EJ AND THE MBTA: A STUDY OF RIDESHARING AND PUBLIC TRANSIT IN THE GREATER BOSTON AREA

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Introduction:

The idea of carpooling with friends and family has long been a practice supported by both environmentalists and transportation officials as a way to reduce urban congestion and fossil fuel emissions (Amirkiaee and Evangelopoulos 9). However, since the launch of Uber in 2009 and Lyft in 2012, a growing number of app-based tech companies have managed to harness the need for low-cost, easily accessible single-vehicle transport for a profit—and in the case of these two front runners, with extreme success (Amirkiaee and Evangelopoulos 10). While some applaud Uber and Lyft for their ingenuity, the extremely fast rate at which these and other rideshare companies have infiltrated American cities has also been met with some trepidation. City officials across the country are struggling to incorporate these newer technologies into their regulatory systems; moreover, given the rate of expansion of these technologies, research into actual social, economic, and environmental outcomes is yet to come to any consensus (Amirkiaee and Evangelopoulos 20).

Ride-sharing, also known as ride-hailing, refers to a method of sharing privately-owned vehicles between the owner of the vehicle and another person, usually with the help of a smartphone app that matches drivers with passengers in exchange for a fee. As ridesharing services continue to expand, it is prudent for cities to look at the potential benefits and detriments

of this new form of transportation, especially for vulnerable urban populations. The city of Boston is no exception. As a bustling urban center, Boston features both a massive public transportation system, governed by the Massachusetts Bay Transportation Authority (MBTA), and a thriving ridesharing network. With the MBTA serving 4,812,658 customers in 200 different Massachusetts cities and towns ("Ridership and Service Statistics" 2), and Bostonians taking an estimated 96,000 Uber and Lyft rides per day in 2017 (Vaccaro), it is obvious that these transportation networks are crucial to urban functioning. However, given the vastness of such networks, there is reason to be concerned over how these services interact to provide transportation for the Boston public.

While literature on ridesharing continues to expand both within and beyond the Boston context, this paper seeks to forge connections between this literature and another [class] of environmental thought: environmental justice. As defined by the Massachusetts government, "Environmental Justice (EJ) is based on the principle that all people have a right to be protected from environmental pollution and to live in and enjoy a clean and healthful environment. EJ is the equal protection and meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies and the equitable distribution of environmental benefits" (EOEA and EDA). The environmental justice movement acknowledges the reality that environmental impacts are not spread equally to all members of society; rather, it pushes environmentalists to consider not only the severity of any given environmental impact, but to question *who* bears the weight of these impacts, and *what systems* determine where this weight is placed.

In the case of ridesharing research in Boston, this approach pushes us to consider who is included and excluded from transit options available in the Boston area. The existing literature on Boston's transportation network demonstrates that some communities are less served by the MBTA than others; moreover, given literature on ridesharing theory and environmental justice theory, this inequality suggests that different neighborhoods in Boston have unique transit needs, and therefore may respond to emerging ridesharing opportunities in unique ways. In this paper, we consider the existing literature on ridesharing and transit inequality, before moving to look at the current status of public transit in the Boston area. Seated in this context, we introduce our own contribution to this literature, pursuing the question: How are commuters in Newton and Mattapan utilizing the MBTA and ride-sharing companies (like Uber, Lyft, etc.), given transit inequalities?

Literature Review:

In 2018, the Metropolitan Area Planning Council (MAPC) published a city-wide survey measuring the impacts of ride-sharing in Boston, marking the first in-depth account of how ride-sharing services are interacting with established forms of transportation. To do this, the MAPC placed a survey in the backseat of ten rideshare vehicles, and recorded the responses of 1,000 passengers. The resulting data offers information about socioeconomic backgrounds, trip context, and general travel patterns and behaviors across Boston (Gehrke et al., 1). The socioeconomic data reveals, 82% of survey-respondents were under the age of 35, 67% of respondents identify as "White and Non-Hispanic", while Asian and Black riders represented 13% and 7% of survey recipients respectively. These statistics, the authors note, largely line up with the racial distribution in the areas where the survey was distributed (Gehrke et al., 6-7). Results indicate, over 50% of rideshare users reported that if they hadn't had access to a

rideshare service, they would have walked or cycled (12%) or taken transit (42%). Given this data, the report concludes that rideshare not only adds to street congestion, but that the "average ride-hailing trip represents 35 cents of lost fare revenue for the MBTA" (Gehrke et al., 2). These results point to a destructive relationship between Boston's existing transit system and ridesharing companies, suggesting that rideshare has begun to attract especially younger, whiter crowds away from the MBTA.

This study also leaves several important questions unanswered. What are the factors, for instance, that drive these populations away from the MBTA and *towards* ridesharing? On the other hand, why do other populations choose to *avoid* ridesharing? The MAPC survey was distributed only by rideshare drivers, thus limiting their data to Bostonians who already use rideshare services. Moreover, the surveys were distributed by drivers who were not limited to any one neighborhood, therefore preventing us from determining the impacts of ride-sharing on any one community. For example, this survey fails to demonstrate if the majority of riders are white because the drivers were located in racially non-diverse areas, or because ridesharing is in some way racially-biased.

In the following pages, we explore some of the literature that—like the MAPC study—attempts to clarify the impact of this new and emerging transportation option. Specifically, we offer two prevalent theoretical approaches to ridesharing, before delving into other recent studies of the impact of ridesharing on a municipal level. We then consider an environmental justice perspective to investigate how ridesharing might interact with existing transit issues within the context of the Greater Boston Area.

As is often true of newly emerging technologies, many authors have begun to theorize how "ride-sharing" fits into existing economic theories. Perhaps most enticing of these theories is that of the "sharing economy." In an article titled "Debating the Sharing Economy", Juliet Schor offers four market actions that are now understood as methods of economic "sharing": recirculation of goods, increased utilization of durable assets, exchange of services, and sharing of productive assets (Schor 9). Schor notes that these "sharing" actions present four potential positive outcomes: 1) economic benefits (for example, distributing the cost burden of a specific tool among a group, rather than shouldering it alone), 2) environmental benefits, as sharing platforms decrease personal ownership of resource intensive goods, 3) social benefits, which are produced by the social nature of "sharing" and 4) anti-capitalist outcomes, as these options are often painted as a solution to market failures (Schor 13). Here, Schor uses ridesharing as an example: Uber and Lyft, she notes, increase the utilization of privately-owned cars by broadening the number of people with access to a single car; in other words, while the typical car is used only by the owner, this owner can broaden the accessibility of her vehicle by offering to drive rideshare customers.

Schor notes that these potential benefits have driven the idea of "sharing economy" to new popularity in recent years, as they suggest a step away from unequal, unjust, and resource-heavy capitalist systems and towards an economic structure focused on "sharing" wealth and resources (Schor 8). However, she also notes growing doubts that these projected benefits will come to fruition. For example, Schor notes that sharing should, in concept, drive down the demand for new goods, thus resulting in a smaller ecological footprint; however, economists have instead seen sharing companies open up new markets, thus creating demand for

services where they didn't exist before. Also unavoidable are charges of labor exploitation by sharing companies, who are accused of paying their (part-time) workers under the minimum wage (Schor 7). In conclusion, Schor notes that the ability of sharing companies to build better economies depends on whether or not they fall into the "business as usual" trap and merely becoming another way for companies to accrue profit through the exploitation of customers and workers (Schor 10).

While Schor critiques ridesharing, others have looked at how it fits into current markets. In *Uber: Innovation in Society*, Schneider details how Uber fits within already-established transportation markets. Schneider frames Uber as a sharing platform that intermediates between two groups of customers: one with excess and idle capacity (car-owners) and one with a demand for that capacity (people who need to travel). Schneider notes that Uber's market approach is unlike those of traditional transportation companies because it is self-defined as a "platform." In other words, it treats both drivers and riders as customers (Schneider 32). Despite this, Schneider argues that Uber is not trying to radically change the already-existing market, but rather capitalize on market inefficiencies (Schneider 38). For example, rather than trying overthrow the public transit system, Uber gains customers by sending drivers to areas that subways and buses don't reach, thus cornering markets in these neighborhoods.

Schneider also makes note of Uber's complex relationship with municipal transportation regulation systems. Regulation systems, according to Schneider, are often to blame for market inefficiencies, as they set roadblocks meant to ensure things such as fair wages, fair treatment, and balanced budgets. For example, most cities use a "medallion" system to limit the number of taxis on the streets, thus ensuring that all taxi drivers can make a living wage; however, these

medallion systems also increase prices and reduce the number of taxis, making taxis less efficient as a transportation mode (Schneider 50). In an effort to avoid such inefficiencies, Uber has only agreed to be labeled a platform. Unlike taxis, Uber can place as many drivers on the street as they want to, driving down prices and gaining customers (Schneider 46).

With the theoretical framework of a "sharing economy" in mind, we now turn to the recent surge of literature surrounding the introduction of ridesharing to the urban landscape, and its potential impacts across social, political, economic, and environmental fields. A study conducted in 2014 by the University of California Transportation Center surveyed 380 participants to determine if ridesharing complements or competes with public transit. Surveys were administered at three "hot spots" in San Francisco: Mission District, Marina District and North Beach. Results concluding that ridesourcing, "serves a previously unmet demand for convenient, point-to-point urban travel." Most respondents contended they would have taken the trip regardless of the availability of ridesourcing services (Rayle et al. 1).

Rayle and colleagues aim to create a fundamental understanding of commuter behavior. When asked if they would still have made the trip if ridesourcing services were unavailable, 92% of respondents said they would, 39% of which said they would have used a taxi instead, while 33% would have selected bus or rail (Rayle et al. 13). In order to determine whether ridesourcing and public transit are complements, the authors "calculated transit accessibility by selecting origins and destinations of trips lying within a 400m buffer of rail transit stations and within 200m of bus stops" (Rayle et al. 9). 28% of trips were within 400m of rail transit, and 81% were possible by bus; this demonstrates that a majority of the sample are using ridesourcing as a *substitute* for public transit, particularly buses. 66% percent of these trips would have been at

least twice as long in minutes via public transit (Rayle et al. 15-16). Results suggest that while ridesharing has the ability to make public transit use more efficient, such efficiency is also leading consumers to use it as a complete replacement. A focus on measuring evening trips (which are overwhelmingly social) and the use of San Francisco as a case (the birthplace of ridesharing) has limitations in generalizability to how the average American city would handle the adoption of this new technology.

A subsequent study by Zhang and Zhang aims to determine if integrating public transit and ridesharing would allow for "easier multimodal transportation" (Zhang et al. 1). Their results demonstrate that individuals' public transit use is positively correlated to the frequency and probability of ridesharing use. In other words, those who use public transit are more likely to *also* engage with ridesharing services. Therefore, Zhang and Zhang argue that this should encourage public transportation agencies to see ridesharing systems as opportunities to broaden their services, rather than as competitive threats. This disagrees with the results from Rayle and colleagues, who contended that public transportation and ride sharing do not exist cohesively.

Employing ZINB (Zero-Inflated Negative Binomial Regression) models with data from the 2017 National Household Travel Survey (NHTS) suggest that a one-unit increase in public transport use is significantly positively related to a 1.2% increase in the monthly frequency of ridesharing use (Zhang and Zhang 1). This relationship was especially strong for people who reside in areas with high population densities and households with fewer vehicles. Sociodemographic patterns for ridesharing and public transit use were similar between men and women, white and minority individuals, as well as among income levels; however, younger people use ride-sharing more frequently than older people. Further, seasonal differences were

realized, as ridesharing use per month was highest in the spring and lowest in the summer (Zhang and Zhang 7-9). Individuals living in areas with rail service were also more likely to use ridesharing. The authors hypothesize that this phenomenon could be caused by travelers using ridesharing as a solution to "first-mile, last-mile" problems (i.e. traveling to from a location to public transit, and from a public transit destination to a final destination) (Zhang and Zhang 3). The authors recommend that public transit operators cooperate with ridesharing services to offer benefits like toll waivers, high-occupancy vehicle lane permits and parking priorities (Zhang and Zhang 19). Causality in the relationship between public transit use and ridesharing was not ensured in this study and factors such as personal habits, attitudes, or culture were not controlled. Furthermore, the inability to separate public transit modes from one another was problematic (Zhang and Zhang 20).

The above theories paint a mixed picture of ride-sharing theory. On one hand, ride-sharing fits into theories regarding the "sharing economy", suggesting that they could be one step in a movement away from resource-heavy capitalist economies. On the other hand, some research into the effect of ridesharing companies paint a bleaker picture, in which rideshare companies push out existing public transport systems – a process which, according to the MAPC study, may already be underway in Boston. In the context of this mixed theoretical setting, we turn to consider the other component of our research: the current status of the MBTA and its relationship with environmental justice.

In recent years, the MBTA began publishing data about its transportation system. Moreover, in an online project, Worcester Polytechnic graduate students Michael Barry and Brian Card in 2014 visualized data from three (Red, Blue, and Orange) subway lines through

several maps; these demonstrate when trains were traveling, how many people entered and exited stations, and when delays occurred. While useful, it is important to note that this data is does not include the Green Line or any other MBTA transportation options (Barry and Card). First, traffic patterns show that the Red Line (which crosses Boston from the Northwest to the Southeast; see Appendix 1) carries the most passengers out of these three lines. Traffic patterns also demonstrate the highest congestion on weekday mornings and weekday evenings, suggesting high commuter use (Barry and Card). Finally, Barry and Card integrate the above data to emphasize that lines with higher congestion face delays up to 40% during peak rush hour. We believe this data suggests both high volume use of the MBTA and delays are connected to high volume use during rush hour.

Barry and Card's work inspires many important questions about Boston's public transportation network unanswered; chiefly—which parts of the city does it best serve? To some extent, this question can be answered by looking at a map of the MBTA subway and bus lines (Appendix 1). Most glaringly, the Green Line extends four branches of rapid transit rail into the suburbs west of Boston; in comparison, a sizeable portion of South Boston (framed by the Orange and Red Lines) is accessible only by bus.

These questions lead us to consider the less illustrious side of modern urban transportation: transit inequality. Writing for the Civil Rights Law Journal, Sean B Seymore argues that public transportation authorities face the reality of unequal service at many junctures. Seymore notes two clear hierarchies: firstly, that transit riders overwhelmingly rate rail service above other transit options due to speed and limited station stops; and secondly, that income is the primary determinant of travel mode, with poor and minority communities much more likely

to rely on (less desirable) busses (Seymore 65). Seymore notes that within the context of urban settings that are already characterized by white flight and racial segregation, these factors are compounded by preferential treatment of the white communities by transit officials, who attempt to retain suburban ridership by expanding rail to these communities; conversely, Seymore reports that while busses carry 60% of average transit riders, they receive only 31% of capital funds (Seymore 68). Finally, Seymore notes the effects that these differential policies have on urban core residents. He cites several studies linking lack of appropriate transit options to lost job and welfare opportunities, higher percentages of children and students missing classes, and to health problems brought on by heavy vehicular traffic and exhaust from busses (Seymore 70-71).

Discussing Boston as a case study, Seymore reports that the quality of transit service varies substantially throughout the city, both in terms of transit options (rail service vs. bus service) and transit availability. In particular, Seymore notes the difference in transit options between Roxbury and Mattapan (which rely primarily on busses) and wealthier suburbs like Brookline, which is served by several MBTA rail lines. Seymore notes that in the early 20th century, Dorchester, Roxbury, and Mattapan were served by an elevated train line (the Orange Line Elevated) and street car service along Blue Hill Avenue. By the 1980s, both lines had been dismantled, and the Orange Line had been moved more than twelve blocks to the West, dislocating the line from the center of these neighborhoods, and necessitating expensive and time-consuming transfers to be made by commuters (Seymore 90-93). Moreover, Seymore reports, the MBTA's promise to replace the elevated line with "equal or better" service clearly failed to come through; rather, the Silver Line (a high-speed bus line) now offers a much slower form of transit, while also drawing complaints for its contribution to local air pollution (Seymore

95-96). Taken in conjunction with Seymore's comments on transit inequality, it is clear that this transit history has contributed to inequitable transit opportunities for the Dorchester, Roxbury, Mattapan corridor, especially as compared to better-served suburban communities—in which train lines remain open (Seymore 107).

Seymore characterizes this issue as ongoing, citing a 2001 Boston Globe report, which claims that since 1990, 40% of MBTA investment was directed towards suburban commuter rail service (which serves 10% of its daily ridership), while the bus system only saw 17% of funds, despite providing service for over a third of riders (Seymore 88). While Seymore's study is extremely valuable in providing a theoretical and historical analysis on transit inequality in Boston, it must be noted that this article is over ten years old, and is therefore unable to provide insight into MBTA conduct since then, especially given a series of leadership changes in the last few years. One pertinent example is the addition of a new Commuter Rail stop, opened in downtown Mattapan in early 2019, which is clearly aimed at expanding transit options in this area.

However, Seymore's work is supported by more recent literature on the state of transit systems around the country. U.S. transit systems transitioned from private to public ownership, causing them to be receptive to political pressure (Taylor and Morris 363). According to Taylor and Morris, these ownership changes have resulted in transit systems lacking a clear and coherent set of goals; as follows, in mission statements of various transportation associations, only 8% mentioned providing services to the poor, low-income or minorities (Taylor and Morris 356-7). When dependence on voter input grows, Taylor and Morris argue, such public institutions become susceptible to unbalanced voting patterns; specifically, the tendency of

white, upper-class people to vote more often than low-income people of color leads transit authorities to subsidize rail over bus, in order to appeal to white voters, who use rail as an alternative to driving (Taylor and Morris, 349). However, Taylor and Morris note, because these wealthier voters have access to private vehicle transportation, rail lines in the suburbs are not used as much as the underfunded bus lines, thus resulting in an inequitable organization of transit resources (Taylor and Morris, 352).

The outcomes of such inequitable systems have also been studied in other contexts. In their study of transit in Atlanta, Peipins and colleagues focused on the racial disparities of patient commutes to radiotherapy facilities in Atlanta, using U.S. census data to calculate how long it would take each patient to get to therapy using private and public transportation times. The Atlanta study reveals that black, low-income women, over 40 years of age, have significantly longer commute times than their white counterparts (Peipins et al. 34). Moreover, it takes these women seven times longer to travel to radiation therapy locations by public rather than private transportation (Peipins et al. 34). Unsurprisingly, there was a "strong correlation between lack of access to a private vehicle and poverty" (Peipins et al. 34). This study calls attention to a less obvious consequence of inadequate public transportation —unreliable access to life-saving healthcare—and environmental justice issue. Public transportation, in other words, is more important than the simply "getting to work;" rather, it is vital component to the accessibility of healthcare, jobs, schools, or just a day of leisurely afternoon at a museum.

Background:
With this theoretical framework in mind, our study moves to examine ridesharing in the context of Boston, Massachusetts. Home to the largest port in New England, Boston has long

provided a vital coastal link between North America and the world, connecting the region commercially, but also in terms of immigration and even intellectual thought—as the homeplace of some of the nation's oldest and most renowned universities (Bagley 78). In the late 19th century, moreover, Boston earned the title "Birthplace of Public Transportation" in America, recognizing the city's early establishment of public rail service, including the construction of the first subway tunnel in North America in 1897 ("The History of the MBTA"). Today, while significance of the port has faded, Boston remains the home of one of the biggest transit systems in the country—Massachusetts Bay Transportation Authority (the MBTA). Known as "the T," the MBTA provides subway, bus, commuter rail, ferry, and paratransit service to the Greater Boston Area. At its founding in 1964, the MBTA took over management of existing train lines to serve 78 municipalities in the Greater Boston area. Today, the culmination of fifty years of state funding has established the MBTA as one of the largest public transit systems in the country, serving nearly 200 cities and towns and over 1 million daily riders ("The History of the MBTA").

The history of the MBTA is a history of consolidation and slow, considered expansion. The early expansion of rail service in Boston established over twenty separate rail companies before the turn of the 20th century, transforming the city into a jumble of rail right-of-way's and competing trolley services ("The History of the MBTA"). Overtime, legislation aimed to create cohesion among these systems gave birth to first the Metropolitan Transit Authority, and then the MBTA; these organizations were charged with setting fares, purchasing rail stock, and deciding where to delegate state and city funds ("The History of the MBTA"). In his 1996 history of the MBTA, Gomez-Ibanez reports, the MBTA resisted then-common ridership declines, and increased bus, streetcar, and trolley bus mileage by 11% (Gomez-Ibanez 33). Gomez-Ibanez

attributes this trend to the MBTA's success in holding down fares, expanding transit lines into the suburbs, and refurbishing the commuter rail. However, Gomez-Ibanez also points out that while ridership has increased, the MBTA's share of the total transportation market has declined steadily (Gomez-Ibanez 35). Gomez-Ibanez attributes this decline to forces beyond the transit agency's control, such as increased wages and decreased job opportunities in Boston (Gomez-Ibanez 38).

Within this context, our research will focus on two communities, which will serve as our case studies: Newton and Mattapan. The city of Newton is located around 12 miles to the west of Boston's downtown, bordering Watertown, Brighton, and Brookline on its eastern border, while Mattapan (a Boston neighborhood) is located eight miles to the southwest of downtown, neighboring Dorchester and Roxbury. With an area of 18.2 square miles, Newton is home to 88,479 residents at a median age of 40.9 (U.S. Census Bureau). Considerably smaller in size than Newton, Mattapan is home to 39,010 residents (BPDA). Today, Newton and Mattapan reside on opposite ends of Boston's demographic spectrum. Newton is often named as one of Boston's wealthy suburbs, with a median household income of $133,853, high employment in managerial professions, and high home ownership (at 71.3%). Mattapan sees a median income of $43,256, a home ownership rate of 55%, and far greater reliance on retail and social assistance employment. Compundly, while 73% Newton residents are white, black/African-American residents represent 74% of Mattapan population, and 35% of Mattapan's population was foreign born.

While these demographics might paint a picture of two diametrically opposed communities, it is important to note that this was not always the case. In their book *The Death of an American Jewish Community*, Hillel Levine and Lawrence Harmon document the exodus of almost 90,000 Boston Jews from southern Boston (primarily, Roxbury, Dorchester, and

Mattapan) to the suburbs of Newton and Brookline in the 1960s (Levine and Harmon ix). During this period, they argue, historical documents point to the unilateral decision by a local consortium of local banks and insurance companies to establish a "carefully limited and well-defined district within which, and only within which, blacks could attain attractive, federally insured housing loans" (Levine and Harmon 6). Under the guise of expanding black homeownership, these banks ignored neighboring Irish and Italian neighborhoods and focused their efforts entirely on Mattapan, Roxbury, and Dorchester—Jewish communities characterized by their high homeownership (and therefore low profitability for these banks). As a result of vicious blockbusting techniques, these banks were instrumental in the rise of racially-motivated panic selling, street violence, and the ultimate mass exodus of wealthy Jewish families to the suburbs (Levine and Harmon 6).

Today, Boston remains in the top 20% of America's most segregated cities (Brooks and Chakrabarti). However, this history of horrific housing policies, and the pitting of two minority groups against one another for the purpose of profit, is a story replicated across the country. In the case of Boston, however, the connections between the resulting urban segregation and the development of the MBTA deserves more attention. While authors like Seymore have begun to explore how the segregation of Boston's neighborhoods have contributed to transit inequality throughout Boston, we believe that emerging literature about ridesharing should push community members and city officials alike to consider how this new technology might exacerbate existing transit tensions. In the following pages, we will describe the methods and results of our exploratory study, before moving to discuss how our study might inform existing and future work on this topic.

Methods & Limitations

Section 1: Data Collection

Recognizing theories that had been established in our literature review, primarily ride-sharing as a complement versus competitor to public transit, our goal was to conduct a quantitative study into commuter use of ridesharing and the MBTA in Newton and Mattapan. Given concerns about language barriers and infringements onto participants' commutes, we felt that quantitative data collection through online surveys to Newton and Mattapan residents was the most prudent way to gather clear, unbiased data. This survey, facilitated through Qualtrics, included questions on commuter practices, private vehicle ownership, decision-making and MBTA and ridesharing use; the full survey, as well as sample dispersal emails and our consent form can be viewed in full in Appendix 2, 3, and 4 (respectively). We distributed the link to the survey with the help of community leaders in Mattapan and Newton. Given our contacts in both communities, our goal was to have 200 responses total; 100 from each neighborhood. Unfortunately, we were only able to yield eighty-five responses from Newton and twenty-four from Mattapan during our collection period of January 22nd to April 16th, 2019.

Section 2: Recruitment and Sampling method

We designed our study around two demographically divergent neighborhoods in Boston: Mattapan, a racially diverse, low-income community that is poorly served by the MBTA; and Newton, a majority white, wealthy suburb that is well served by the MBTA (see "Background" for details). To be a part of our study, survey participants had to be residents of either Mattapan or Newton. We confirmed this by requiring participants to list their home zip code, and deleted all data connected to zip codes that do not match one of the neighborhoods, or for participants who did not include a zip code. Additionally, participants under the age of 18 were excluded

from the study, in order to avoid conducting research within a vulnerable population (Kanazawa, 335).

Our objective was to obtain a quota sample, as we intended to gather the same number of samples (100 each) from our two locations, Newton and Mattapan, using identical surveys and recruitment methods. While we first approached our survey with a purposive sampling method in mind, we did not have the resources to distribute surveys across the entirety of either community; rather, we pursued a "convenience sample" by using our existing connections to distribute our survey via the following listservs: Mattapan Food and Fitness Coalition's newsletter recipients, Mattapan Director of Constituent Services Walter Apperwhite's personal listserv, Green Newton's e-news subscribers, and Newton Councilwoman Emily Norton's personal listserv. Through this method, the survey was distributed to 900 Mattapan residents and 1700 Newton residents; however, we recognize this survey sample as non-random and therefore potentially unable to represent either the greater populations of Newton and Mattapan with as much accuracy.

Section 3: Map Creation

In the later phases of project development, we became aware of publicly available data collected by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) in 2010, regarding environmental justice communities in the Boston area. The EEA created an interactive map (see Appendix 5) identifying populations who matched with one or more of the following criteria: group whose annual median household income is equal to or less than 65% of the statewide median ($62,072 in 2010); 25% or more of the residents identify as a race other than white; or 25% or more of households have no one over the age of 14 who speaks English

only or very well ("2010 Environmental Justice Populations: Boston Area"). Given our use of MBTA maps throughout early stages of project development, we quickly recognized an opportunity to combine resources and draw greater conclusions about the environmental inequalities within the MBTA system. Using ArcGIS software, we overlaid the map of the 2010 environmental justice populations with a map of MBTA bus routes, subway lines, and commuter rail lines. This resulted in the creation of eight separate maps, each one focusing either on a different geographical region within the Greater Boston Area, or on a different MBTA service. This component furthered the scope of our project, directly tying in environmental justice concerns as they relate to public transportation, and helped supplement our lower-than-expected number of survey respondents.

Section 4: Analysis & Ethics

Using Microsoft Excel, we downloaded the collected data from Qualtrics and separated it out by neighborhood (Mattapan or Newton) and question, and then constructed circle charts to statistically breakdown and display the different chosen responses as percentages. We concluded that percentages were the best way to view the data, given the discrepancy in the number of participants for Mattapan versus Newton. Initially, there had been discussion of using Stata software to analyze the data, particularly though regressions and confidence intervals, however, the switch to convenience sampling ultimately made this unnecessary. The analysis we did through Excel following data collection was still important in determining the validity and significance of our findings, though. For the other half of our results, the maps, we analyzed them visually after creating them and completed a write-up that parsed out the connections we felt had been made by combining the environmental justice data with the MBTA routes.

Given our research questions, methods and analysis tools, we do not foresee any risk to the participants of our study. We hold ethical concerns in the highest regard, and have carefully considered all possible risks, including targeting of people of a lower socioeconomic status, breaches of privacy, hindering participants' travels, and coercion, among other concerns, especially in regards to any vulnerable populations in Newton and Mattapan. In January, the Institutional Research Board of Boston College approved our project, thus confirming that none of these risks are applicable to participants in our project.

Section 5: Benefits & Limitations

With our study, we hoped to supplement the MAPC's study by conducting similar, quantitative research within Newton and Mattapan, two communities in the Boston area that already vary widely on access to public transportation. We believe that the comparison between Newton and Mattapan is a well-founded, and interesting one due to the racial/economic composition of the two neighborhoods and coinciding transportation options to residents. We then hoped to add to this conversation with the creation of maps that visualized of how communities of different socioeconomic status are under-served or over-served by public transit. Overall, this study should provide Newton and Mattapan residents with a better understanding of the inequities that exist within the public transportation system, as well as how their ride-sharing behavior complements or competes with it. We have structured our data collection process in a way that is as user-friendly as possible for the respondents. By utilizing an online survey, rather than in-person interviewing, we are allowing participants to fill out the survey at their earliest convenience. Therefore, we are not delaying or inconveniencing their travel plans, compared to if we spoke to them on-site at a MBTA station. We wanted to evenly represent the responses of

both Newton and Mattapan residences, without placing too much attention on one, and neglecting the other.

There are, however, study restraints that we must acknowledge. First, recognizing that a large majority of residents do not speak English as a first language in Mattapan, a great deal of importance relied on translating our survey in Haitian-Creole, the community's predominant language. Though we gave our best attempt to have the survey translated, we were ultimately not able to do so and the survey was only available in English. We understand that this prevented some of the community from participating in the survey or completing it in the language they are most comfortable in, impacting the overall reliability of our study. Lack of access to computers was another factor that could have affected survey responses. We also must note that our survey yielded a very low number of respondents. Further, there were many more responses from Newton versus Mattapan. Therefore, on the whole, the relatively small-scale of our project and the discrepancy in responses limits the abilities of our study to be representative of actual commuter behavior.

As a Senior Project for the Boston College Environmental Studies Major, this study was conducted without a budget and within a limit of six months; these parameters narrowed our ability to interact with our chosen communities, Newton and Mattapan, and offer incentives for completing our survey. Due to time constraints, we were not able to do any sort of trial run with the survey, though doing so would have been extremely beneficial in order to amend our survey to be exactly as intended; for example, Newton community members later pointed out the failure to include an option regarding barriers to transit due to disabilities. Additionally, a Mattapan participant commented that the survey was "written with a bias implying that Mattapan residents

only have negative experiences or face barriers related to transportation choice." Though the survey was identical for both Mattapan and Newton respondents, our own preconceived ideas of how transit serves these communities may have biased the way in which the survey was phrased.

Lastly, before choosing our communities of study, there should have been a greater effort made in comparing the relative size and city versus neighborhood status of these sites. While Newton and Mattapan have great socio-economic differences, which is important for our study, they also have vastly different population sizes (with Newton being much larger), and Newton is considered a city, while Mattapan is a neighborhood of Boston. Therefore, Newton, as its own municipality, has powers in determining its own policies and resource-use in ways than Mattapan does not, as much work in these areas is under Boston's command. This distinction makes Newton and Mattapan not completely compatible options for our study.

Results
Section 1: Demographic layout of the Greater Boston Area

Table 1: 2017 socio-demographic data of Boston communities. [1]Only combined socio-demographic data was available for these Boston neighborhoods (https://censusreporter.org)

	Newton	Mattapan & Roxbury[1]	Dorchester & South Boston[1]	Hyde Park, Jamaica Plain, Roslindale & West Roxbury[1]	Milton
Population	88,989	145,319 (combined)	119,731 (combined)	143, 252 (combined)	27,527

Racial makeup	74% white, 14% Asian, 5% Hispanic	10% white, 55% black, 29% Hispanic	47% white, 26% black, 10% Asian, 13% Hispanic	50% white, 23% black, 4% Asian, 21% Hispanic	72% white, 15% black, 7% Asian, 4% Hispanic
Median household income	$144,403	$32,814	$82,592	$85,644	$126,000
Persons below poverty line	3.4%	28.8%	16.7%	9.7%	4.1%
Median value of owner-occupied housing units	$930,400	$439,000	$557,900	$471,000	$558,700
Educational attainment (high school grad or higher)	97.4%	79.7%	88.6%	91.3%	95.6%
Persons with language other than English spoken at home	74% English only	42.9% persons with language other than English spoken	33.6% persons with language other than English spoken	34.4% persons with language other than English spoken	82% English only
Foreign-born population	22.9%	32.2%	28.2%	24.5%	13.9%

Data from the American Community Survey (ACS) highlights the wealth and racial differences throughout the areas surrounding the city. About 70% of Newton and Milton residents are white, and wealthy (with median household incomes of $144,403 and $126,000, respectively), and enjoy a high level of educational attainment. Additionally, in the majority of households in Newton and Milton, only English is spoken. In contrast, Mattapan & Roxbury are much more diverse and struggle with poverty and low-income. Nearly 30% of the individuals in these communities are below the poverty line and their median household income is one-fourth of Newton's. Additionally, in 42.9% of households, a language other than English is spoken. Dorchester and South Boston, as well as Hyde Park, Jamaica Plain, Roslindale and West Roxbury find themselves in-between the two extremes of Newton/Milton and Mattapan/Roxbury. While still more diverse than Newton and Milton, individuals in these communities are more financially secure and have more schooling on average than Mattapan and

Roxbury residents. For the purpose of the survey responses, which will appear in Section 3 of the Results Section, it is important to note that only residents of Newton and Mattapan were surveyed (Census Reporter).

About 70% of Newton and Milton residents are white, and wealthy (with median household incomes of $144,403 and $126,000, respectively), and enjoy a high level of educational attainment. Additionally, in the majority of households in Newton and Milton, only English is spoken. In contrast, Mattapan & Roxbury are much more diverse and struggle with poverty and low-income. Nearly 30% of the individuals in these communities are below the poverty line and their median household income is one-fourth of Newton's. Additionally, in 42.9% of households, a language other than English is spoken. Dorchester and South Boston, as well as Hyde Park, Jamaica Plain, Roslindale and West Roxbury find themselves in-between the two extremes of Newton/Milton and Mattapan/Roxbury. While still more diverse than Newton and Milton, individuals in these communities are more financially secure and have more schooling on average than Mattapan and Roxbury residents. For the purpose of the survey responses, which will appear in Section 3 of the Results Section, it is important to note that only residents of Newton and Mattapan were surveyed.

Section 2: Mapping the MBTA
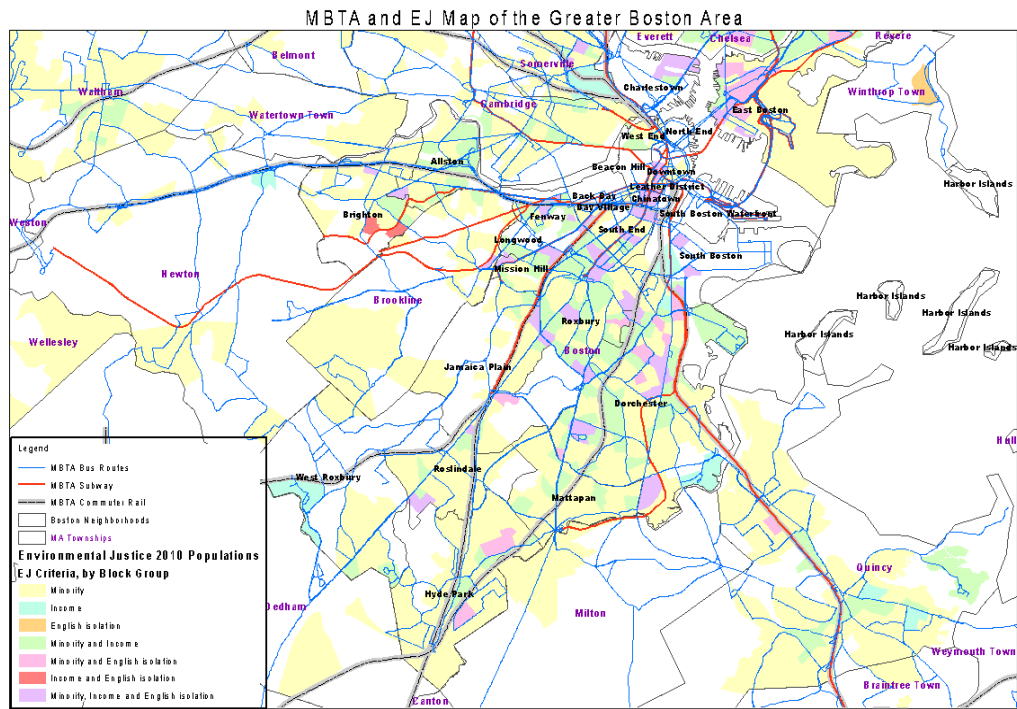
Figure 1: Map of the Greater Boston Area, overlaid with MBTA train, bus and commuter rail lines
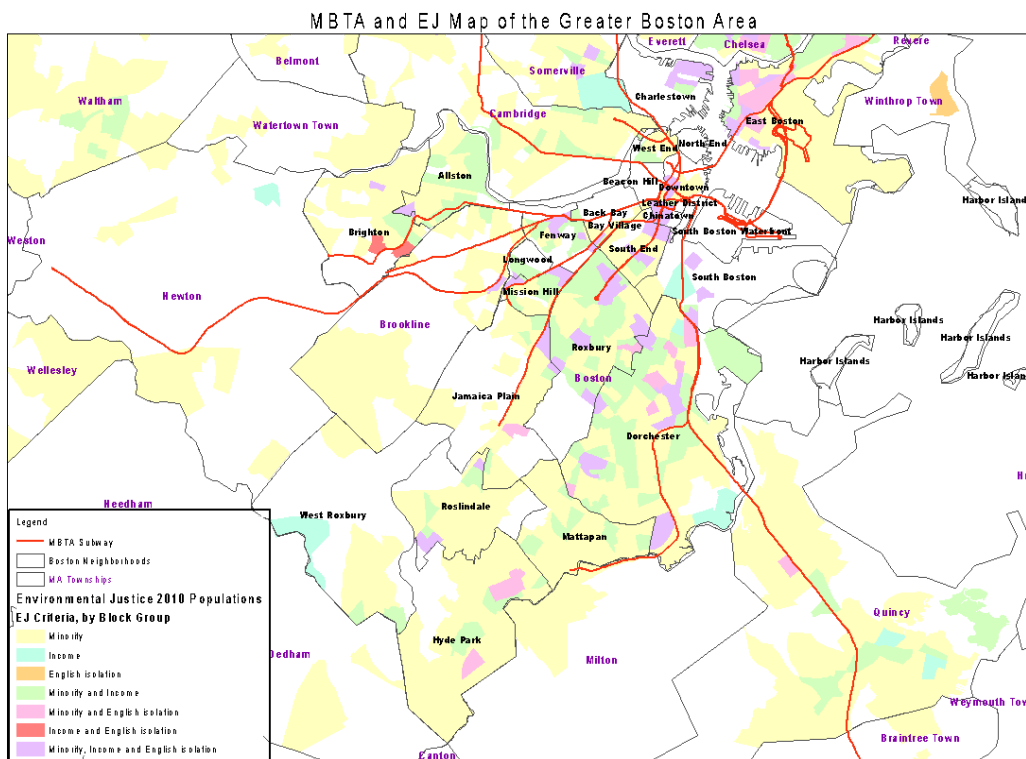
Figure 2: Map of Greater Boston Area, overlaid with MBTA subway lines only

Figure 1 illustrates the MBTA bus, subway, and commuter rail lines against populations with high significance to environmental inequalities (i.e. minority, low income, and non-English speaking populations). As demonstrated here, environmental inequality populations are concentrated to the south and (to a lesser degree) to the west of downtown Boston, with an exception in Western Brookline. In particular, those populations in which two or more of the aforementioned criteria (minority, low income, and non-English speaking populations) overlap are concentrated in the neighborhoods of South End, Roxbury, Dorchester, and Mattapan. Whiter, more affluent, and majority English-speaking populations are located to the west of the city (see Table 1 for further detail on income and educational attainment discrepancies).Many of the wealthier areas (such as Newton, Brookline, Needham, Brighton, and Dedham) are also classified as independent cities; as such, it should be noted, these communities are afforded more resources, as well as more governmental autonomy than those communities that fall under Boston's jurisdiction (including Mattapan, Roxbury, and Dorchester) (2017 Census).

Figure 1 shows the greatest concentration of MBTA lines (bus, train, and commuter rail) in downtown Boston, with these lines radiating out into the neighboring cities and communities (i.e., resulting in lower concentrations of transportation on the outskirts of the city). In Figure 1, we see that bus and commuter rail coverage is fairly even throughout the city, with perhaps greater bus access to the south of Boston. As demonstrated in Figure 2, the MBTA subway extends both west and south of the city; however, the highest subway service outside of downtown Boston is available to the west of the city (including Longwood, Brookline, Brighton, and Allston). On the other hand, to the South of Boston (including Roxbury, western Dorchester,

Mattapan, and Roslindale) there is a sizable area that does not have subway access. Finally, while Figure 2 shows commuter rail service extends through both Newton and Mattapan, it should be noted that until February 2019, there were no commuter rail stops in Mattapan. In other words, these high-speed trains traveled through Mattapan, but prior to 2019 there was not an access point in the neighborhood (Lavery).
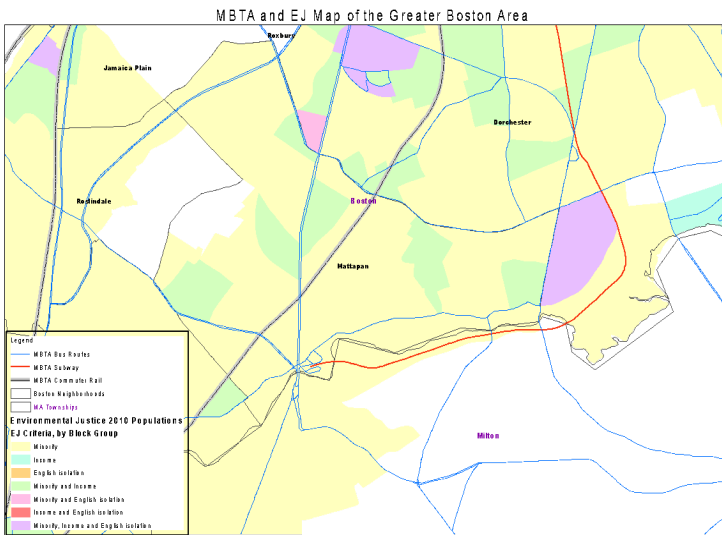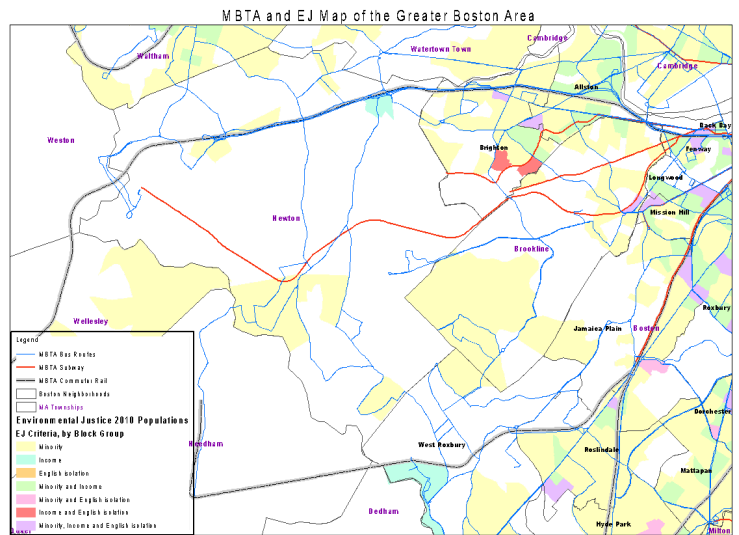

Figure 3: Environmental inequality map of Mattapan overlaid with train and bus lines

Figure 5: Environmental inequality map of Newton overlaid with train and bus lines
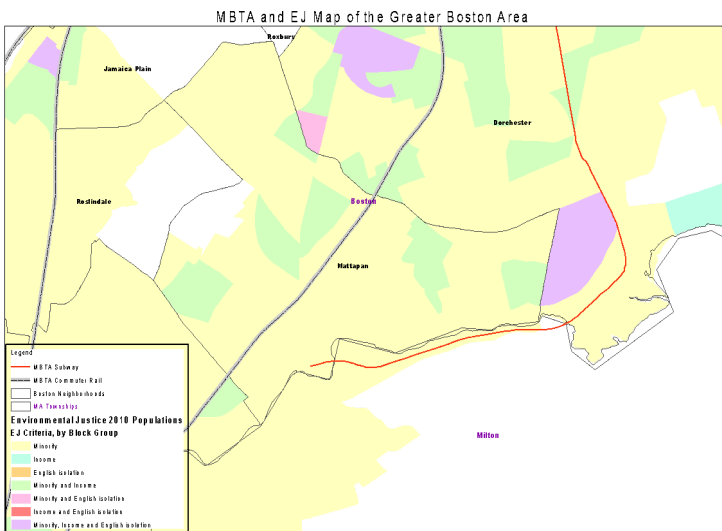
Figure 4: Environmental inequality map of Mattapan overlaid with subway lines only
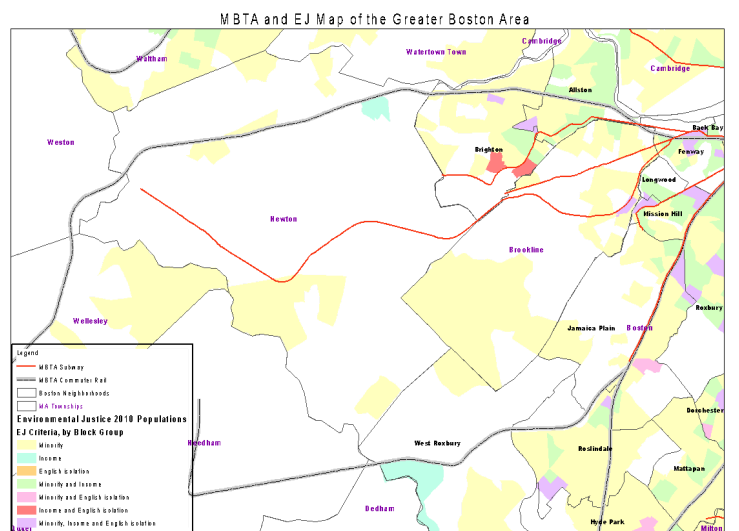
Figure 6: Environmental inequality map of Newton overlaid with subway lines only

Figures 3, 4, 5, and 6 offer a closer perspective on MBTA routes in Mattapan (Figures 3 and 4) and Newton (Figures 5 and 6). In looking at the MBTA bus routes, subway, and commuter rail options, it is clear that the bus is the most accessible form of public transit in Mattapan. This neighborhood is served by only one subway line, which skirts the eastern and southern borders before providing one single stop at the southern tip of the neighborhood. While the MBTA map plots Mattapan Station as the end point for the high-speed Red Line, this subway branch actually ends several stops earlier, at Ashmont Station. From Ashmont, passengers must transfer to trolleys (many of which have not been replaced since the mid-1940s) to reach the southern border of Mattapan. Mattapan does also have an option of using the commuter rail but its service is much less frequent (roughly 45 minutes between arrivals) and depending on destination, more expensive than the subway. Given that the subway is only available on the periphery areas of Mattapan, it is the least convenient option for residents, despite providing the fastest service and lowest fares. The end-portion of the subway line actually drifts into the Milton border, Mattapan's wealthier neighbor – Milton's median household income is $126,000, compared to $32,814 for Mattapan & Roxbury (Table 1). The bus lines hug the borders of the neighborhood, with only one true bus line running through the center.

As demonstrated in Figures 5 and 6, Newton is not considered to be an environmental inequality community, as determined by the criteria of minority, income and English isolation; rather, Newton is dominated by wealthier, whiter, and English-speaking populations (Table 1). Three separate train lines feed into the eastern border of Newton, one of which extends directly through the center of town and features seven stops within city limits, and an additional three on Newton's border (Figure 5). These train lines are supplemented by several bus lines, two of

which feed through the center of Newton township (Figure 6), as well as the commuter rail. These transportation options are reasonably spread out throughout the city, although we do see some gaps, especially in geographic center of the city.

The state of transportation options in Newton and Mattapan gain increased significance when taken in light of the demographic differences between these communities. Mattapan, a community highlighted as an area home to many minority, low income, and non-English speaking populations, is clearly currently underserved by Boston's train system; moreover, until recently, it had no access to Commuter Rail as well, thus left to depend on the bus system for public transportation. Newton, on the other hand, is served by the Green Line, which runs directly through the center of the city, as well as Commuter Rail access and several bus lines. Although it should be noted that there are large areas of Newton that do not have direct access to train or bus lines, we note that this area is largely whiter, higher income, and home to more English-speakers -- attributes that likely open up access to private transportation. In this context, we can characterize the Boston public transportation system as home to significant transit justice concerns, namely that at-risk populations are not seeing sufficient transportation opportunities, while traditionally privileged populations are better served.

Section 3: Survey Results – Commuter Practices and Use of the MBTA and Ridesharing Services
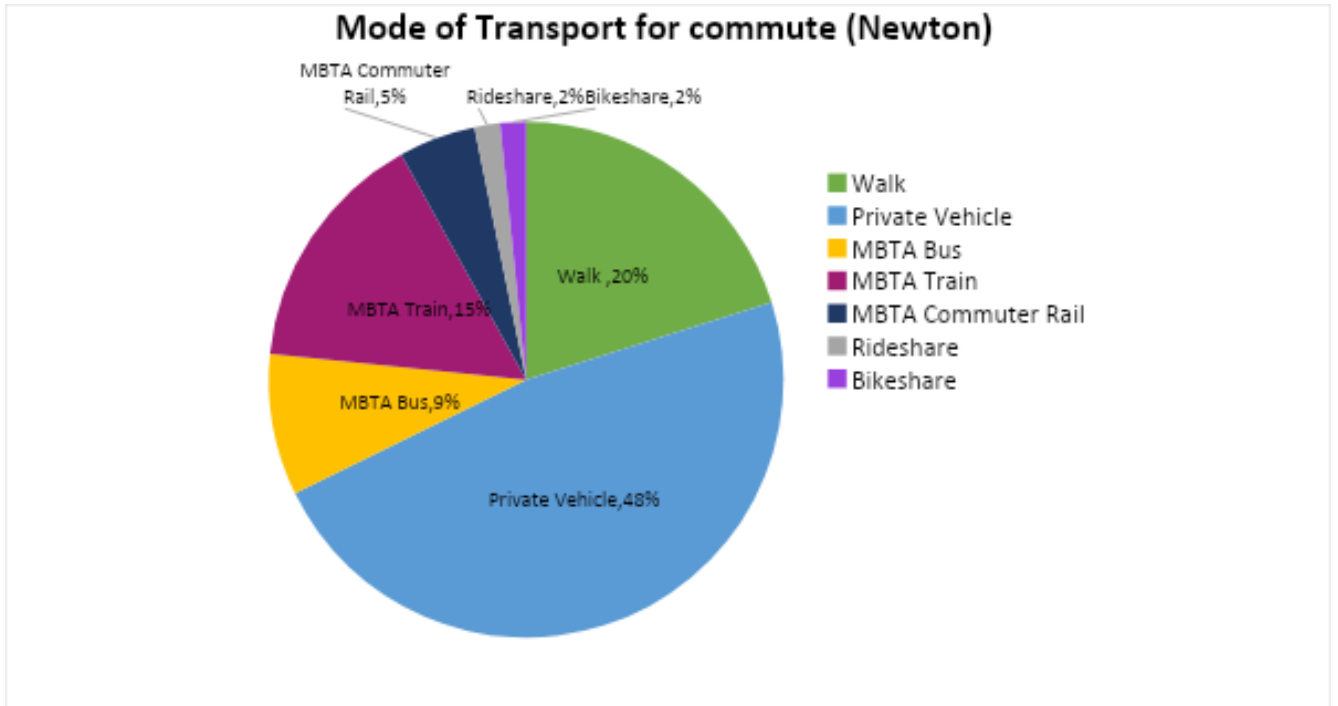**Commuter Practices, Newton**

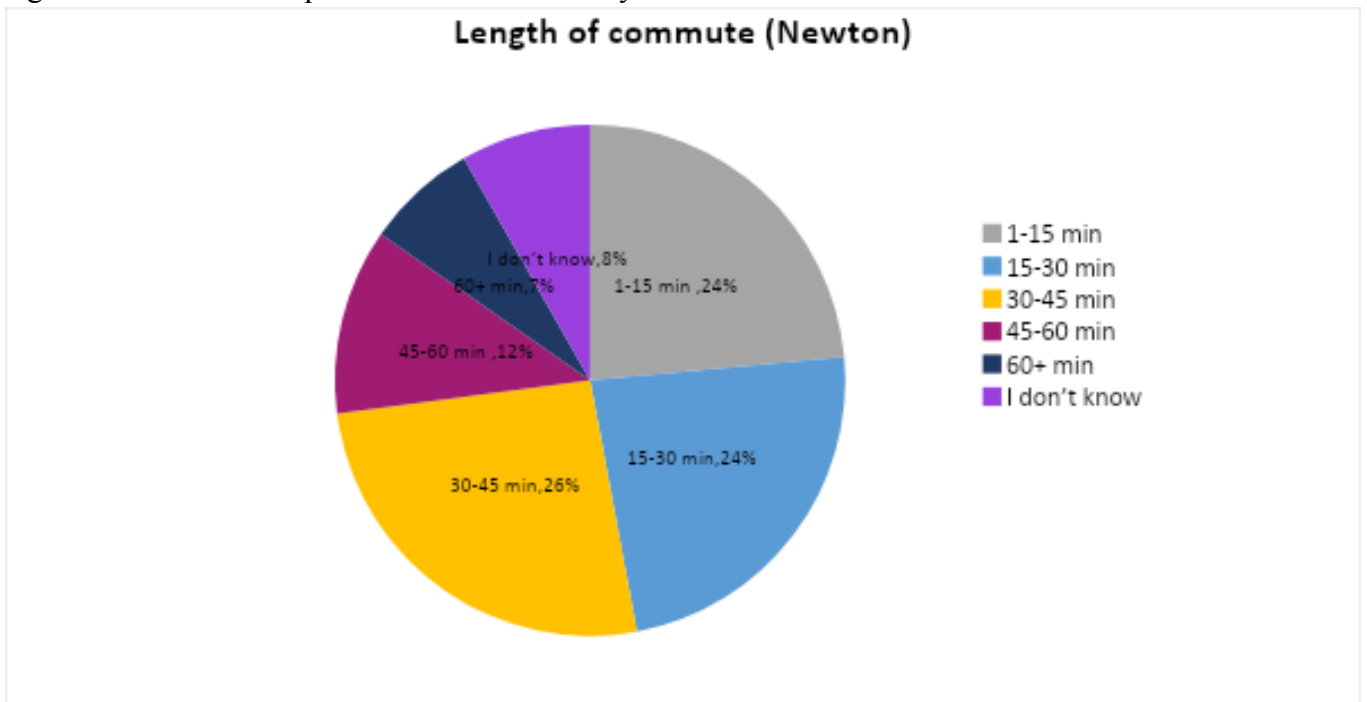Figure 7: Mode of transport used for commute by Newton residents

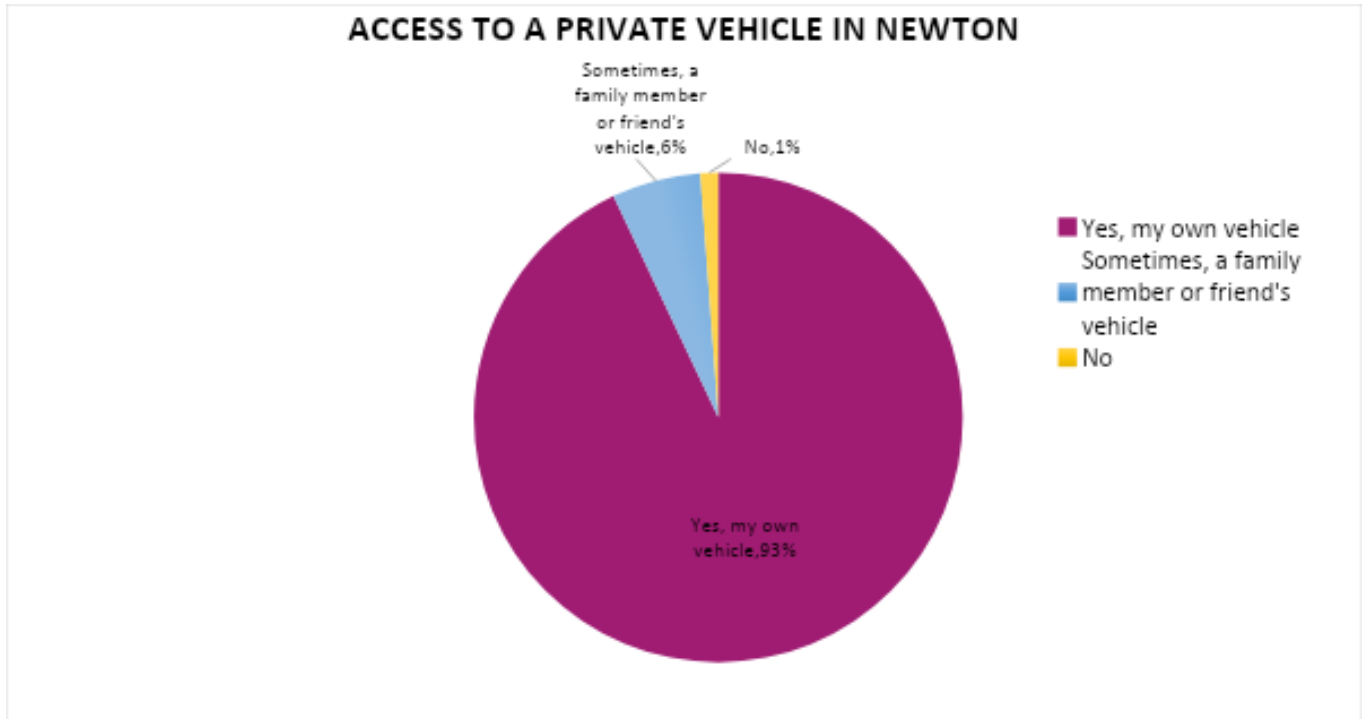Figure 8: Length of commute reported by Newton residents

ACCESS TO A PRIVATE VEHICLE IN NEWTON

Sometimes, a family member or friend's vehicle, 6%

No, 1%

Yes, my own vehicle, 93%

- Yes, my own vehicle
- Sometimes, a family member or friend's vehicle
- No

Figure 9: Ownership of private vehicles in Newton

As Figure 7 demonstrates, 47% of all Newton respondents reported use of a private vehicle in their daily commute, while the MBTA (sectioned into bus, train, and commuter rail) attracted 29% of survey participants and ridesharing and bike sharing services saw use by 4% our survey respondents. Across these commuter choices, commute lengths varied, where only 7% of survey recipients reported a commute of an hour or longer, as shown in Figure 8. Commute times of 1-15 minutes, 15-30 minutes and 30-45 minutes each represented about a quarter of responses. Finally, in Figure 9, an overwhelming majority (93%) of Newton survey recipients reported that they had ownership or access to a private vehicle, a statistic in line with the national average. Taken together, these results paint Newton as a community that is still fairly dependent on private vehicles for transportation, but in which this car-driven system is

functioning well – in other words, granting residents reasonable commute times and securing commuter satisfaction.
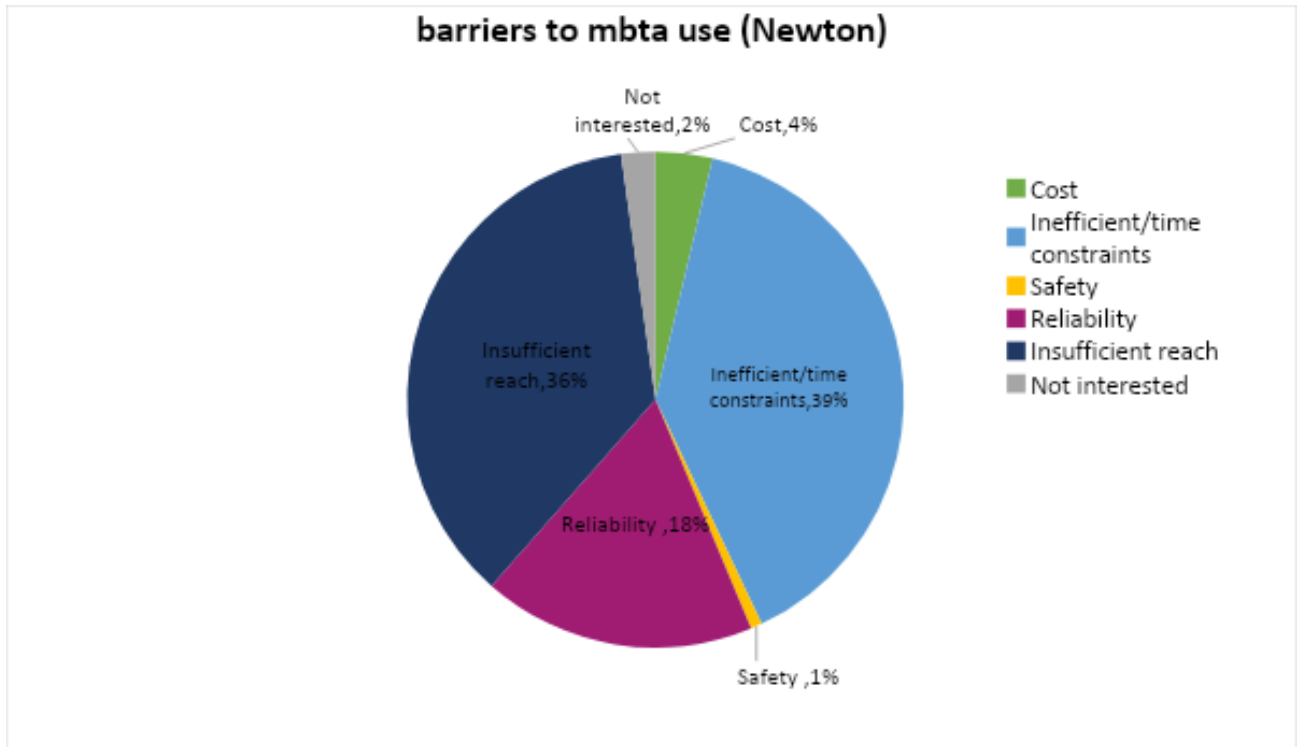
MBTA Use – Newton

Figure 10: Barriers to MBTA use among Newton residents

When asked about barriers to MBTA use, respondents point to a lack of access and reliability on the part of the MBTA, as shown in Figure 10. Only 7% of participants listed safety, cost, or lack of interest as issues preventing them from using the MBTA; rather, 36% of Newton residents reported insufficient reach and 39% reported inefficiency as the main drivers away from the MBTA, with 18% pointing to a lack of reliability. Given widespread dependence on cars by Newton residents, these barriers suggest that the MBTA is not providing service that is reliable, efficient or accessible enough to compete with single-person vehicles.
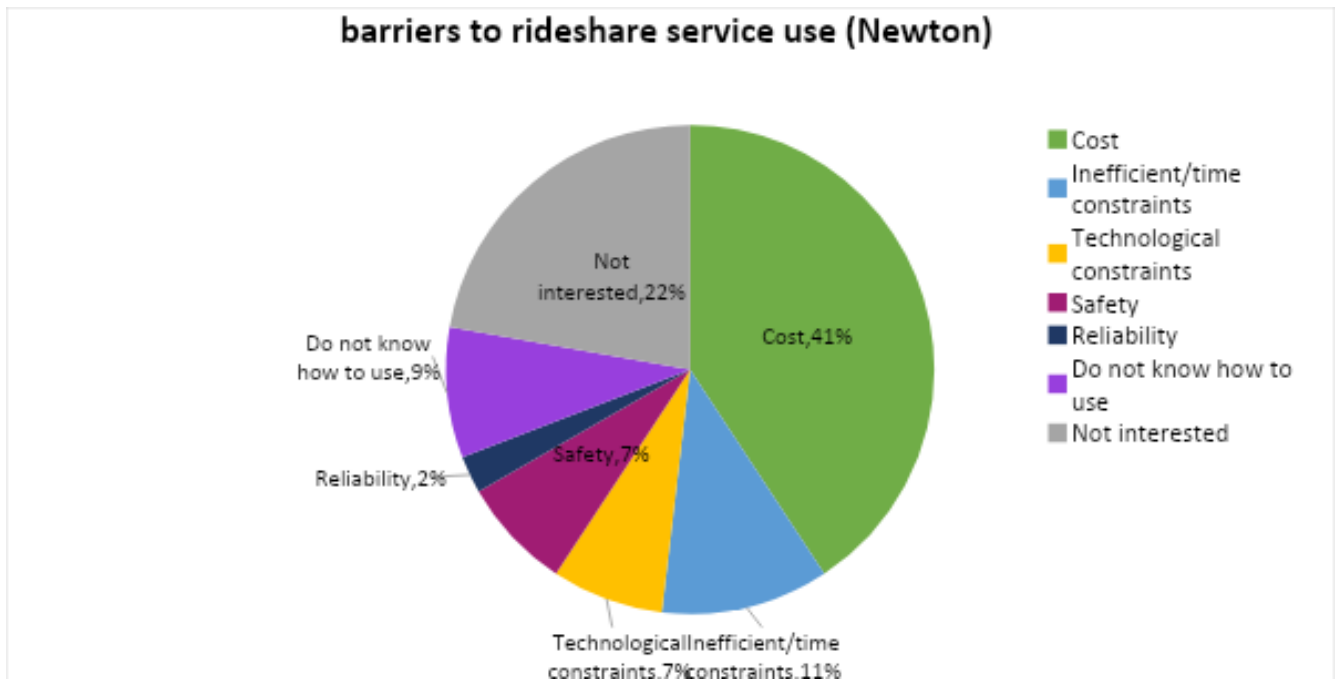
Ridesharing Use – Newton

Figure 11: Barriers to ridesharing use among Newton residents

In regards to barriers to ridesharing, Figure 11 shows that the greatest deterrent for Newton respondents was cost, cited by over a 41% of participants as a barrier to usage. A significant portion, 22%, also reported a lack of interest in ridesharing.
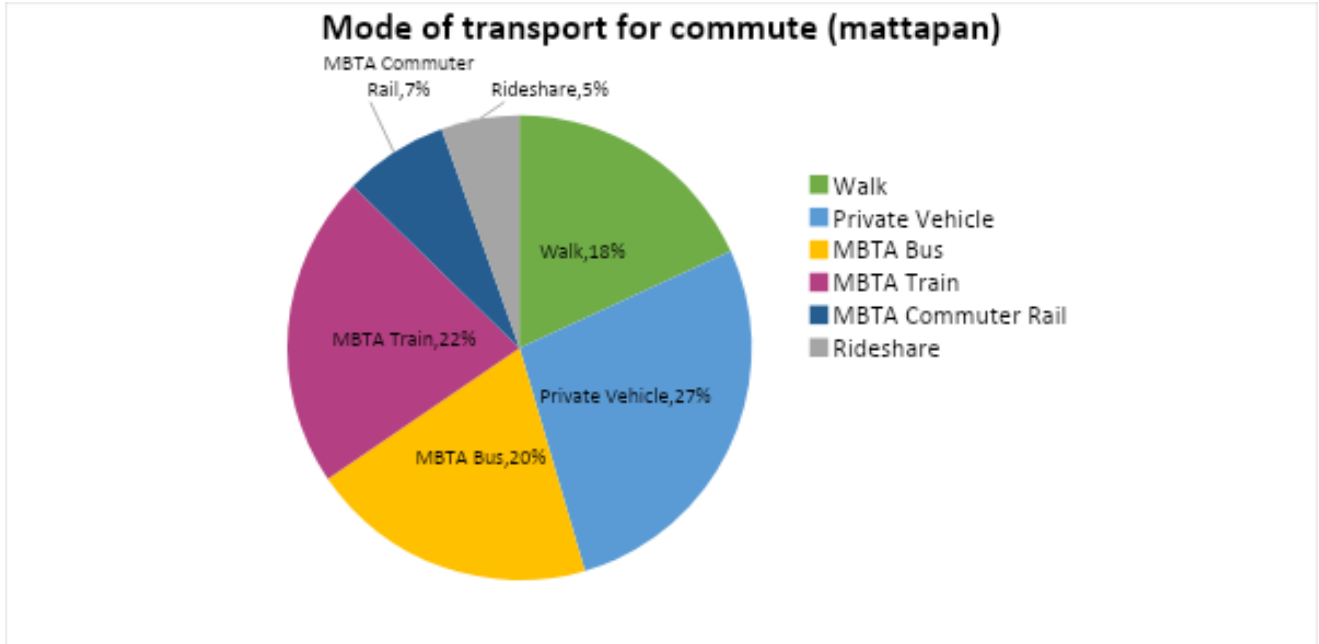
Commuter Practices – Mattapan

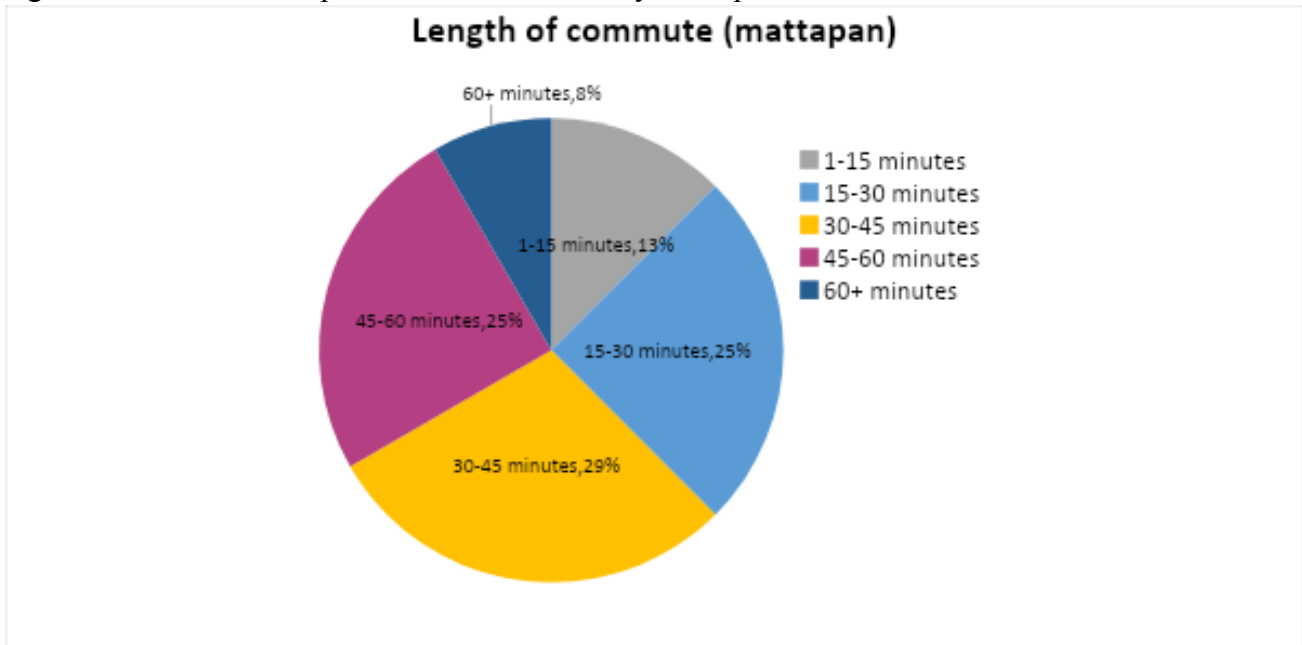Figure 12: Mode of transport used for commute by Mattapan residents

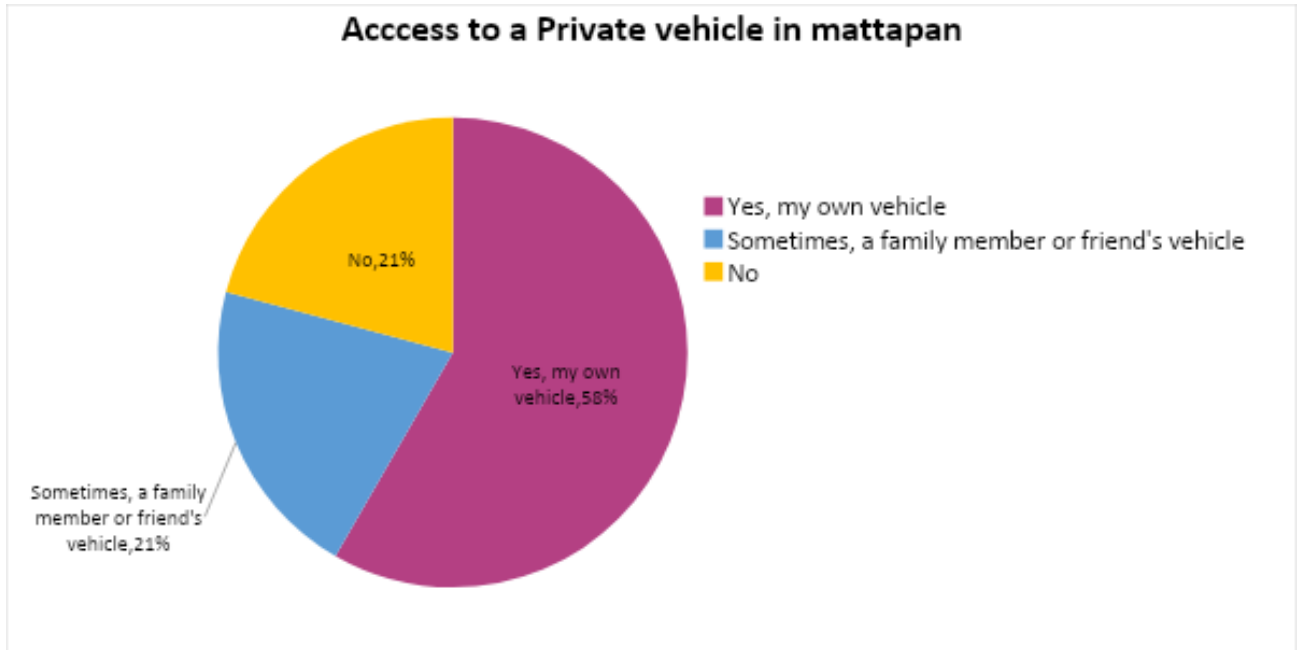Figure 13: Length of commute reported by Mattapan residents

Figure 14: Ownership of private vehicles in Mattapan

In Figure 12, the most common commute method among Newton respondents was using a private vehicle (27%), though MBTA bus, MBTA train and MBTA commuter rail were popular responses as well, at 20%, 22% and 18%, respectively. Commuting by walking was chosen by 18% of respondents, while only 6% chose rideshare. 0% of respondents chose bikeshare. Similar to Newton, Figure 13 shows diversity in the length of commutes for Mattapan respondents: 25% chose 15-30 minutes, 29% chose 30-45 minutes and 25% chose 45-60 minutes. Only 8% of participants traveled more than this to their place of work or school. Lastly, while the majority of respondents have access to a private vehicle (58%), there are still a good portion of Mattapan residents (42%) who only have private vehicle access sometimes or not at all, as depicted in Figure 14. Private vehicle ownership in Mattapan is much lower than in Newton, indicating their reliance on public transit – this may also tie into their slightly longer commute times.
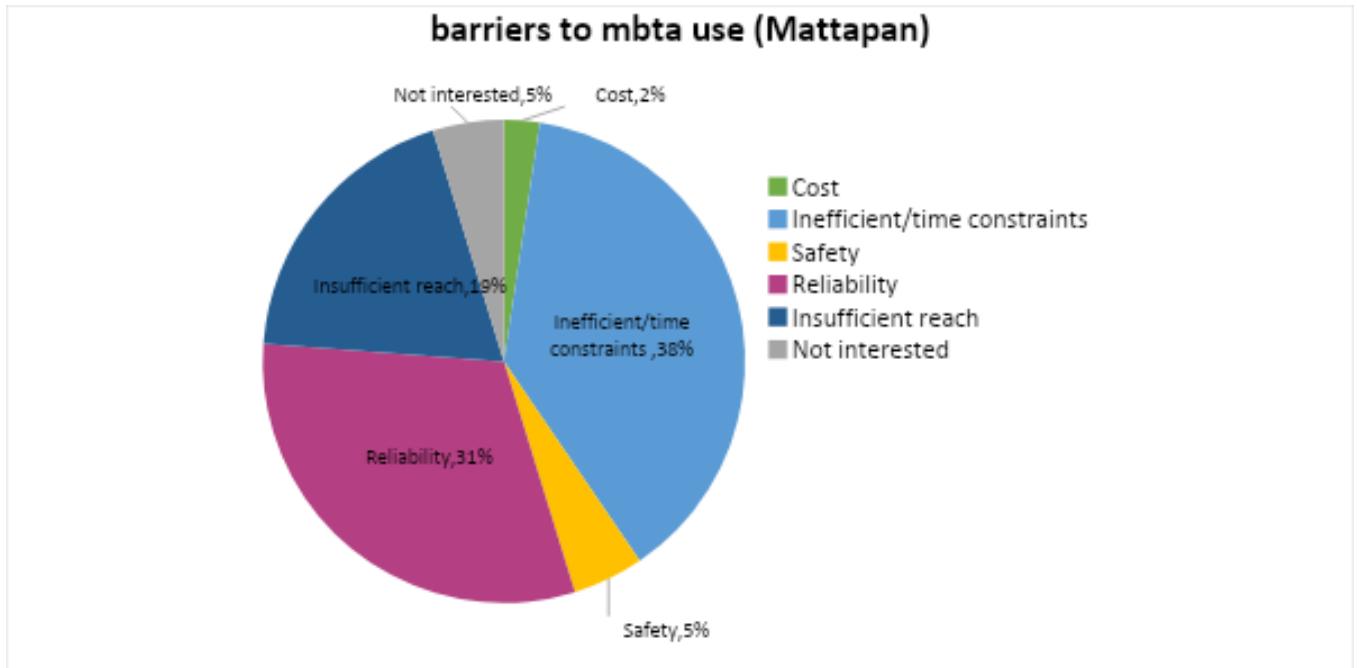
MBTA Use – Mattapan

Figure 15: Barriers to MBTA use among Mattapan residents

Figure 15 shows that, overall, an overwhelming majority of survey respondents in Mattapan cited reasons related to capability on the part of the MBTA as a barrier to use. Respondents were given the option to choose as many reasons as applied to them, and 38% claimed inefficient/time constraints, 31% said reliability, and another 19% felt there was insufficient reach.
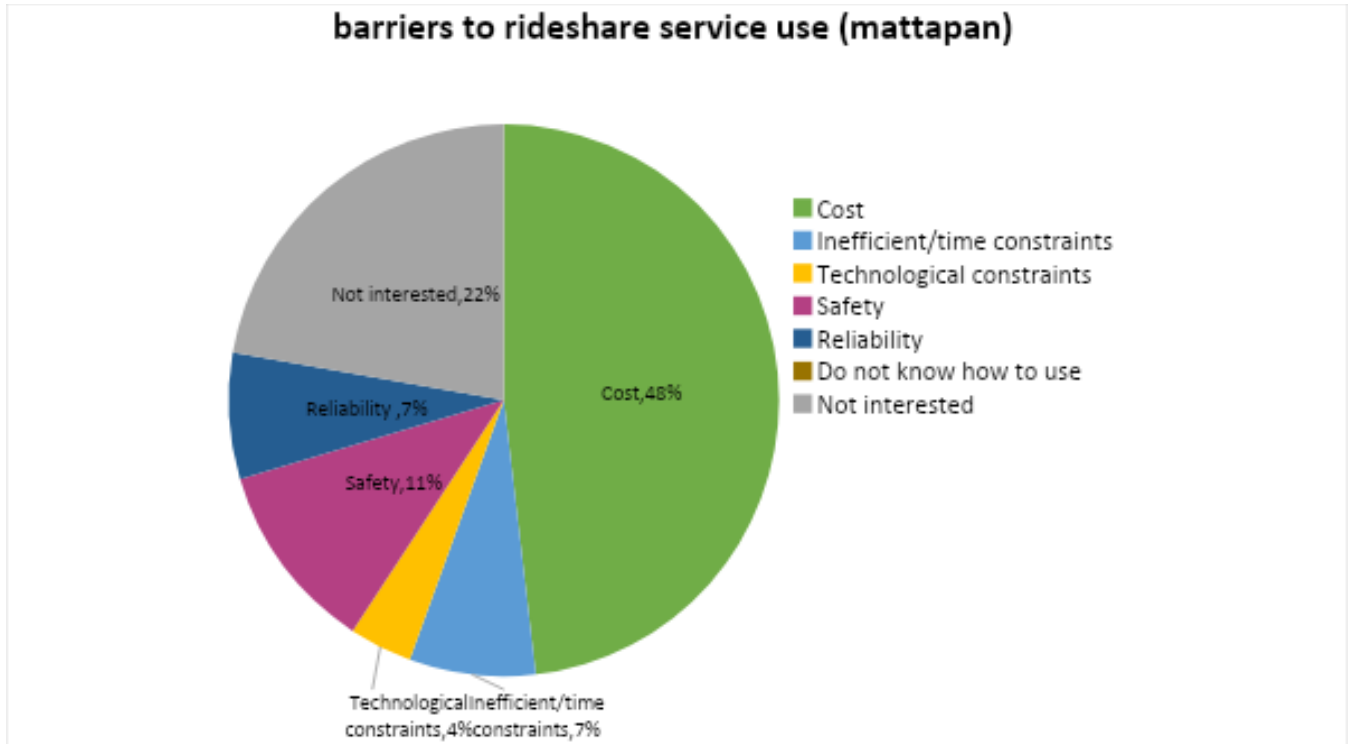
Ridesharing Use – Mattapan

Figure 16: Barriers to ridesharing use by Mattapan residents

In Figure 16, 48% of Mattapan respondents explained their primary barriers to ridesharing services are cost. This stands in contrast with the matching MBTA question, shown in Figure 15, where only 2% of respondents claimed cost as a barrier. Additionally, 22% of respondents simply said they were not interested in the service, compared to 5% claiming disinterest in Figure 15. Therefore, overall, due to cost, Mattapan respondents seem to prefer MBTA services over ridesharing services, despite the unreliability of the former.

Discussion:

Our findings point to four major conclusions; firstly, that dual-pronged, spatial and community-centered research is a valuable approach to issues relating to transit justice and innovation; secondly, that the comparison between Mattapan and Newton demonstrates inequitable public transit access, as articulated by Seymore (see Literature Review); thirdly, that

despite inequity in commute length, commuters in both neighborhoods are reasonably satisfied with their commutes; and finally, that while rideshare appears to fill a need for efficient travel, cost restraints have prohibited residents in both Newton and Mattapan from fully accepting this new transit option.

First and foremost, we can see that taking a dual (spatial and community-oriented) approach helps to integrate geographical, infrastructure-based theories with qualitative input from the communities in question on how said infrastructures are viewed and used. For example, Figures 3, 4, 5, and 6 demonstrate that while both Newton and Mattapan see incomplete MBTA coverage (especially by the more efficient train lines), the lesser coverage of Mattapan aligns negatively with higher concentrations of minority, non-English speaking, and low-income communities. These graphs lead us to suspect an occurrence of transit inequality–however, they do not give us the authority to make claims about the experiences of either Mattapan or Newton residents, either bad or good. Rather, geospatial results suggest the further need for investigation into how Mattapan and Newton (and other communities included in the results above) in Boston use and view the MBTA.

Our maps of the entire city (Figure 1 & 2) are bolstered by the findings in Seymore's work, noting the neighborhoods of color rely primarily on buses while wealthier areas are serviced by rail lines (90-93). We started this work on a very small scale with our initial surveying, however the work needs to be expanded into other neighborhoods and include qualitative input from researchers. We only spoke to a few community members in passing, but their comments helped us gain a clearer understanding of the community and current events.

Finally, the maps and data demonstrate that the existing infrastructure may give rise to future transportation inequality.

Survey results show that Mattapan participants prefer to use the MBTA, despite noted inefficiencies and unreliability, mainly because they found ridesharing to be too expensive (Figures 12, 15 & 16). By MBTA inefficiencies, we mean: frequent construction and upkeep, inefficient routing, traffic delays, infrequent service (specifically for the commuter rail) etc. These results, particularly the issues of inefficiencies, lines up with our maps representation of Mattapan perfectly. If you look closely at the map of Mattapan, you see that only one bus line runs directly through the heart of the neighborhood, the other bus lines skirt the edge of the neighborhood (Figure 3). Residents can take catch a trolley from the Mattapan Station which will connect them to the Ashmont (Red) high speed rail line.

The bus and the trolley are very slow options. For example, if a Mattapan resident wanted to travel to Newton Centre, it would take them 80 minutes on three buses (best case, if each bus is on time), or two hours by taking three trains. The commuter rail recently opened a station in the southern border of the neighborhood, which Mattapan participants told us has certainly helped their commute, however the commuter rail only comes every few hours, unlike a typical subway line which comes every 8 minutes. The clear lack of access to public transit, expressed concerns over cost of rideshare, and longer commute times by Mattapan residents confirm the literature findings on the lesser treatment of low-income and minority populations (Taylor and Morris 356-357; Peipins et al. 34).

The survey results for Newton participants show that most people use the MBTA for recreational activities (Appendix 10), which could be explained by about 90% of the population

having access to a private vehicle (Figure 9). These findings are interesting, given how much

access Newton has to the MBTA, but residents mainly choose to use it for recreation. However,

these findings are frustrating, given that this neighborhood has been given more access that they

do not need, while Mattapan was only given access to the commuter rail a few short weeks ago

after a decade of watching it pass through its neighborhood. It seems that for Newton residents,

access to private vehicle was a barrier to using MBTA options (Bus, Train and Commuter rail)

more often (Figures 7, 9 & 10). This finding lines up with an article from the literature review

which notes that wealthy neighborhoods petition for increased public transportation options, but

do not actually use the access they voted for (Seymore 107; Taylor and Morris 349).

Interestingly, residents indicated that inefficient reach was one of the main reasons Newtonites

didn't use the MBTA more often (Figure 10). This finding does not align with our maps (Figures

5 & 6), as we feel that the border Newton neighborhood is well served. Perhaps more research is

needed on how far residents are willing to walk to MBTA stations in relationship with the

opportunity to use private vehicles (which are certainly more convenient). These findings are

supported by Seymore's contribution to the literature which talks about white communities'

preferential treatment by transit officials (Seymore 65, 107).

The most striking comparison of this data is in length of commute and commute

satisfaction. In Newton, about 50% of residents use private vehicle for their commute to work,

about 25% use various forms of the MBTA and 1% use ridesharing (Figure 7). Only about 15%

of Newtonites had a commute time longer than 45 minutes (Figure 8) and 75% were

very/somewhat satisfied with their commute (Appendix 9). However, the data for Mattapan is

intriguing. Figure 12 shows a pretty close distribution of Mattapan residents commuting to work

on MBTA train, bus, private vehicle and walking. 58% of residents indicated that they were very/somewhat satisfied by this commute (Appendix 6). 1/3 Mattapan participants face a commute that is longer than 45 minutes (Figure 13). While our study did not have as widespread reach as we hoped, we still believe this data could be replicated given the strong visual of injustice the maps create (Figures 3 & 5). Many Mattapan residents indicated that their commute is not as convenient (many using the MBTA) and quite a bit longer, and yet still participants were quite satisfied. If they saw the ease and access of Newtonites, we wonder if their responses would change.

Our final map (Appendix 12 & 13) suggests that the gaps in public transit options are not only an issue for the Mattapan community–it is a pervasive problem that affects many low-income, minority and English isolation (meaning a quarter or more of households have no one over the age of 14 who speaks English) communities in the greater Boston area. Among those visible on the map, this includes but is not limited to: Dorchester, Jamaica Plain, Roxbury, and the South End. Similar to Mattapan, these communities are primarily serviced by the MBTA Bus, rather than the MBTA Subway.

Transportation discrimination is clearly a serious issue within Boston, and likely other major cities. We suggest future research deepen their reach into low-income, non-white communities by noting some of our limitations and recognizing the massive literature gap around transportation inequality in Boston—a gap that is impacting several million people in the community. We also suggest focusing on different parts of the wealthy, white communities in the Greater Boston Area to better understand how private vehicles and wealth play a role in consumer transit choices. Even though our specific survey was not focused on the impacts of

transportation options on individual respondents, we want to refer back to research that points to negative impact on health, lost jobs, high rates student absences, etc. (Peipins et al. 34; Seymore 70-71).

Our results demonstrate, ridesharing services, such as Uber and Lyft, are not a sufficient replacement for lack of public transit—since the communities who tend to live in areas with less access to public transportation, tend to be low-income people who cannot afford the premium of a rideshare service. Both Mattapan and Newton respondents suggest ridesharing options as too expensive (Figure 11 & 16), which we did not expect from Newton given their socioeconomic (Table 1) but we can understand given their high rate of private vehicle ownership (Figure 9) (Taylor and Morris 349). Prior literature has tried to understand the relationship between public transportation and ridesharing, particularly whether they function as complements or competitors–our research adds to this literature by demonstrating how our respondents feel that ridesharing is not a suitable replacement for public transportation (compatible with the findings of Zhang and Zhang), even though they find the MBTA unreliable and inefficient. This finding is interesting because it draws a question between participants perceptions and reality of the compatibility between ridesharing and public transit, since the literature that shows most ridesharing trips take away from otherwise possible use of public transportation (Rayle et al. 15-16).

While ridesharing is an emerging service, new to the transportation market, our findings suggest commuters may lack interest in ridesharing primarily because they are unfamiliar with it, especially in comparison to the MBTA system. Only time will tell if ridesharing services, as well as bike-sharing, scooter-sharing, etc. options become popular enough to properly compete with

public transportation. We recognize the more eco-friendly transportation options, like bike-sharing and scooter-sharing, are more likely to succeed in cities with warmer weather. Regulation–such as public policy–could be Boston's best chance at ensuring more equitable public transportation, as well as managing the explosion of transportation network companies, such as ridesharing, bike-sharing, scooter-sharing, etc.

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Appendices

Appendix 1: Map of the MBTA

Figure 17: Massachusetts Bay Transportation Authority (MBTA). Rapid Transit/Key Bus Routes Map. Apr. 2018,
cdn.mbta.com/sites/default/files/maps/2018-04-map-rapid-transit-key-bus-v31a.pdf.

1. What is your home zip code?

   [Write in]

2. What neighborhood do you live in?

   - Mattapan
   - Newton

3. How did you usually get to work last week? (If you use a combination of transportation options, please select all that apply)

   - Walk
   - MBTA Bus
   - MBTA Train
   - MBTA Commuter Rail
   - Private Vehicle
   - Bikeshare
   - Rideshare (i.e. Uber, Lyft, Curb, etc.)

4. Are you satisfied with this method of transportation?

   - Very Satisfied
   - Somewhat Satisfied
   - Neutral
   - Somewhat dissatisfied
   - Very dissatisfied

5. On a normal day, meaning no extreme weather or traffic, how long does your commute to work or school typically take you? Source: "Bay Area Ridesharing Survey" (Civil Engineering 256 Sustainable Transportation, UC Berkeley, Berkeley CA, 2009) https://www.ocf.berkeley.edu/~emai/?TB_iframe=true

   - 1-15 minutes

- 15-30 minutes
- 30-45 minutes
- 45-60 minutes
- 60+ minutes

6. In the last week, how often did you take: MBTA bus, MBTA train, MBTA commuter rail, private vehicle, bike share or rideshare other?

Rate each on a scale of 0 times to 7 times.

Mode of transportation/ Number of times used per week	1 day per week	2	3	4	5	6	7
Walk							
MBTA Bus							
MBTA Train							
MBTA Commuter Rail							
Private Vehicle							
Bikeshare							
Rideshare							

7. Do you have access to a private vehicle? Source: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey. URL: https://nhts.ornl.gov.

- Yes, my own vehicle
- Sometimes, a family member or friend's vehicle
- No

8. As a rider, what do you use the MBTA for? (Choose all that apply)

- School/University
- Work
- Recreational activities
- For travel (to the airport, train or bus station, etc.)
- Emergencies
- When driving oneself would otherwise be impaired (by alcohol or drugs)
- To get to another form of transportation (Example: an MBTA stop that is too far away from home to walk)
- Never; I don't use the MBTA

9. What are your primary barriers to using the MBTA more often? (Choose all that apply)
 Source: "Bay Area Ridesharing Survey" (Civil Engineering 256 Sustainable Transportation, UC Berkeley, Berkeley CA, 2009) https://www.ocf.berkeley.edu/~emai/?TB_iframe=true

- Cost
- Inefficient/time constraints
- Safety
- Reliability
- Insufficient reach
- Do not know how to use
- Not interested

10. As a rider, what do you use ride sharing for? (choose all that apply)

- School/University
- Work
- Recreational activities
- For travel (to the airport, train or bus station, etc.)
- Emergencies
- When driving oneself would otherwise be impaired (by alcohol or drugs)
- To get to another form of transportation (Example: an MBTA stop that is
- too far away from home to walk)
- Never; I don't use ride sharing
- Other:

11. What are your primary barriers to using ridesharing more often? Source: "Bay Area Ridesharing Survey" (Civil Engineering 256 Sustainable Transportation, UC Berkeley, Berkeley CA, 2009) https://www.ocf.berkeley.edu/~emai/?TB_iframe=true

- Cost
- Inefficient/time constraints
- Do not have access to a smartphone
- Safety
- Reliability
- Not interested

Appendix 3: Sample Emails

Dear Newton Residents,

Do you find yourself or your kids using Uber or Lyft almost daily? Alternatively, are you a consistent MBTA rider? Or, are you concerned about how these new transportation apps might be impacting your commute?

Our names are Elena West, Grace Marra, and Annette Heffernan, and we are undergraduate students at Boston College in the Environmental Studies Program. With the help of the Massachusetts chapter of the Sierra Club, we are researching ride-sharing and its impacts on the MBTA system. Our research aims to explore how apps like Uber or Lyft are being used in different Boston communities, and deepen understanding of how these new transportation options are impacting people in these communities (like you!).

During the next few weeks, we are conducting a survey of the Newton community to gain a better understanding of how Newton residents regard and use the MBTA system and ride-sharing programs.

The survey is very brief and will take less than 3 minutes to complete (we've timed it!). Please click the link below to go to the survey Web site (or copy and paste the link into your Internet browser).

Take the Survey Here!

Follow this link to the survey:
https://bostoncollege.co1.qualtrics.com/jfe/form/SV_1YragErMA3fmTt3

Your participation in the survey is completely voluntary and all of your responses will be kept confidential. No personally identifiable information will be associated with your responses to any reports of these data. The Boston College Institutional Review Board has approved this survey.

Should you have any comments or questions, please feel free to contact Elena West at westeb@bc.edu. We look forward to hearing from you.

Thank you!

• •

Dear Mattapan Residents,

Do you find yourself frustrated by a lack of convenient public transit options in your community? Additionally, are you concerned by how ride-sharing apps like Uber or Lyft may affect your daily commute?

Our names are Grace Marra, Elena West, and Annette Heffernan, and we are undergraduate students at Boston College in the Environmental Studies Program. With the help of the Massachusetts chapter of the Sierra Club, we are researching ride-sharing and its impacts on the MBTA system. Our research aims to explore how apps like Uber or Lyft are being used in different Boston communities, and how the inequality of public transportation options in these neighborhoods may be worsened by the introduction of ride-sharing.

During the next few weeks, we are conducting a survey of the Mattapan community to gain a better understanding of how Mattapan residents regard and use the MBTA system and ride-sharing programs.

The survey is very brief and will take less than 3 minutes to complete (we've timed it!). Please click the link below to go to the survey Web site (or copy and paste the link into your Internet browser).

Take the Survey Here!

Follow this link to the survey:
https://bostoncollege.co1.qualtrics.com/jfe/form/SV_1YragErMA3fmTt3

Your participation in the survey is completely voluntary and all of your responses will be kept confidential. No personally identifiable information will be associated with your responses to any reports of these data. The Boston College Institutional Review Board has approved this survey.

Should you have any comments or questions, please feel free to contact Grace Marra at marrag@bc.edu. We look forward to hearing from you.

Thank you!

Boston College Consent Form
Boston College Environmental Studies Department
Informed Consent to be in study "Ride-sharing and the Massachusetts Bay Transportation Authority: A
Case Study of Newton and Mattapan Communities"
Researchers: Annette Heffernan, Grace Marra, Elena West
Study Sponsor: Dr. Jennifer Kelly
Type of consent: Adult Consent Form

Invitation to be Part of a Research Study

You are invited to participate in a research study. You were selected to be in the study because you are a resident of either Newton or Mattapan neighborhoods. Taking part in this research project is voluntary. Please note, you must be at least 18 years old and have conversational English skills to participate.

Important Information about the Research Study

Things you should know:

- The purpose of the study is to further understand commuter choices and motivations between ride-sharing companies and the MBTA.
- Participation means filling out an online survey that should take 5 minutes
- Minimal risks or discomforts will come from this research are mitigated by our measures taken to ensure confidentiality, see below for more details.
- The study will benefit the community, the MBTA, local government and individuals, as there is presently little data on ride-sharing.
- Taking part in this research project is voluntary. You don't have to participate and you can stop at any time.

Please take time to read this entire form and ask questions before deciding whether to take part in this research project.

What is the study about and why are we doing it?

The purpose of the study is to gather data on commuter practices in Newton and Mattapan, understand motivations for consumer choices between MBTA and ride-sharing, etc. The study will hopefully provide a baseline dataset that can inform future research, policy or legislation on the subject.

What will happen if you take part in this study?

If you agree to take part in this study, you will be asked to answer a series of questions on an online survey. We expect this to take about 5 minutes, we estimate approximately 30 seconds per question.

How could you benefit from this study?

Although you will not directly benefit from being in this study, the study will benefit the two communities, the MBTA, the local government, as there is presently little data on ride-sharing.

What risks might result from being in this study?

There are minimal risks you may encounter by participating in this study, one being backlash by ride-sharing companies (which is highly unlikely). However, we will protect our participants by refraining from using identifying information.
We do not foresee any other physical, psychological or informational risks for this survey.

How will we protect your information?

We will protect participant identity by not asking for names or other demographic information on the survey. Survey data will be stored on secure hard drives, which only the researchers have access to. However, please note that a few other groups may also gain access to the data. These groups might include: government agencies, the Institutional Review Board (IRB) at Boston College and, internal Boston College auditors may review the research records. Otherwise, the researchers will not release to others any information that identifies you unless you give your permission, or unless we are legally required to do so.

What will happen to the information we collect about you after the study is over?

We will not keep your research data to use for future research.

How will we compensate you for being part of the study?

There is no compensation for your participation in this study.

What are the costs to you to be part of the study?

There is no cost to you to be in this research study.

Your Participation in this Study is Voluntary

Participating in this study is voluntary. Even if you decide to be part of the study now, you may change your mind and stop at any time. You can skip any questions you do not wish to answer. If you decide to withdraw before this study is completed, your results will be deleted, and not count towards our data. If you choose not to be in this study, it will not affect your current or future relations with Boston College University.

Getting Dismissed from the Study

The researcher may dismiss you from the study at any time for the following reasons: (1) it is in your best interests (e.g. side effects or distress have resulted), (2) your zip code does not match Newton or Mattapan zip codes, (3) if you are younger than 18, or (4) if the participant is not fluent in English, they will be ejected from the study.

Contact Information for the Study Team and Questions about the Research

If you have questions about this research, you may contact Dr. Jennifer Kelly, jennifer.kelly.3@bc.edu, 6175524131 Annette Heffernan, hefferac@bc.edu, 7603337631
Grace Marra, marrag@bc.edu, 2034487993

Elena West, westeb@bc.edu, 8572316407

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the following:

Boston College
Office for Research Protections Phone: (617) 552-4778 Email:irb@bc.edu

Your Consent

By clicking "I consent" below, you are agreeing to be in this study and you are agreeing that you have at least conversational level English skills. Make sure you understand what the study is about before you sign. We will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I understand what the study is about and my questions so far have been answered. I agree to take part in this study. I agree that I have conversational English skills and can understand this survey as it is presented.

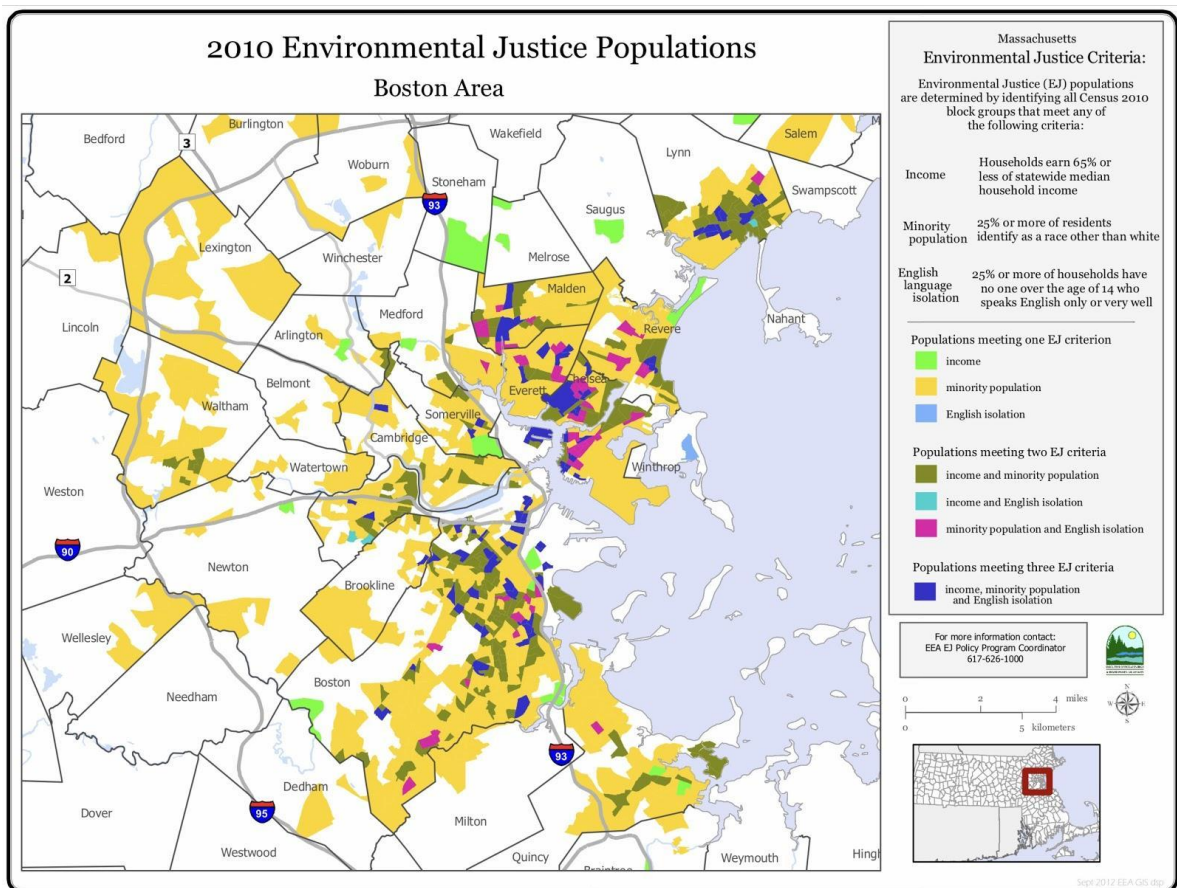_____ I consent _____ I decline

Appendix 5: Environmental Justice Map

Figure 18: Map of environmental justice populations in the Greater Boston Area (EEA 2010)
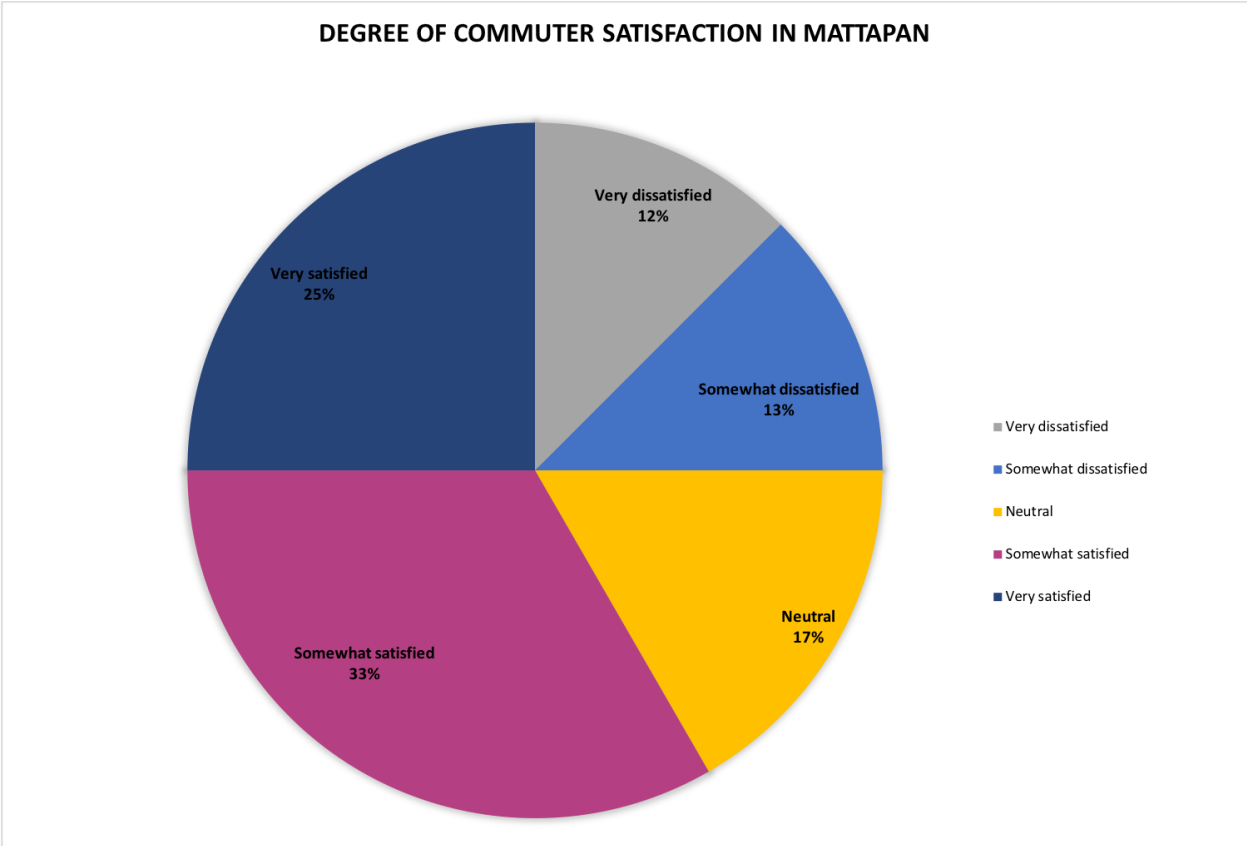
Appendix 6: Additional Survey Results

DEGREE OF COMMUTER SATISFACTION IN MATTAPAN

Very dissatisfied
12%

Somewhat dissatisfied
13%

Very satisfied
25%

Neutral
17%

Somewhat satisfied
33%

- Very dissatisfied
- Somewhat dissatisfied
- Neutral
- Somewhat satisfied
- Very satisfied

Figure 19: Commuter Satisfaction in Mattapan

Appendix 7: Survey Results Cont.
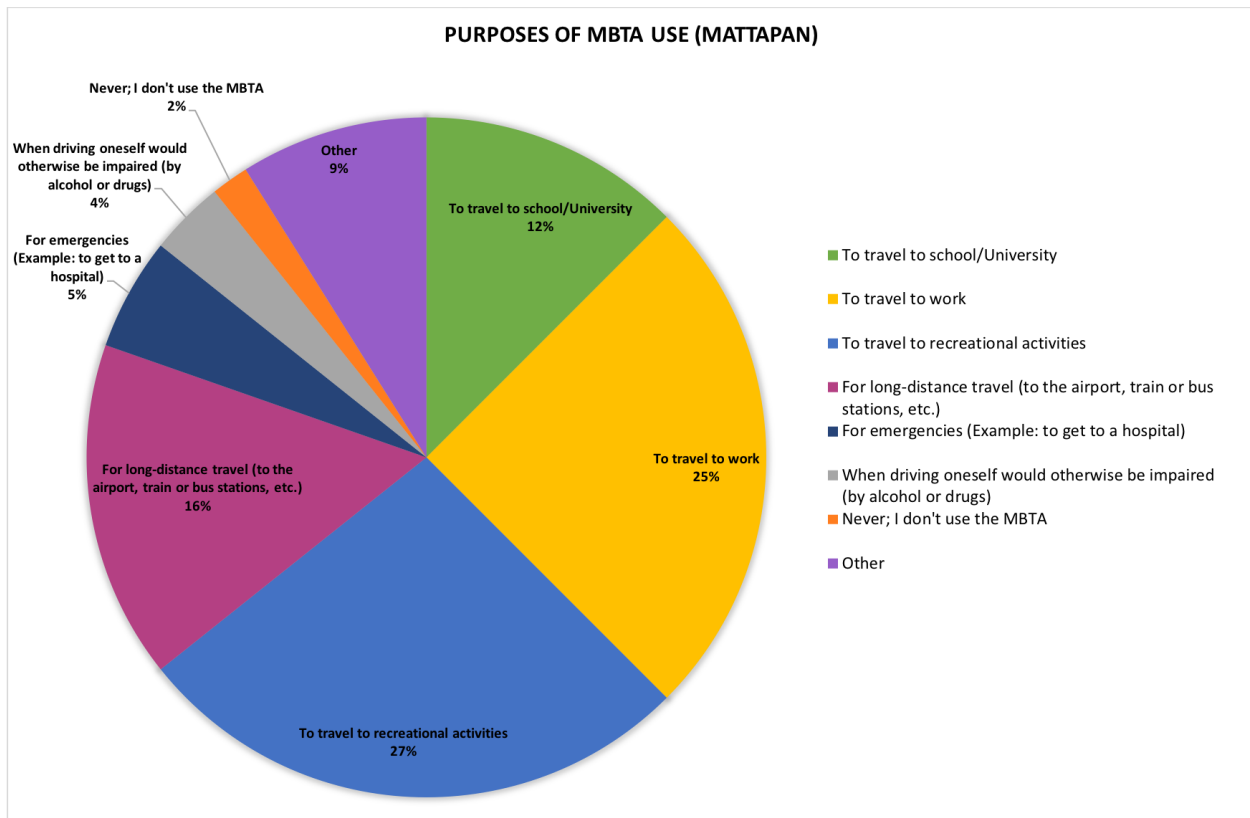
Figure 20: Purpose of MBTA use by Mattapan residents

Appendix 8: Survey Results Cont.
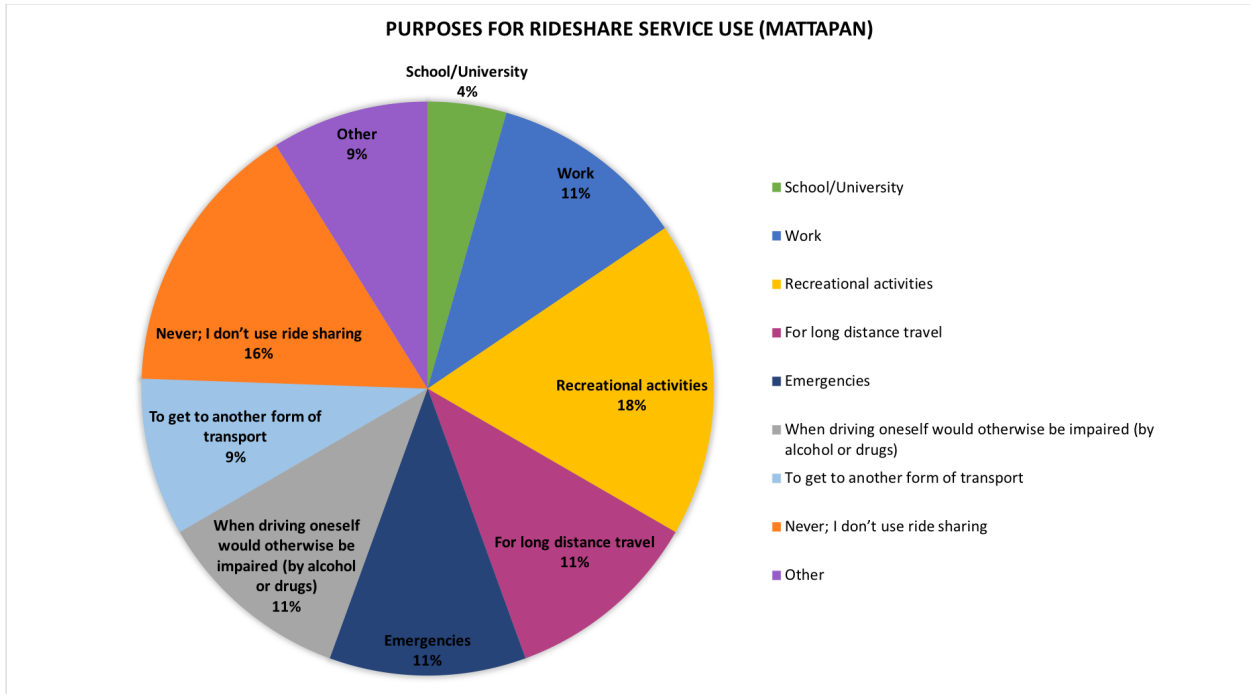
Figure 21: Purpose of Rideshare use by Mattapan residents
Appendix 9: Survey Results Cont.
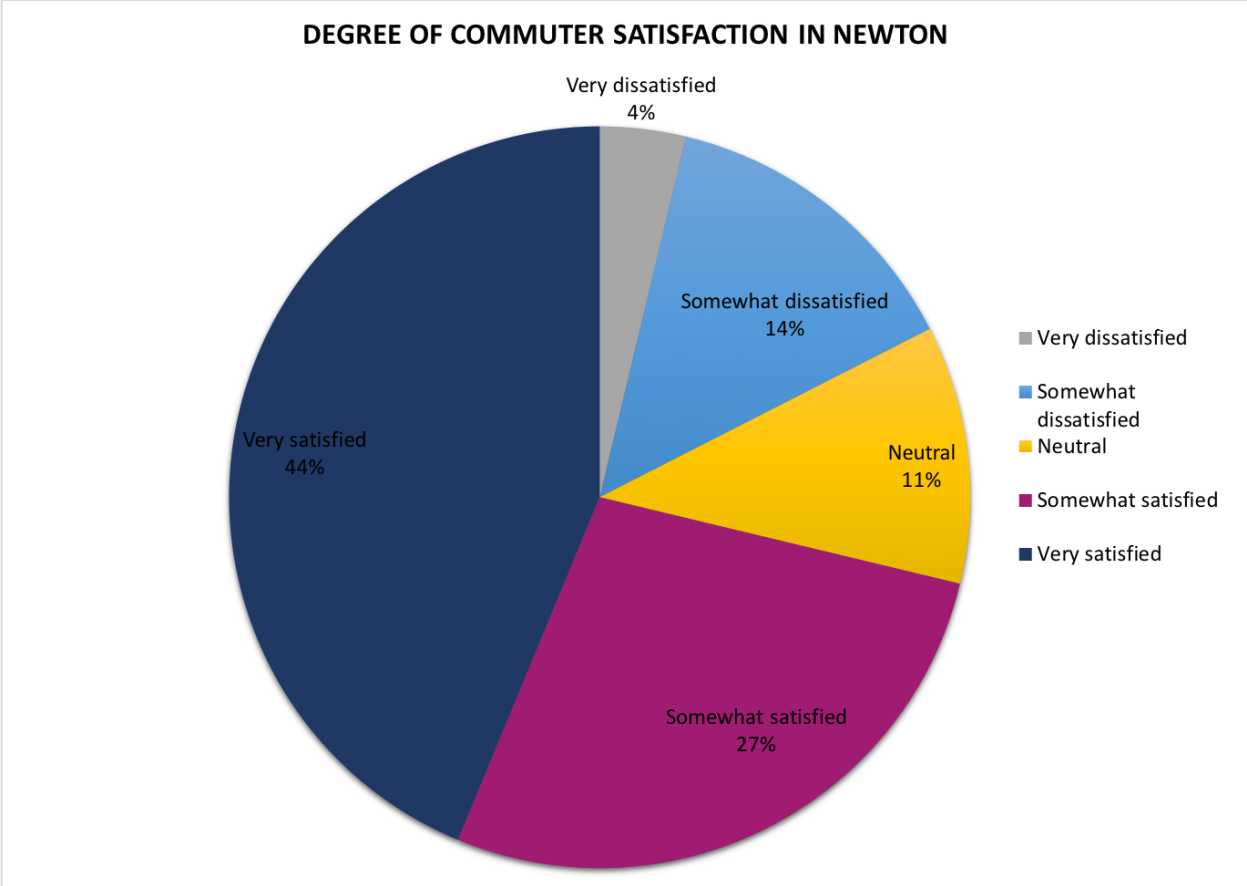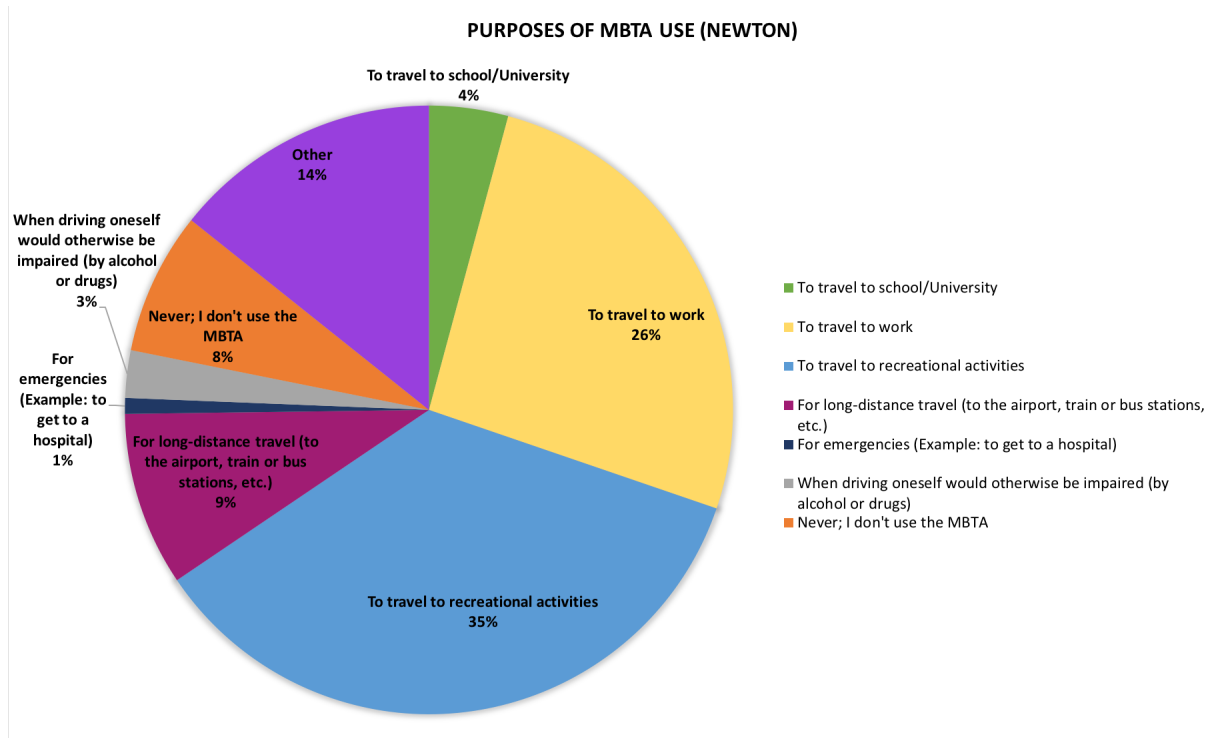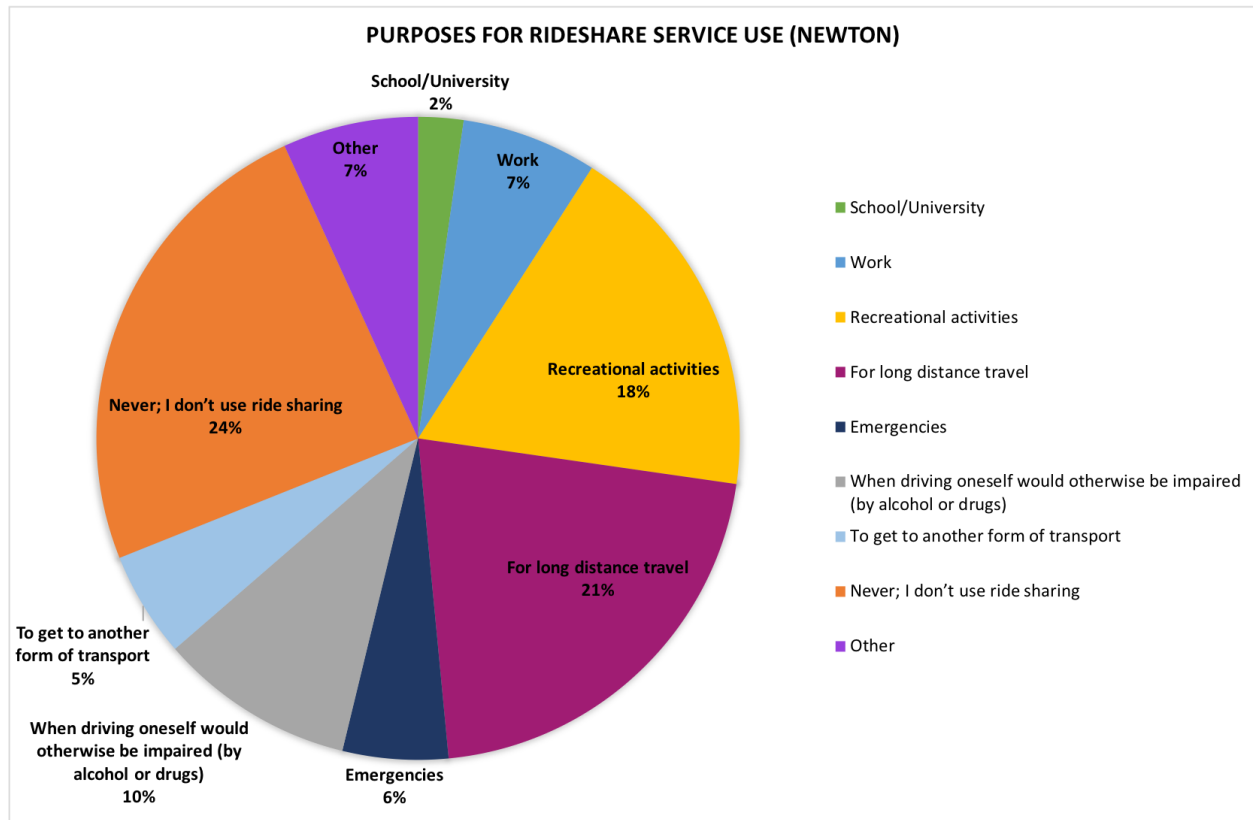
Figure 22: Commuter satisfaction in Newton

PURPOSES OF MBTA USE (NEWTON)

Figure 23: Purpose of MBTA use by Newton residents

Appendix 11: Survey Results Cont.

PURPOSES FOR RIDESHARE SERVICE USE (NEWTON)

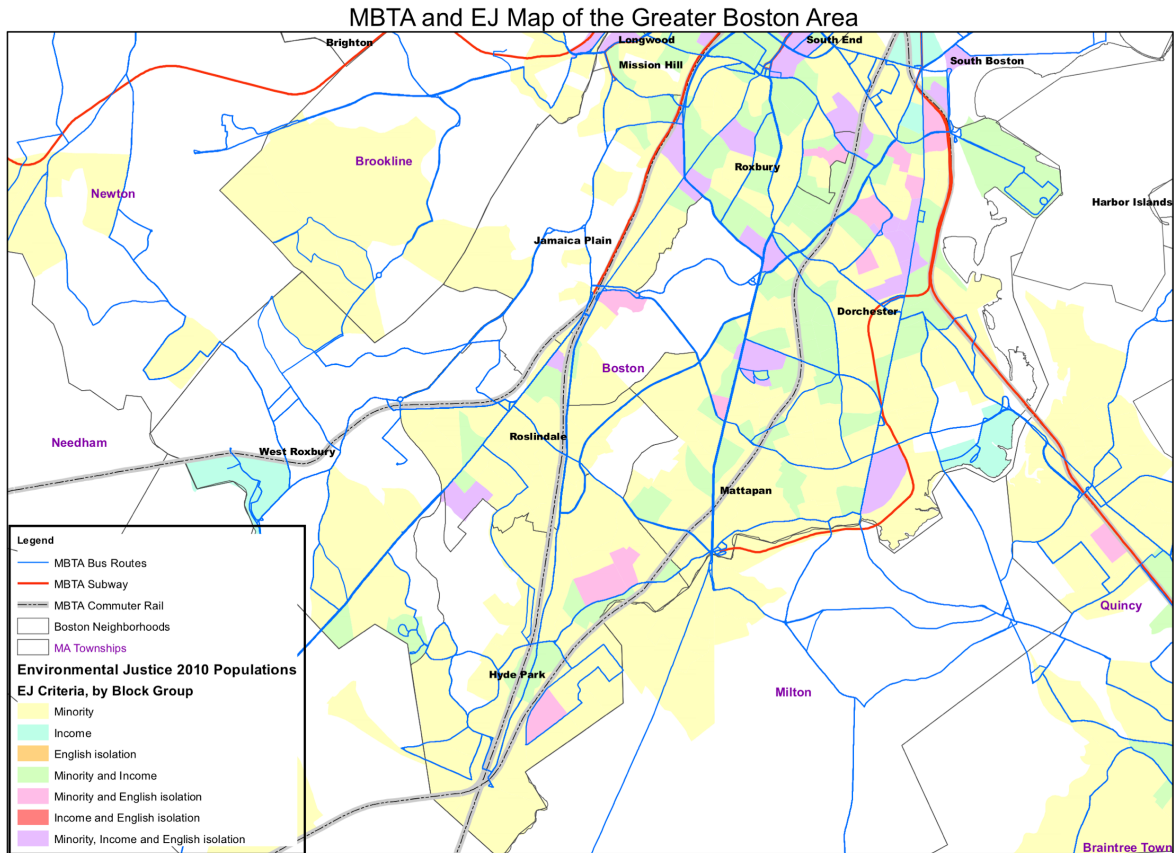Figure 24: Purpose of Rideshare use by Newton Residents

Appendix 12: Full MBTA Services

Figure 25: Map of EJ corridor in Boston that is most impacted by lack of access to high speed rail options and impacted by bus idling

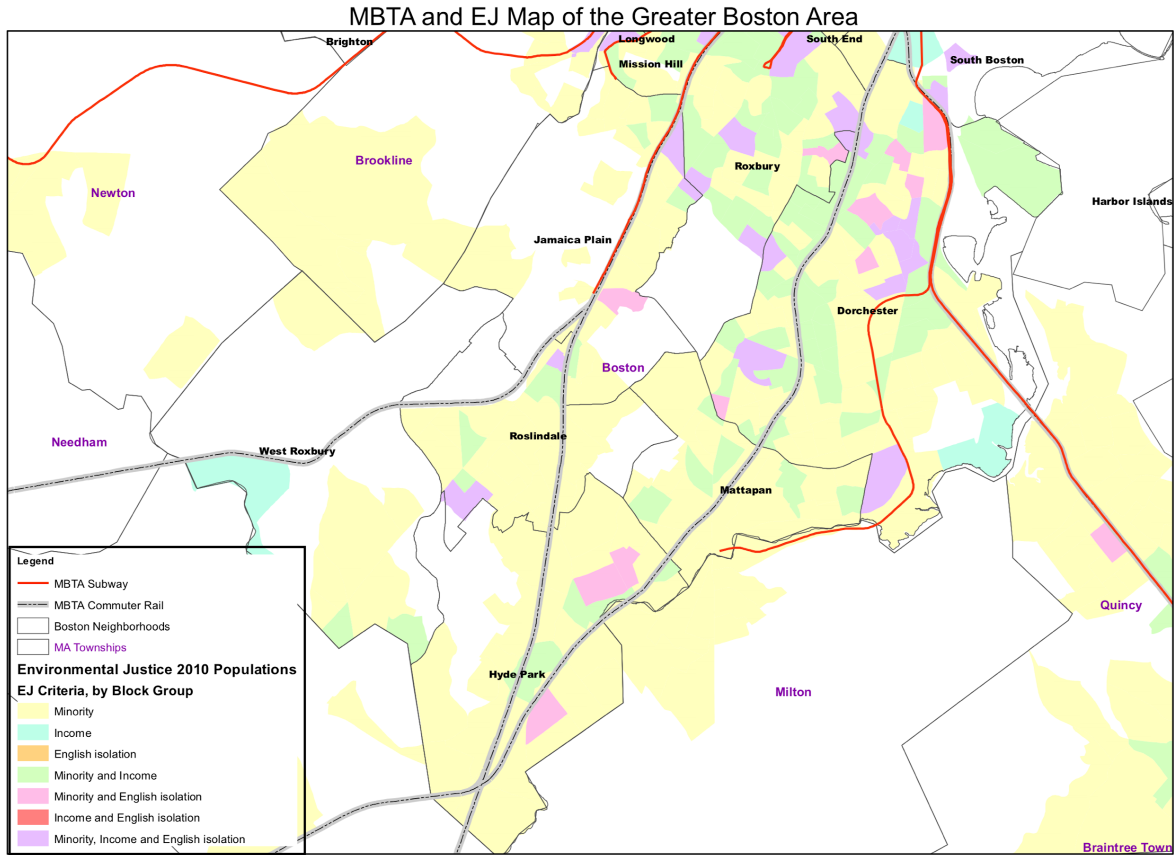MBTA and EJ Map of the Greater Boston Area

Figure 26: Map of EJ corridor in Boston which is straddled by the regular, high speed subway options (in red) with the commuter rail passing through center.