each topic, discussed some of the specific comments, and mapped a few of the responses to display where these incidents and experiences occur as well as where changes can be made.

The maps that I created as part of this analysis drew upon a variety of other “alternative mapping” projects. The project “This is Not an Atlas” gathers “counter-cartographies” with the intention of learning how to “read space and how to initiate emancipatory processes from below¹⁶”. Some of their works include a Newcastle-upon-Tyne map made with the input of the city’s homeless population, which includes shelters, “no-go” zones, history, and more that is excluded from typical maps of the city but very relevant to those experiencing homelessness. Other maps show the public toilets of Hyderabad, empty lots in New York City, aqueducts in Mexico, and much more. These projects not only provide knowledge for the people who might need the information shown on the maps, but legitimize and empower both those creating the maps and the causes for which they have created them by literally putting the issues on the map. Another interesting example I drew from was from the site “Bostonography”, which conducted a project on local perceptions of Boston neighborhoods¹⁷. Some neighborhoods, like the Back Bay or the North End, have very defined boundaries due to their unique grid system or their hard boundaries of I-93 and the waterfront, respectively. However, some areas like Roslindale have a lack of perceived boundaries; furthermore, in the South End, the consensus on what the boundary between the neighborhood and Roxbury is different than the City’s actual definition. Through my analysis, I hope to draw from these concepts of creating maps by and for the people who want reform, maps that show perceptions as well as actual distance, the illustration of “no-go” zones and other limitations, and representations of resources and characteristics not typically displayed by professional cartographers.

¹⁶ <https://notanatlaser.org/about/>

¹⁷ <https://bostonography.com/2017/official-unofficial-neighborhoods-2017/>

RESULTS

Stress

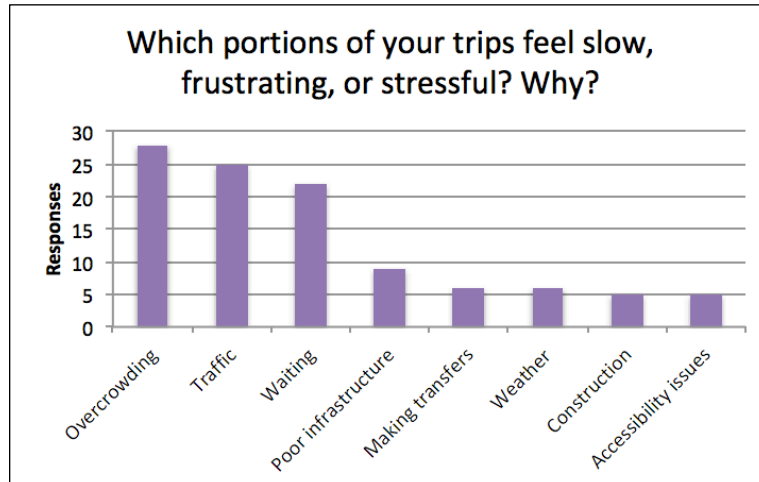


Figure 3: Topics mentioned in response to Question 1

The most common cause of stress was overcrowding, with 28 respondents mentioning it in their answer. A common complaint was the stress of “having to fight your way onto the train” or the “no guarantee of even getting on the first train”, which can lead to delays and uncertainty of how long a regular trip may take. Four of these 28 respondents referred to the difficulty of bringing a stroller on a crowded train; one person wrote that when commuting downtown in the morning, she had to get on an outbound train, travel a few stops, and then get off and take an inbound train in order to find a seat. Two respondents with disabilities mentioned that fellow passengers rarely offered them seats on crowded trains, contributing to stress and exhaustion on their commutes.

After overcrowding, traffic was the next most common complaint. Three of the 25 mentioned the Green Line and how frustrating it felt for the trolley to sit in traffic and wait for lights alongside the motor vehicle traffic. Others brought up how frustrating it was that, with all of the frequent stops and heavy traffic, their buses moved slower than walking speed.

Construction, particularly surrounding the Green Line Extension, was another common concern: for example, not only does the Washington Street bridge closure add significant time and distance on the bus, there is no easy pedestrian alternative. Other reasons included motion sickness from the frequent starts and stops, cars frequently cutting off buses when they try to merge back into traffic, and the general uncertainty caused by varying levels of traffic day-to-day.

For respondents with children in strollers or respondents with disabilities limiting their ability to use stairs, bad experiences with elevators were a common refrain. One person with a physical disability requiring her to use elevators wrote that “elevators are also often placed very far from the platform, requiring me to walk farther than most abled people do, as the stairs are closer to the platform” and that they are generally not in “intuitive places”, causing her to have to spend extra time searching the station. Another respondent who travels with her child in a stroller called the elevators “filthy”; another wrote that they often smell like urine and malfunction frequently.

The time spent waiting for buses and trains to arrive was frequently cited as a point of frustration. Respondents often mentioned cold and rainy weather, dark and empty stations, and a lack of alignment between the schedule and actual arrival times. The stress caused by general uncertainty of when trains and buses will come, how long it will take to get to the next destination, and whether or not it will be possible to get on the train or bus after waiting for so long a regular theme throughout the survey responses, and the period of time spent waiting and not moving appears to be when these feelings of anxiety peak. A few respondents mentioned children and family in conjunction with the stress of waiting for the train, including worries that they would be late to pick up children from daycare, the added stress of tantrums and crankiness

from frustrated children traveling with them, and the inability to get home quickly in case of a family emergency.

Transferring between lines or modes was brought up a few times as one of the most stressful portions of the trip. Respondents described long walks down tunnels and up and down stairs or elevators as being frustrating, especially with the stress of not knowing if they were going to just miss a connection. Buses are particularly challenging in this manner, as they often come so infrequently that timing a connection right is difficult. A few respondents added that timing transfers with fixed events like school dropoff or pickup was stressful because of how unpredictable the bus schedules tend to be. Suggested solutions included simply increasing bus frequency--missing a transfer is far less stressful when the next bus comes in 5 minutes instead of 30--and improving the waiting experience with better protection from the weather, “next arrival” signs, and more seating.

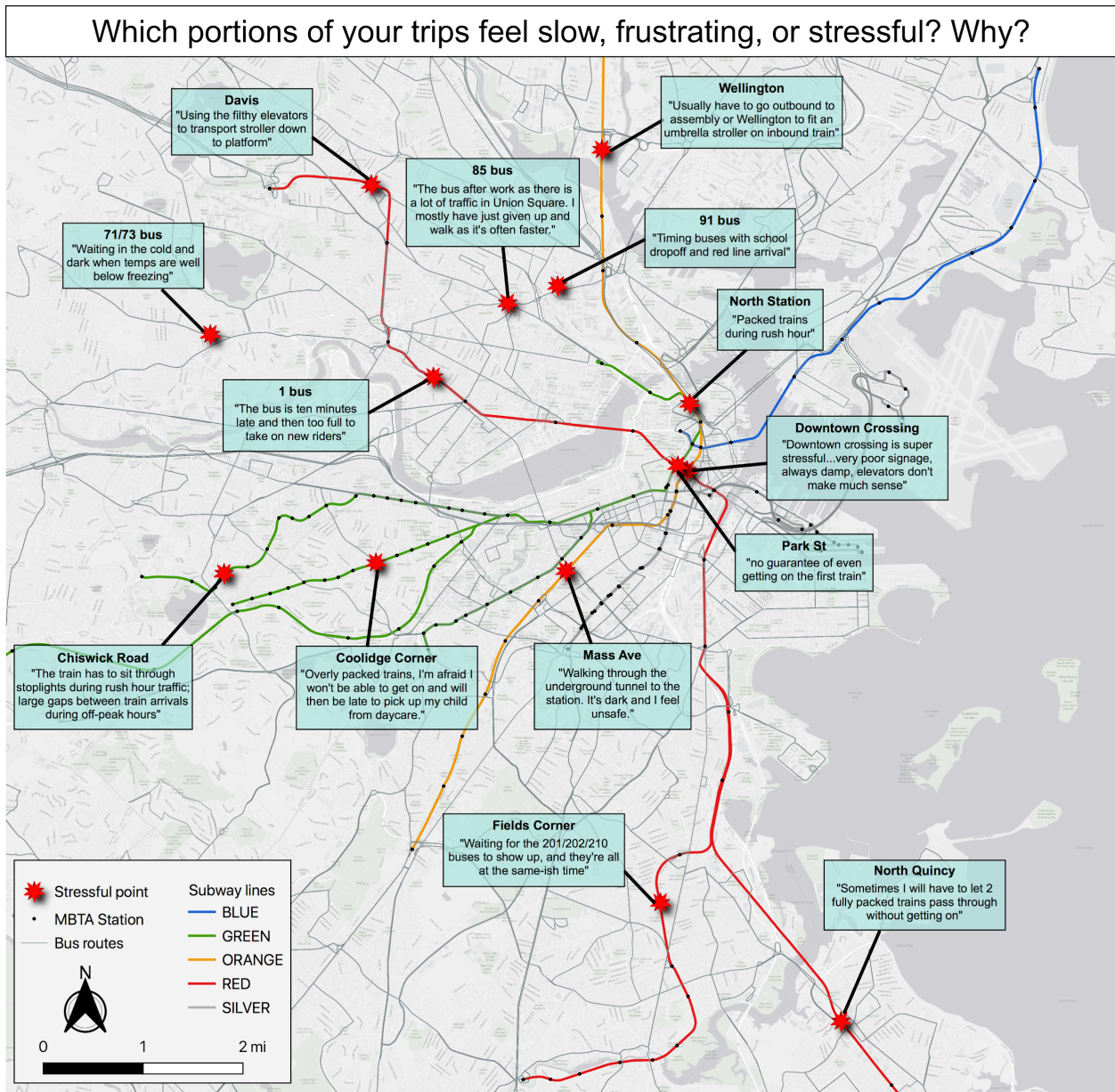


Figure 4: A map of stress and frustration on the MBTA. Many respondents cited making transfers, overcrowded trains, unsafe or unsanitary conditions, and general unreliability as major sources of stress.

Safety

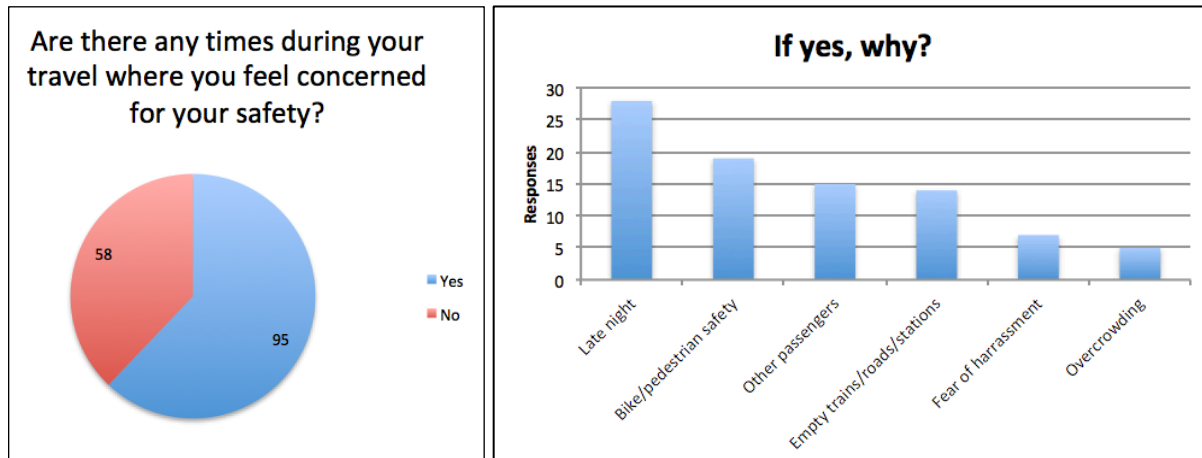


Figure 5: Answers and topics mentioned in response to Question 2

Late-night travel was the most frequently cited reason for feeling unsafe. This was usually tied in with dark, empty stations, a lack of staff or law enforcement in the area, or long walks home in the dark after leaving a transit station. As I will expand upon later, a few participants changed their commutes or restrict their travel hours to avoid traveling late at night, thereby adding time to already lengthy commutes or limiting opportunities. Particularly unsafe areas that were alluded to in the responses included tunnels in train stations “with no direct escape route”, poorly lit areas under bridges and overpasses, empty roads or train cars, and parking garages. The responses reflected that MBTA’s lack of 24-hour service contributes to anxiety surrounding safety. Missing the last train or bus means being stranded with no other choice but to walk home through dark, empty roads.

Very crowded or very empty trains were also a cause for concern. Respondents described overcrowding as both uncomfortable and stressful due to the fear of theft or harassment, and worried about empty trains because, in the words of one respondent, “I am trapped in there with that person and if they decided to hurt me there would be nobody to help.” The limited measures that exist to protect people in these situations, such as the emergency buttons in the train cars, are

not always reliable--one person wrote, “any time I have been on a car that uses the emergency button, it never works and take[s] forever to hear back from MBTA employees.” Without any emergency response system, a 3-minute ride in an otherwise unaccompanied train car can become a dangerous risk.

A striking theme was the number of respondents who altered their commutes for safety reasons despite the inconvenience that it causes. A few respondents had explicitly mentioned incidents that had occurred on the MBTA that had caused them to fear public transportation, such as harassment and unwanted touching. In some cases, these incidents prompted major and often inconvenient alterations. One respondent wrote that she sometimes takes expensive Uber rides home rather than wait in the empty Back Bay station at night for her safety, and one person said that she stopped riding the MBTA completely because of safety concerns. Another respondent said that she often drives to work in case she ends up staying at work late, not wanting to risk taking transit late at night, and others without the option to drive limited their travel hours to avoid traveling in the dark. A few people made changes to the walk portion of their commutes to avoid danger as well, with one person taking the slower Green Line instead of the Orange Line to shorten her walk home because “the area was unsafe”, and another calling a friend when walking home alone for her safety.

Are there any times during your travel where you feel concerned for your safety?

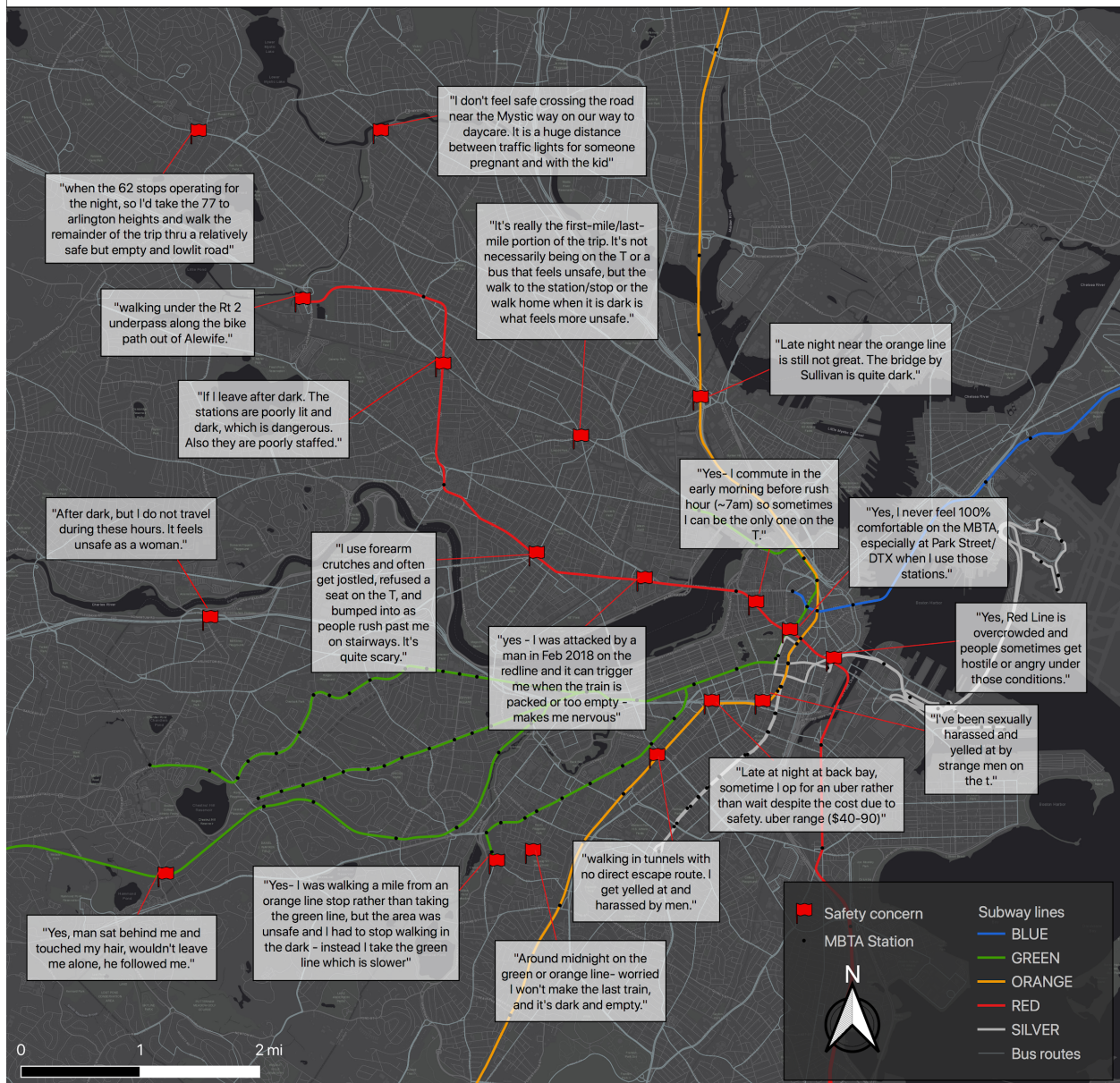


Figure 6: A map of safety concerns on the MBTA. Respondents avoided late night travel, shaded areas such as tunnels and overpasses, and both very empty and very crowded trains and buses.

Access

As expected, the areas that were described as difficult to access varied according to where the respondent lived, but a very common refrain was that the ring of towns and neighborhoods just outside of Boston--Allston/Brighton, Dorchester, Charlestown, Somerville, etc.--were very challenging to travel between. Occasionally, a crosstown bus route such as the CT2 or 66 will link these areas together, but as these buses do not have their own right-of-way, they are limited by heavy car traffic. More often, traveling between these towns and neighborhoods requires traveling all the way downtown, transferring, and traveling back out on a different line--or perhaps making multiple transfers between buses, which can be difficult to time well when the buses have infrequent service. Spending more time and traveling far more distance than would be necessary in a car can be frustrating and disheartening, especially when bus routes end up stuck in the same traffic as cars do.

A specific example that was mentioned multiple times in the responses was the lack of north/south connections in Somerville, a dense city just northwest of Boston with limited rapid transit access. The two major subway connections in the city are the Davis station on the Red Line and the Sullivan Square station on the Orange Line, which are at the northwest and southeast ends of Somerville, respectively. About a half dozen bus routes run inbound across the city either from Davis, to Sullivan, or both, at which point passengers typically transfer to the subway and continue on towards downtown Boston. However, there are no buses that run perpendicular to the aforementioned routes--i.e. from the southern end of Somerville on its border with Cambridge to the northern end on its border with Medford. Respondents that referenced this issue explained that this led to many difficulties making trips within the city, such as traveling from home to drop off children at school and then continuing onto work. One

respondent even said that she could not send her child to the school she wanted because her Somerville neighborhood was so inaccessible from the part of Somerville where the school was. Although the majority (70%) of MBTA bus trips are commute trips according to the MBTA's Systemwide Passenger Survey and although these trips are likely served well by bus routes that connect neighborhoods to major rapid transit stations, these are not the only trips that transit-reliant passengers need to make. Limiting bus service to simply feeder routes to subway stations makes intra-city travel challenging and frustrating.

Another example that was brought up frequently was the lack of service between the Boston neighborhoods of Allston/Brighton, Jamaica Plain, and Dorchester. These neighborhoods are mostly urban but residential, and are at least partially served by rapid transit-- Allston/Brighton by the Green Line, Jamaica Plain by the Orange Line, and Dorchester by the Red Line. However, all of these lines lead to Downtown Boston, meaning that to go between these neighborhoods, one must either travel all the way downtown and transfer or take multiple buses. The map in Figure X shows how not only are much of these neighborhoods a long way from a rapid transit stop, but that rapid transit "ring service" is completely absent.

A few respondents with disabilities answered that neighborhoods without accessible public transit were difficult and frustrating to access. For example, the Central Square station elevator has been under construction for over a year, meaning that passengers who rely on the elevator must travel an extra stop to Kendall and take a shuttle bus in the reverse direction. Another issue that was brought up was overly crowded trains--if other passengers do not give up their seats, the train can become inaccessible to riders who cannot stand for long periods of time.

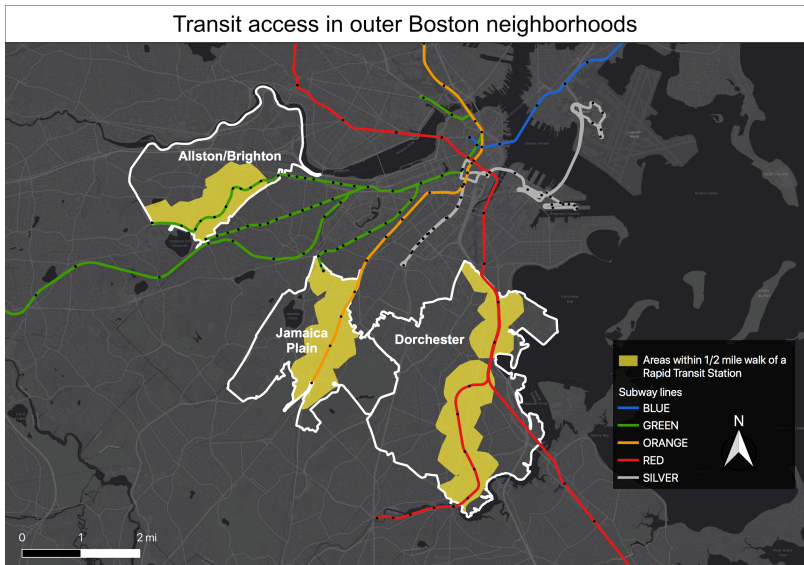


Figure 7: Outer Boston neighborhoods are only partially served by rapid transit, and all routes go towards Downtown Boston, limiting inter-neighborhood connections.

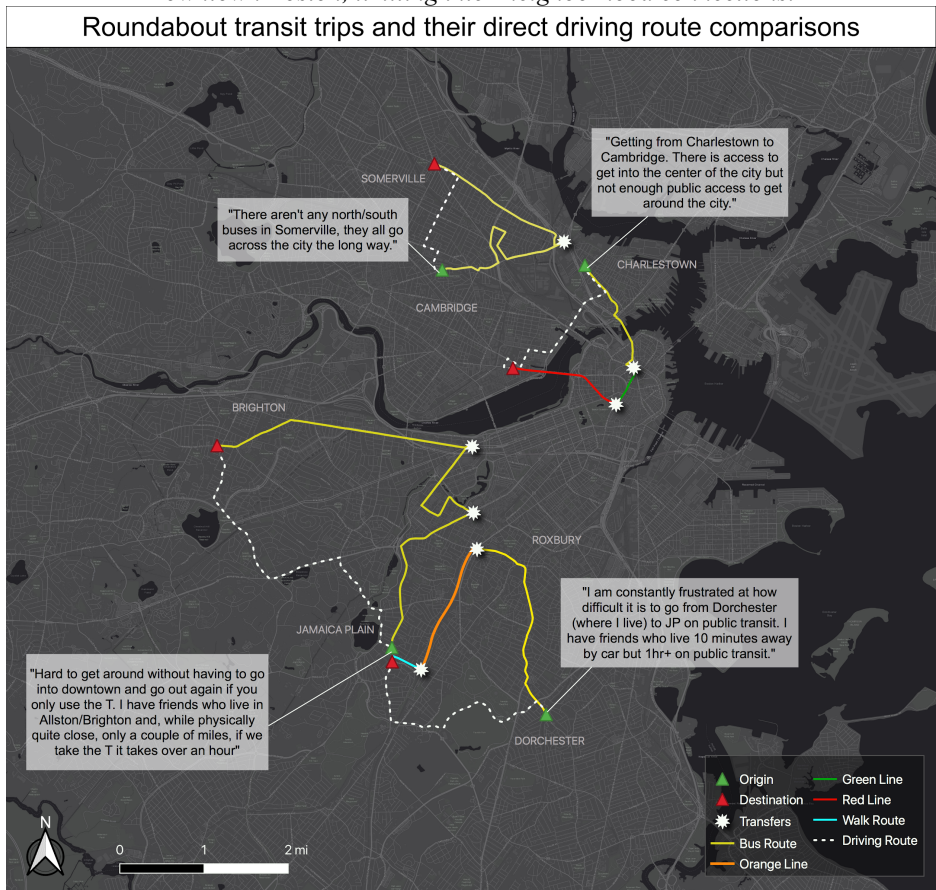


Figure 8: A visualization of some of the out-of-the-way transit trips survey respondents have to make in comparison with the far more direct driving routes. Transit trips don't just take longer, they come with the added stress of catching multiple transfers and the frustration of having to travel so far out of the way--just to be limited by the same vehicular traffic as single-occupancy vehicles.

Change

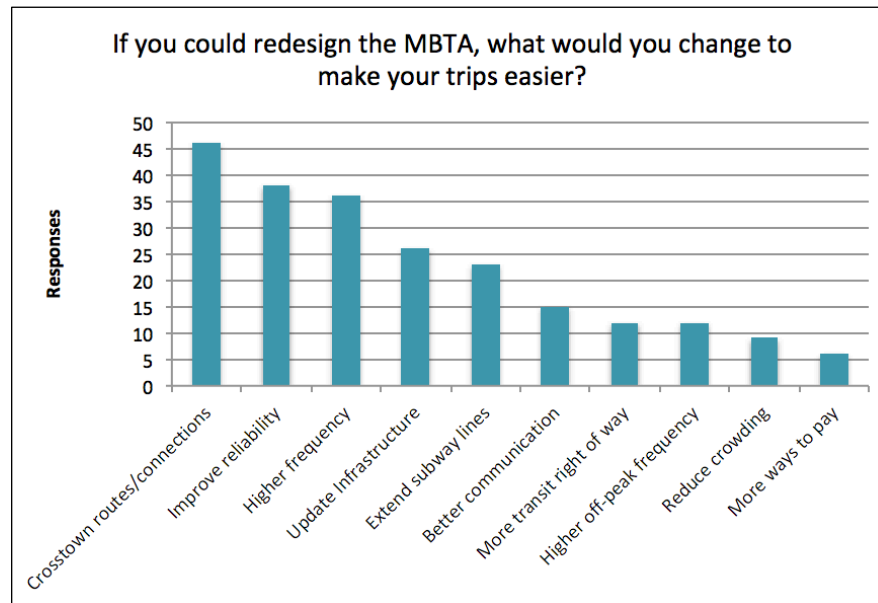


Figure 9: Topics mentioned in response to Question 4

Dozens of people answered that their trips would be improved with some form of increased crosstown/ring service. As was described in the previous section about access, traveling between the towns and neighborhoods outside of downtown Boston requires either traveling all the way inbound and outbound or making multiple transfers on buses. Respondents used terms such as “the outdated hub-and-spoke model” and compared the “as the crow flies” distance to the actual distance they had to travel to describe their frustration with the MBTA’s design. While many of those who referenced this acknowledged that creating a new rapid transit line through existing neighborhoods would be expensive, disruptive, and almost impossible, bus rapid transit (BRT) was offered as a possible alternative. Extending the subway lines, adding express service, and increasing the “right-of-way” that buses and trolleys currently have were other popular responses to improve access across Greater Boston.

Unsurprisingly, improved reliability and frequency were frequent requests. Annoyance with “bus bunching”--when multiple buses arrive at a stop at once instead of being separated in even intervals--came up multiple times. Often, frustration with unreliability was mentioned in conjunction with another common ask for better communication from the MBTA to passengers experiencing delays. Respondents mentioned being stuck in stopped trains with no explanation, mismatches between bus arrival times on tracker apps and actual arrival times, unintelligible announcements over broken speakers, and more as failures of communication that made delays even more frustrating. Some wrote that they appreciated the “time until arrival” signs at subway stations, and made their own suggestions for bus stops and other locations where these signs could be installed.

Many respondents lamented the poor infrastructure of the MBTA, sometimes comparing it to better public transit systems that they had experienced in other countries. Experiences with trains breaking down, setting on fire, or otherwise going out of service unexpectedly were common, sparking requests for new, more reliable trains--particularly ones that can fit more people. Others asked for cleaner, brighter stations, including better upkeep of the elevators. Another aspect of the MBTA that some respondents found outdated is paying for tickets. For example, a Commuter Rail passenger cannot transfer for free to the bus or subway, and Green Line and bus passengers have limited places where they can purchase tickets.

Measures to improve accessibility came up in many different forms. In terms of accessibility within train cars, two women mentioned that especially in the new Orange Line trains, there are very few places to hold onto for shorter people who have difficulty reaching the hanging loops. This makes it difficult and stressful to stand on rides with many starts-and-stops. In addition, there is no signage within train cars asking passengers to give up their seats for

pregnant people, making it awkward for those who struggle to stand for the whole train ride to ask a seated person to give up their spot. Within the stations, some asked for more elevators and to improve the reliability and cleanliness of the existing ones, as well as to limit the duration that elevators are closed for maintenance. Respondents also suggested adding more signage directing travelers to the nearest elevators, and to not put them in such “out-of-the-way” locations compared to the stairways.

Although the MBTA has expanded payment methods on the Commuter Rail to allow passengers to pay with cash, credit card, an app, or a pass, paying for the bus or the subway can be challenging. Bus stops and Green Line stations on the B, C, and E lines often do not have ticket machines, so passengers sometimes have to pay with cash and slow down boarding. Installing more ticket machines or allowing passengers to pay with alternate methods could both reduce stress on passengers and limit the time buses and trolleys spend idling at stops.

RECOMMENDATIONS

Design Guidelines

The MBTA is constantly undergoing construction, from minor station upgrades and revitalization to major infrastructure development, such as the Green Line Extension and the rollout of the new Orange Line cars. While changing the design of all existing stations and vehicles would be very challenging, these new projects are a useful opportunity to adopt inclusive design guidelines. Based on the suggestions from the survey responses, I have listed a few recommendations below.

- 1. Limit tunnels and other dimly-lit areas.** Tunnels can feel frightening and unsafe because they are often poorly lit and have limited exits. While tunnels are by no means avoidable, if possible, alternatives such as overpasses or at-grade crossings should be utilized. If they are necessary, tunnels should be well-lit with clear exits, and should ideally be well-trafficked.
- 2. Have conveniently-placed and well-maintained elevators.** It can be frustrating for those who rely on subway elevators, either because of mobility issues, children in strollers, or other reasons, to have to walk further and go farther out-of-the-way than those who can use the stairs. In addition, riding the elevators can be a very unpleasant experience due to unsafe or unsanitary conditions. Prioritizing elevators instead of including them as an afterthought can make a substantial difference in the comfort and stress levels of the passengers who rely on them.
- 3. Expand emergency response systems.** Without reliable emergency response measures in place, taking public transit--particularly at night--can feel very risky. Emergency buttons in stations, at bus stops, and within vehicles, as well as other more discreet

reporting systems such as texting hotlines should be well advertised and maintained.

Information about safe places to be in stations or on trains--such as which areas are well-staffed--should be made available.

- 4. Create guidelines for people with strollers in trains and buses.** Currently, it isn't very clear to other passengers what they should do to accommodate strollers, especially during peak periods when there is limited space to begin with. Clearly designating a portion of the train or bus as a priority area for strollers could make it easier both for the people with strollers and the other passengers.
- 5. Keep shorter people in mind when designing the "standing room" on trains and buses.** Especially on the new Orange Line cars, the poles and hand loops to help support people standing on train cars are difficult to reach for shorter-than-average people, many of whom are women and children. When designing new train cars and buses, there should be enough places for shorter people to comfortably hold onto, both for their own safety and for the safety of others on a crowded vehicle.
- 6. Include time-to-arrival signs and ways to clearly communicate delays.** Although most rapid transit stations have time-to-arrival signs, many major bus stops do not. In addition, communication about delays to passengers is usually very limited, and the announcements can be difficult to understand. New vehicles and stations should include clear, reliable modes of communication to reduce the stress that comes from uncertainty and confusion.
- 7. Design comfortable "waiting" infrastructure.** Many of the survey respondents wrote that the time they spend waiting for the bus or the train was the most stressful portion of their commute. Part of this stress can be alleviated with better communications about

delays and arrivals, but the design of the waiting area can make a significant difference as well. If passengers have to stand outside in the rain with no shelter, a ten-minute wait for the bus might not be worth it.

- 8. Extend hours of bus service.** Many MBTA bus routes end service in the evening, meaning that those who travel late at night may have to either take a less direct route and walk long distances on dark and empty streets, choose a more expensive option such as Uber or Lyft, or otherwise inconvenience themselves by limiting their hours of travel. Expanding late-night service offers a safer and affordable option for those who have to travel during these hours.

Major Infrastructural Changes

Many of the survey responses discussed the limitations of the “hub-and-spokes” system and the lack of connections both *between* the neighborhoods along the “spokes” and *within* neighborhoods and towns. Although creating new subway lines would be a huge endeavor, other possibilities such as above-ground light-rail or BRT could be alternative solutions or stepping stones to more substantial projects.

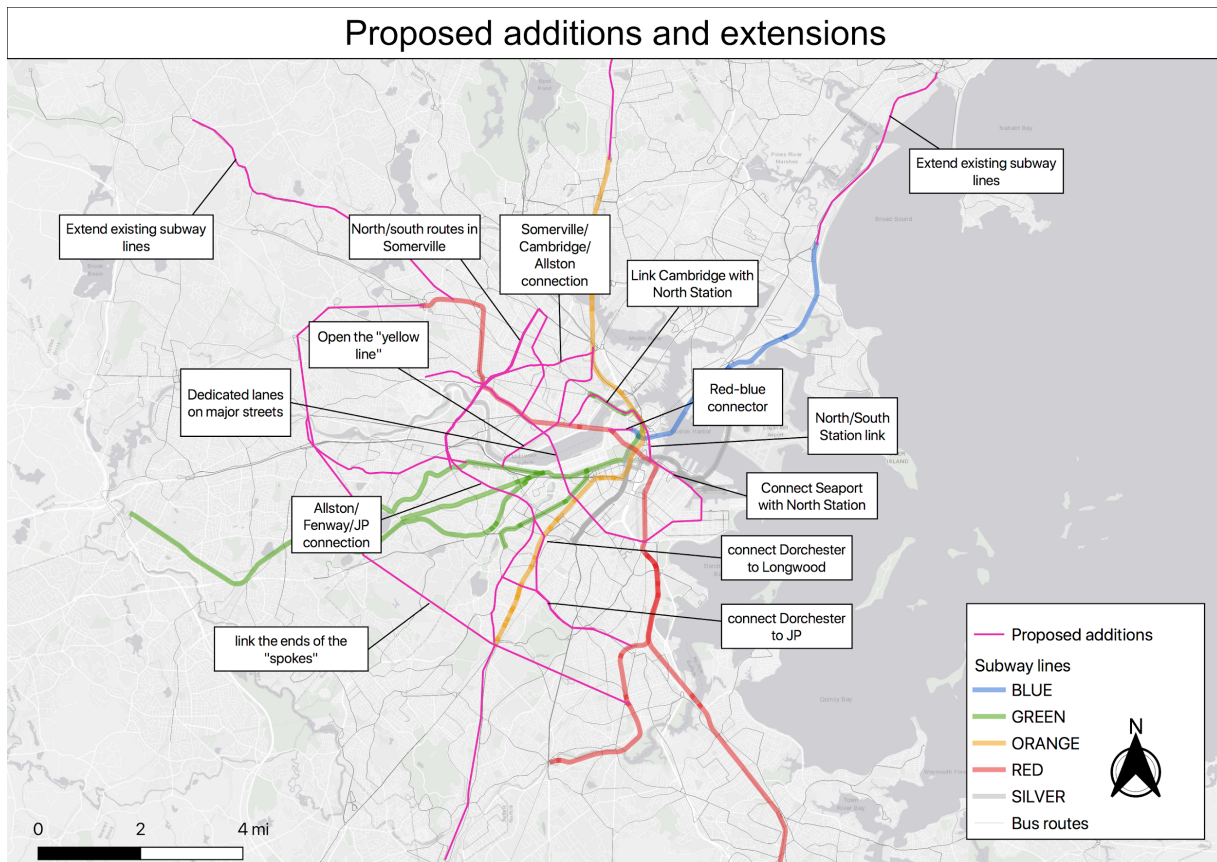


Figure 10: All of the proposed extensions and additions to the MBTA mentioned in the survey.

Figure X shows all of the different suggestions provided in the survey responses. Many respondents either mentioned two neighborhoods that they would like to connect (e.g., Dorchester and JP) or proposed a more vague “circle line” that would connect the ends of the spokes, so I interpreted the results as best as I could. A few connections in particular came up multiple times, such as the inaccessibility of Allston/Brighton and Jamaica Plain from anywhere but downtown, how the Seaport feels cut off from the rest of the city, and how difficult it is to traverse Somerville from its Cambridge border to Medford. Others called for extensions of the existing subway lines into the suburbs, which, as I will discuss, is far easier on certain lines than others.

Options utilizing existing infrastructure

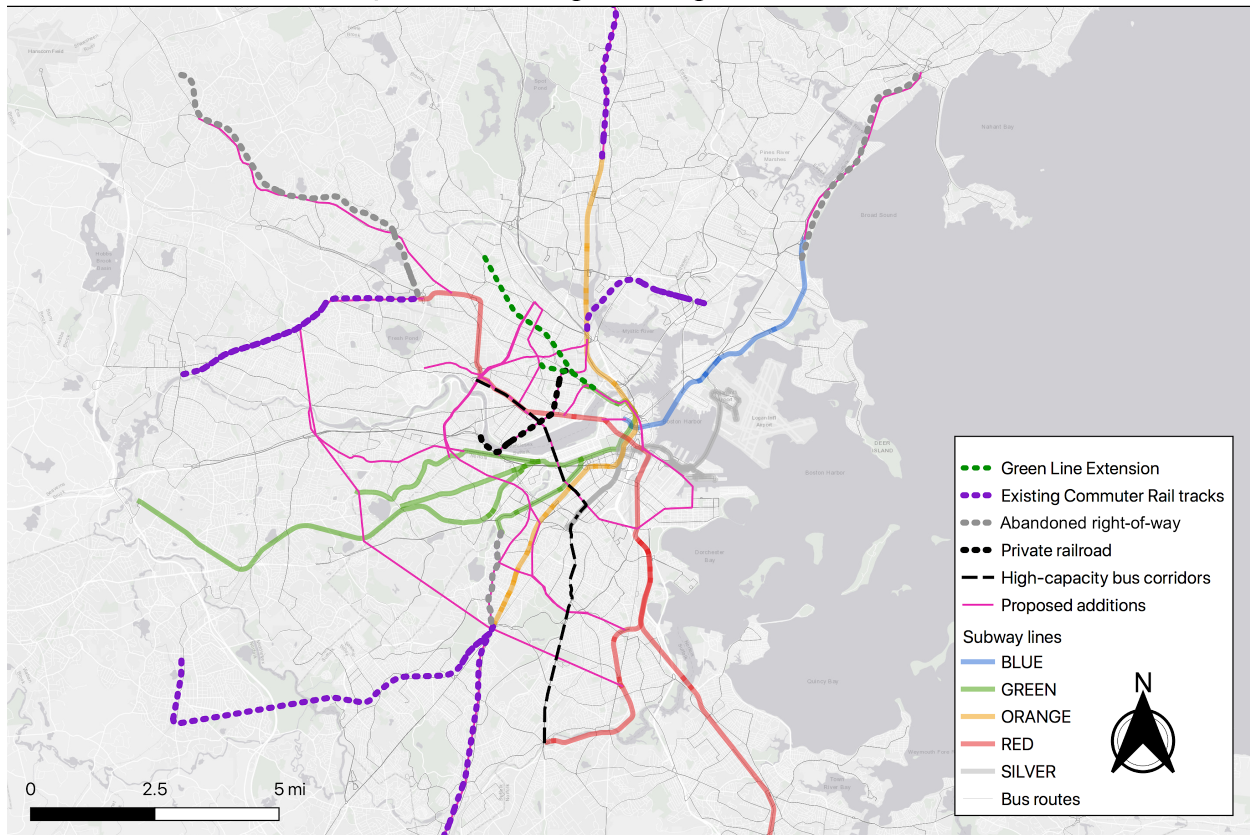


Figure 11: Existing infrastructure that could be used to expand service

On the North and South ends of the Orange and Red Lines, Commuter Rail tracks extend past the terminus stations out towards the suburbs. The existing right-of-way could potentially be used for subway extensions; in fact, the Green Line Extension is currently being constructed alongside the existing Fitchburg and Lowell lines. Although building new tracks and stations would by no means be low-hanging fruit, it is definitely more feasible than removing existing infrastructure to create a new right-of-way. On this map, the Orange Line extends on the north side to Reading and on the south side to Needham via Roslindale and West Roxbury and to Dedham via Hyde Park; the Red Line extends on the north Side to Waltham via Belmont.

Similarly, the Newburyport/Rockport line branches off of the northern branch of the Orange Line and continues on through Everett and Chelsea, two communities with large transit-reliant populations but limited rapid transit access. In Chelsea, the tracks eventually run parallel

to the Silver Line 3, a BRT service, and then branch off north towards Revere. This existing right-of-way could be used to bring service to communities underserved by transit.

Although the tracks have since been removed, the MBTA-owned right-of-way along the Minuteman Bikeway could potentially be used to extend the Red Line towards Lexington. However, as this “rail trail” is well-used and beloved, this project may be unlikely. A more probable conversion of an abandoned right-of-way is an extension of the Blue Line from Wonderland to Lynn along the old Boston, Revere Beach, and Lynn Railroad, as was originally intended during the initial construction of the Blue Line¹⁸. This could bring rapid transit service to Lynn, a community with a large transit-reliant population.

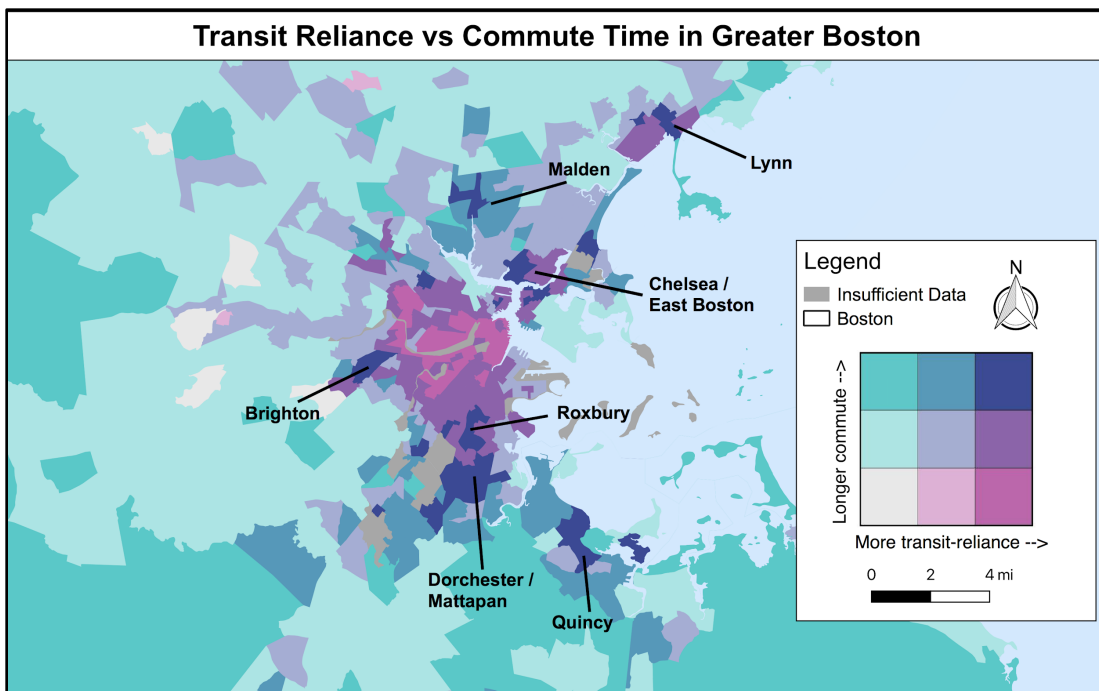


Figure 12: Lynn, Chelsea, East Boston, and Dorchester are just a few examples of Greater Boston communities with transit-reliant populations that also have long commutes, and should be high-priority areas if new rapid transit service is constructed.

It may seem redundant to extend subway lines along existing Commuter Rail tracks, since those areas are already serviced by the Commuter Rail. However, MBTA subway service (referring to the Red, Green, Orange, and Blue rapid transit lines of the MBTA, not necessarily

¹⁸ Hilton, George W. (1990). *American Narrow Gauge Railroads*.

underground lines) is far more frequent than Commuter Rail service; midday Red Line service runs at about 9 trains per hour, but midday Fitchburg Line trains run less than once an hour. An increase of off-peak frequency by 10-fold makes the difference between having to schedule one's entire day around the train's departures and simply being able to arrive at the station and wait a few minutes. This particularly eases the stress of making transfers--with frequent trains, passengers don't need to give themselves a buffer zone to account for unreliability of the mode they are transferring from. In addition, the subway is significantly cheaper than the Commuter Rail and offers free transfers to other subway lines or buses. For example, the trip from Braintree to South Station costs \$2.40 on the subway but \$6.50 on the Commuter Rail. Rapid transit provides cheap and frequent service for transit users who have unpredictable or variable schedules or who travel at off-peak times.

Another existing piece of infrastructure is the Grand Junction Railroad (GJR), sometimes referred to by transit advocates as the "Yellow Line". The GJR runs from Allston across the Charles River, through Kendall Square and East Cambridge, and terminates near North Station, and is currently used to connect Commuter Rail trains running from South Station to the Boston Engine Terminal (BET), the largest Commuter Rail maintenance facility. It runs along its own right-of-way, but it crosses major streets such as Massachusetts Avenue at-grade and runs very slowly: at some crossings, a conductor walks in front of the train ringing a bell to alert pedestrians and traffic of the approaching train. Despite these infrastructural shortcomings, the GJR has the potential to function as about one third of an "inner loop" connecting Charlestown, Cambridge, and Allston. With the rise of Kendall and Longwood Medical Area--not far from the GJR's southern terminus--as major job centers, this right-of-way could be extremely useful.

Lastly, the highly-trafficked bus corridor from Harvard to Mattapan via Nubian Square, traversed by the 1 bus on the northern end and the 28 bus on the southern, has potential to become the city’s formative “bus priority corridor”. Most of Massachusetts Ave, the street where that makes up the majority of the 1 bus route, has two lanes of vehicular traffic and one lane of parking in each direction. Most Blue Hill Ave, where the 28 bus travels, has two or three lanes in each direction, a parking lane, a bike lane, and a median--a remnant of the old Blue Hill Ave trolley--leaving plenty of space for bus lanes and stations while still preserving room for other modes. Right now, only one segment of this corridor has bus priority lanes, but only for a few blocks and only in one direction. Even with the bus lanes, the buses on this segment from Central Square to the Charles River are slowed by frequent stoplights. The situation is even worse for the 28 bus, where the 4.5 mile trip from Mattapan to Nubian Square typically takes 50 minutes during rush hour due to slow traffic and long boarding times: with limited places to load money onto bus passes, many passengers pay with cash¹⁹. Furthermore, according to the most recent MBTA Blue Book, over 13,000 people ride the 1 bus every day and over 14,000 ride the 28. Combined, that is 8,000 more daily riders than the Providence Line, the Commuter Rail line with the highest ridership. This Mass Ave/Warren St/Blue Hill Ave bus priority corridor would improve tens of thousands of commutes without having to remove much space from other modes.

Circle Lines

Circle or “loop” rapid transit routes address many of the inefficiencies and stress described in the survey responses. First, passengers can be dissuaded from taking public transportation if they have to go all the way inbound and outbound, which can feel frustrating

¹⁹ <https://mass.streetsblog.org/2020/03/05/city-pitches-transformative-transit-focused-redesign-for-blue-hill-ave/>

and unintuitive. Driving is usually noticeably more direct--see Figure X for some examples referenced by the survey respondents. Moreover, making transfers was often cited as one of the more stressful parts of a transit trip in the survey responses. A circle line could provide a “one-seat ride” between neighborhoods, limiting the stress associated with making a tight connection.

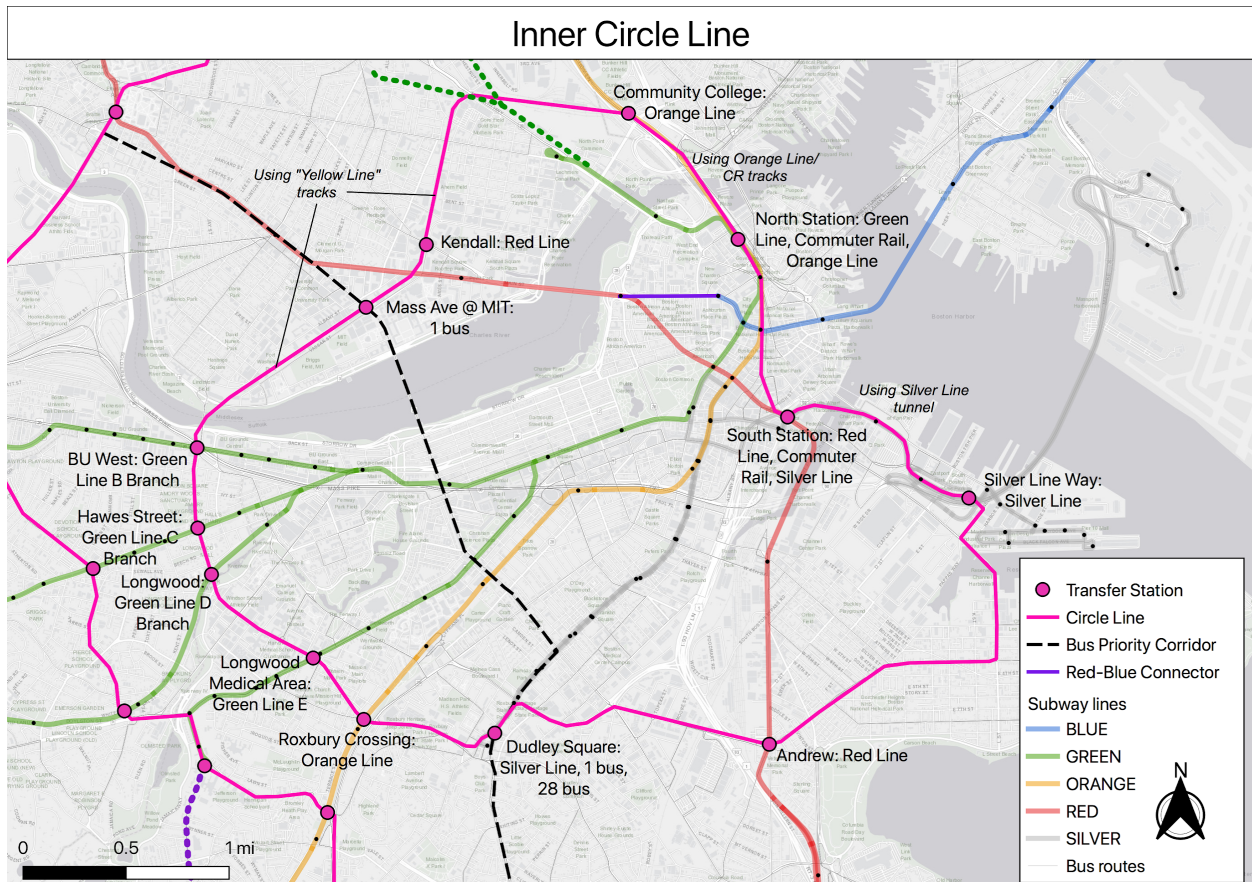


Figure 13: Transfers on the proposed “Inner Circle Line”. Note that this does not show all proposed stations, just the places where the Circle Line would connect with existing transit infrastructure.

Using a combination of suggestions from the survey and existing transit infrastructure, I proposed a circle line linking the “spokes” of the MBTA together. This line would use the GJR/“Yellow Line” tracks to link Charlestown, Cambridge, and Allston, would run perpendicular to the four Green Line branches through to Longwood, and connect with the Orange Line and the Silver Line/routes 1 and 28 bus priority corridor in Roxbury. Afterwards, it would continue on to Andrew Station and South Boston, eventually linking up with the Silver

Line in the Seaport District and connecting South Station to North Station, a project that has been pushed for by transit advocates for years.

Kendall, Longwood, and Seaport are quickly becoming major Boston job centers, but they are very difficult to reach if you do not live on the right subway line. This loop could provide an easier connection to these areas without having to go all the way downtown or to sit in traffic on a local bus. While some of the sections of the route will be harder to build than others, particularly the sections connecting the Green Line branches and the North/South Station connection through downtown, this loop could potentially begin as Bus Rapid Transit service instead of subway service, giving an opportunity to pilot the project and gain support for a more established route.

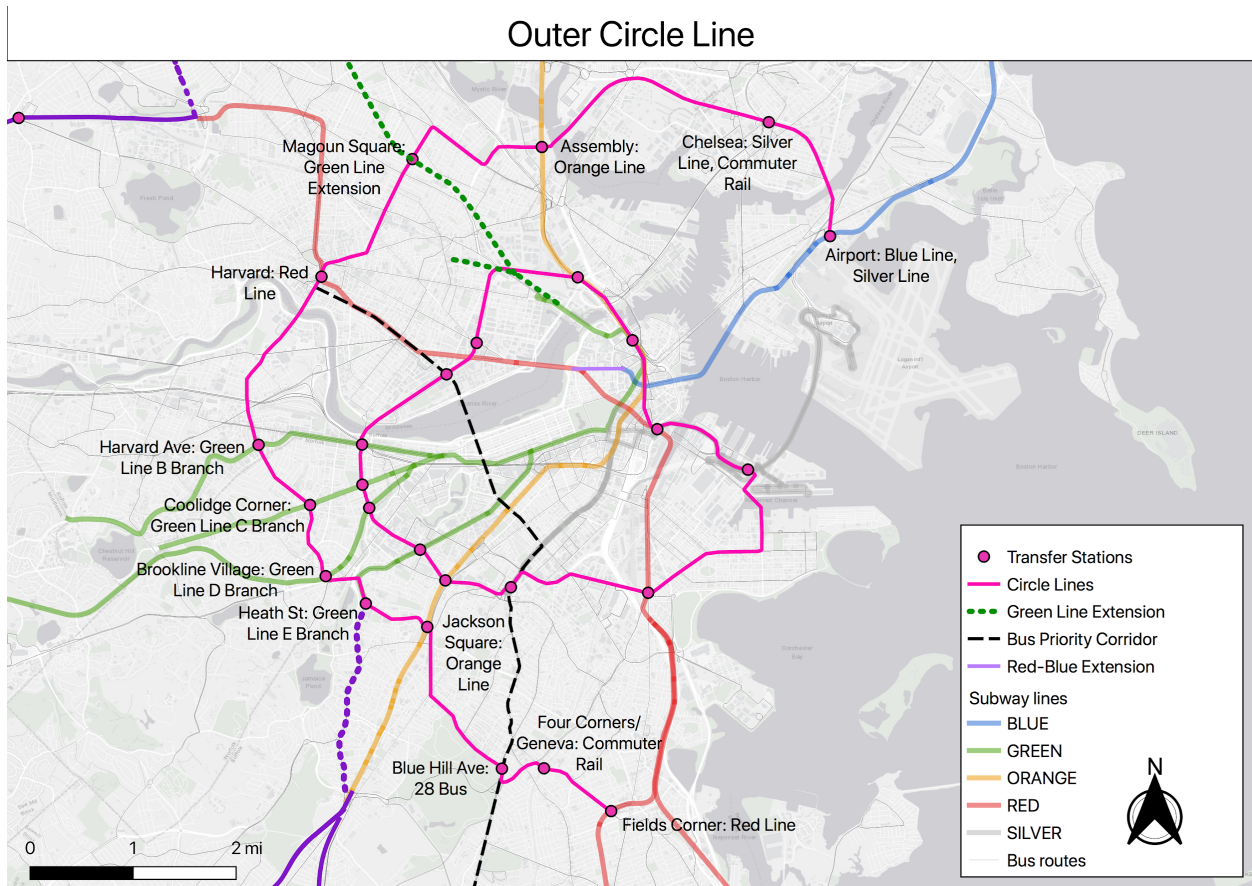


Figure 14: Transfers on the proposed “Outer Circle Line” would connect the outer but dense neighborhood and cities of Dorchester, JP, Allston, Cambridge, Somerville, Chelsea, and East Boston.

The Outer Circle Line addresses many of the comments noting the lack of connections between outer Boston neighborhoods, including Dorchester, Jamaica Plain, and Allston, as well as the difficulty in traversing Somerville in the north/south direction. Importantly, this outer loop brings rapid transit service to Chelsea and Everett via the Newburyport/Rockport Line right-of-way and the SL3 right-of-way. Unfortunately, save the aforementioned Chelsea section and a short stretch along Somerville’s Broadway bus lanes, the Outer Circle Line travels through mixed traffic, such as along Harvard Ave in Allston/Brookline. Creating priority lanes along these stretches would require removing parking, an often controversial measure. In order to gain traction, this loop could pilot in certain segments to start: perhaps in the form of BRT service on the 66 bus, which currently follows the route of the Inner Circle Line from Harvard to Brookline Village.

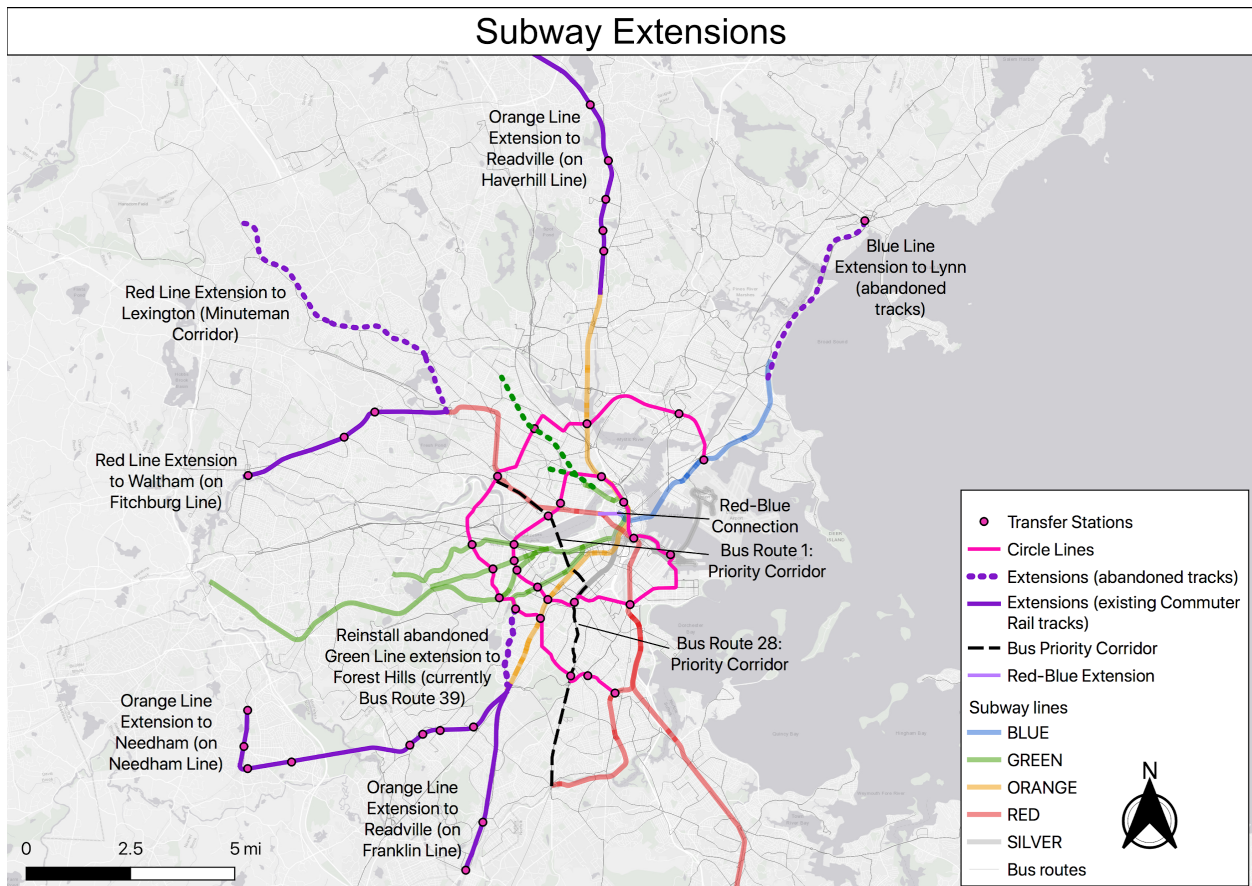


Figure 15: Extensions to existing subway lines would be a relatively non-disruptive way to expand transit access.

As mentioned earlier in this section, extensions of subway lines along the Commuter Rail tracks could transform transit access in many Greater Boston neighborhoods. For example, traveling downtown from the Boston neighborhoods of West Roxbury, Roslindale, and Hyde Park on the Commuter Rail costs \$6.50--a hefty price for a trip entirely within Boston city limits. The price and the infrequency of the Commuter Rail leaves transit-reliant residents of these neighborhoods dependent on bus service; extending the Orange Line would make accessing these neighborhoods easier and less expensive.

DISCUSSION

The experiences of the women who took the survey were varied, and by no means represent the views of every transit-reliant woman in the Boston area. However, many of the survey responses were in line with the conclusions from literature on women and public transit. These results reinforce that changes such as enhancing safety through better station design and extended, frequent service as well as increasing intra-neighborhood and off-peak service to support trip-chaining are widespread and not unique to a particular city.

Potential Roadblocks

Improving public transit and building new infrastructure can be positive in theory, but it also has the possibility to spur gentrification and displacement in surrounding neighborhoods, harming the residents that it was intended to help. This has been particularly relevant in discussions surrounding two transit projects in the Boston area--the Green Line Extension (GLX) and the Fairmount Line. While the GLX is expected to bring rapid transit access to an area now only served by local buses and to reduce daily Vehicle Miles Traveled (VMT) by 25,728 miles²⁰, many have voiced concerns about the potential gentrification, displacement, and rising rents that the extension could bring. The Metropolitan Area Planning Council (MAPC) conducted an investigation about the potential impacts of the extension, and predicted a demand for 6,300 new units from 2010 to 2030. If supply does not keep up with demand, they warn that the effects of gentrification will be even more significant. On the southern side of the city, the Fairmount branch of the Commuter Rail line runs from South Station in Downtown Boston through the transit-underserved neighborhoods of Roxbury, Dorchester, Mattapan, and Hyde Park. Although the route is similar to a rapid transit line in the way that it runs through dense neighborhoods

²⁰ <https://www.mass.gov/info-details/about-the-green-line-extension-project#benefits->

with frequent stops, the Fairmount Line runs at a frequency of one train every 45 minutes during rush hour and one train every hour at off-peak times, making it challenging to time connections or to have a flexible schedule.

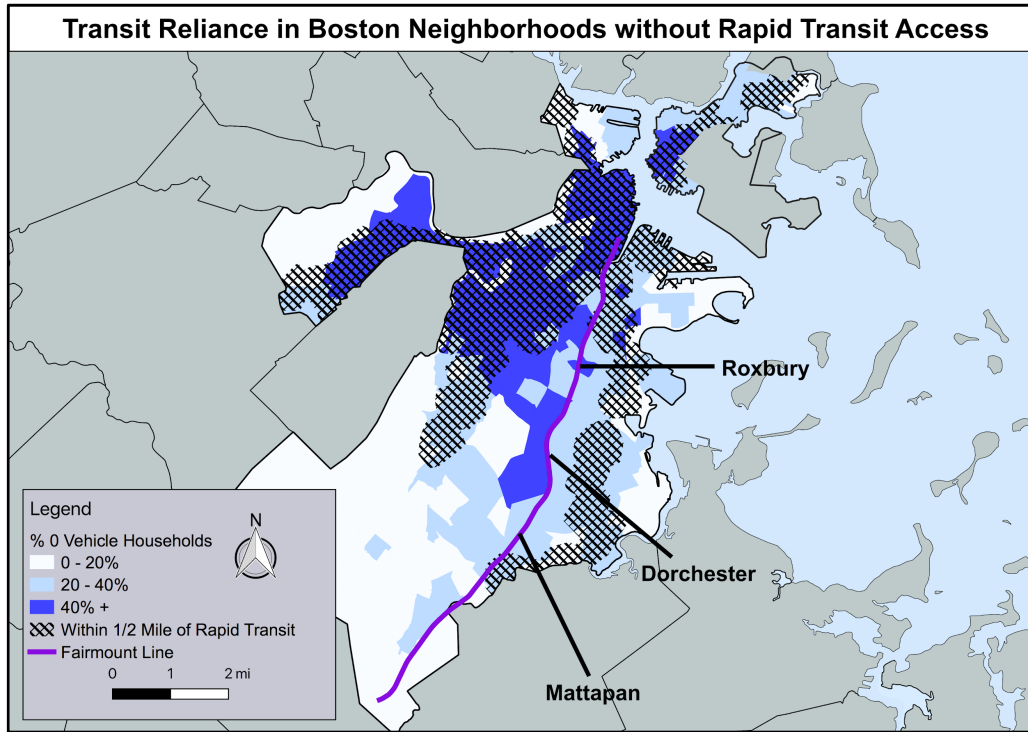


Figure 16: The crosshatch overlay shows neighborhoods within a half-mile walk from a rapid transit station; the darker blue areas are neighborhoods where > 40% of households do not own a car. The Fairmount Line travels through neighborhoods that have high transit reliance but limited access to rapid transit.

Increasing service on the Fairmount Line could drastically cut down commute times for many residents of the neighborhoods along the “Fairmount Corridor”. Community advocates have pushed for higher frequency, free transfers to the subway and bus systems, and time-to-arrival signs in order to make the Fairmount Line more reliable, accessible, and affordable²¹. Moreover, the Fairmount Line is the only Commuter Rail line with “majority-minority” ridership. 53% of Fairmount Line riders and 80% of Fairmount Corridor residents are racial minorities but only 15% of all Commuter Rail riders are, and the conversation surrounding the

²¹ <https://www.dotnews.com/2016/indigo-line-advocates-keep-pushing-switch-transit>

improvement of the Fairmount Line typically involves discussions of equity and racial justice²². However, as with the GLX, transit improvements make the surrounding neighborhoods more desirable, and eventually, more expensive. Residents fear that the Fairmount Corridor neighborhoods will gentrify as the adjacent neighborhood of Jamaica Plain did when the Orange Line relocated there in the 1980s²³.

However, this does not mean that there should be no public transportation development in low-income neighborhoods in fear that they will gentrify. Advocates for Fairmount Line improvements have suggested a variety of tactics to prevent displacement. The group Action for Equity has drafted an article proposing a “Transit Oriented Development Special Protection Zone” along the Fairmount Corridor, in which the City of Boston would commit to maintaining at least 40% affordable housing within the zone in order to mitigate displacement²⁴. Another option is establishing Community Land Trusts (CLTs), which are non-profit corporations that “acquire parcels of land, held in perpetuity, primarily for conveyance under long-term ground leases” and provide long-term affordable housing²⁵. Many of Boston’s vacant or “distressed” units lie along the Fairmount Corridor and could be purchased and repurposed by CLTs in order to maintain a substantial stock of sub-market-rate units²⁶. These potential externalities of improving public transportation should be considered when adopting the principles recommended to support transit-reliant women in order to ensure that these changes benefit them, not displace them.

²² <https://www.ctps.org/apps/mbtasurvey2018/>

²³ <https://www.baystatebanner.com/2014/12/10/fairmount-line-redevelopment-sparks-displacement-concerns/>

²⁴ https://www.action4equity.org/uploads/1/2/6/3/126323714/special_protection_zone_draft_article_91_8.1.19.pdf

²⁵ <https://www.govtrack.us/congress/bills/102/hr5334/text>

²⁶ <https://sites.tufts.edu/jamesjennings/files/2020/01/reportsCommunityVoicesFairmoun2019.pdf>

CONCLUSION

This thesis is not only about expanding the mobility of transit-reliant women, although that is far from an unimportant or narrow subject. As transit-reliant women are more likely to use public transportation in unorthodox ways and to, by necessity, use transit for many purposes, their experiences and suggestions are a useful template for how we can transform and rethink public transportation to function well for all travel. In order to reduce traffic congestion and greenhouse gas emissions, the MBTA must change its approach to public transportation and consider how the difficulty of making trips that aren't along the rapid transit "spokes" or at rush hour limits the accessibility of the system and pushes people to use their cars. These changes won't just affect those who rely on public transit: increased off-peak service could convince the suburbanite who drives to work in case he has to stay late for a 6pm meeting and doesn't want to wait an hour for the next train home to start taking the Commuter Rail instead. By "designing from the margins" with an approach centered on transit-reliant women, the MBTA could address many of the issues that often make transit a less attractive option than driving.

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