Boston and the 30 Minute Window

Abstract

The access to transit at either end of a transit journey, usually termed as the first-and-last mile, has been recognized as one of the major barriers to improving transit accessibility (Zuo et al.). Furthermore, research shows that commutes longer than 30 minutes have adverse effects on health and productivity (Vitality Health). Adequate public transportation access should maximize the amount of people within this 30 minute window. Specifically, this paper focuses on how to increase accessibility to public transportation in the Boston area using cycling. In order to investigate this topic, geolocation data for bike docks in Boston, as well as geolocation and trip data for T stops has been gathered. Each bike dock was assigned to its nearest train station. Then, each train station was assigned a commute time based on its distance to Boston's busiest station. With this data, each bike dock was assigned a commute time. This provides a radius around every bike dock and T stop, equal to the distance that can be covered walking to each of these places in 30 minutes minus each stop's commute time. Upon investigation it was found that most stations have a bike sharing station within 1 mile of it. Some major stations had multiple biking docks within reasonable walking distance. This increases accessibility and area covered for certain stations with more than average number of bike docks. Installation of bike docks near stations that currently have 1-2 would increase transit access and reduce commute time for less accessible neighborhoods of Boston.

Problem Statement

Out of all of the sectors of the economy, transportation is the sector with the highest percentage of emissions. The average household's emissions are almost half transportation-based, and projected improvements in fuel technology would be negligible when applied to the projected transportation growth.(United States Environmental Protection Agency). One of the best ways to reduce household emissions is to switch car commuting to using public transportation, saving about 48,000 pounds of CO2 emissions per person per year (APIA). But simply providing transport infrastructure is not enough to reduce transportation emissions. The access to transit at either end of a transit journey, usually termed as the first-and-last mile, has been recognized as one of the major barriers to improving transit accessibility (Zuo et al.). This is due to the fact that disadvantaged populations often live in urban centers and have low percentage ownership of automobiles, which makes it harder to access their job locations. Moreover, research shows that commutes longer than 30 minutes have adverse effects on health and productivity (Vitality Health). In order to provide adequate public transportation access, there should be enough options to maximize the amount of people within this 30 minute window, and there should also be measures to increase accessibility to these transportation options. For this purpose, this paper is investigating how increasing access to biking could increase the amount of people in this 30 minute window.

Currently, Bluebikes is Boston's public bike share, owned and managed by the City of Boston in partnership with neighboring municipalities. They own more than 250 stations and around 2,500 bikes sponsored by Blue Cross, Blue Shield. Today, more than 90% of Bostonians live within a 10-minute walk of a bike share station(Boston gov). However, there is no data available on how many people are within a 30 minute commuting distance. The goal of this

paper is to analyze the accessibility between bike sharing stations and the closest subway station. By analyzing the bike dock and station positions, it shows which people have access to this 30 minute window.

The research question that is going to be answered is who has access to the 30 minute window, and which stations could benefit from additional bike docks to increase commuter accessibility. In the process of answering this question, it will also create new knowledge and analyze the accessibility with the current bike stations. This hopefully fills the gap about the current and desired state of bike sharing to include more and more people. Time permitted, cost analysis and quantification of health benefits rendered from the final product is a possible area of exploration. In September 2022, Mayor Wu announced a 100-station expansion of the bike share system in Boston (Bluebikes) in the next three years but details of expansion plan are yet to be shared. The final product is an optimization problem which will hopefully provide the government data on how accessible these current and new bike stations are.

As bike stations are becoming more used in urban locations to provide a simple means of transportation for many people living in these areas, more people are using them as easy, cost effective, and environmentally friendly means of transportation to get to other public transit options such as buses or train stations. The first major cohort study reporting cycling-specific effect estimates was conducted in Copenhagen, Denmark (Andersen & Cooper, Andersen, Schnohr, Schroll, & Hein 2000). In a sample of approximately 20,000 study participants, almost 7000 reported commuting by bike. Adjusted for other physical activity and various risk factors, cycling to work was associated with a 28% decrease in all-cause mortality risk. These findings were later confirmed by Matthews et al. (2007) in a large cohort of Chinese women, which found a 21% reduction in all-cause mortality for 3.5 hours of cycling per week, compared to none. And

to conclude, of course the main goal of the study was to reduce the commute time of maximum people. However, the locations that bike stations are placed are not always feasible for people to use when trying to get to work. An overview of how the bike stations are placed should be altered to fit a 30 minute window. In which a person is able to go from their home to a bike station and then take that bike to some form of public transit which will get them to work all within 30 minutes. For people who live within the greater Boston area and in underserved communities in Boston, this will also provide relief from emission inequality and the first-last mile problem, as access to public transportation will reduce emissions in these areas and provide them with more access for them to make the trips they want to take, rather than just the ones needed. With the traffic, and pollution that is generated creating bike stations that are placed generously around the city, allows for people to use cycling as a means to reach their destination, and not have to struggle to get to a bike station within a reasonable time, as well as reduce carbon emissions. Allowing people living in these underrepresented communities will be able to get access to public transit at a more affordable price.

Methods

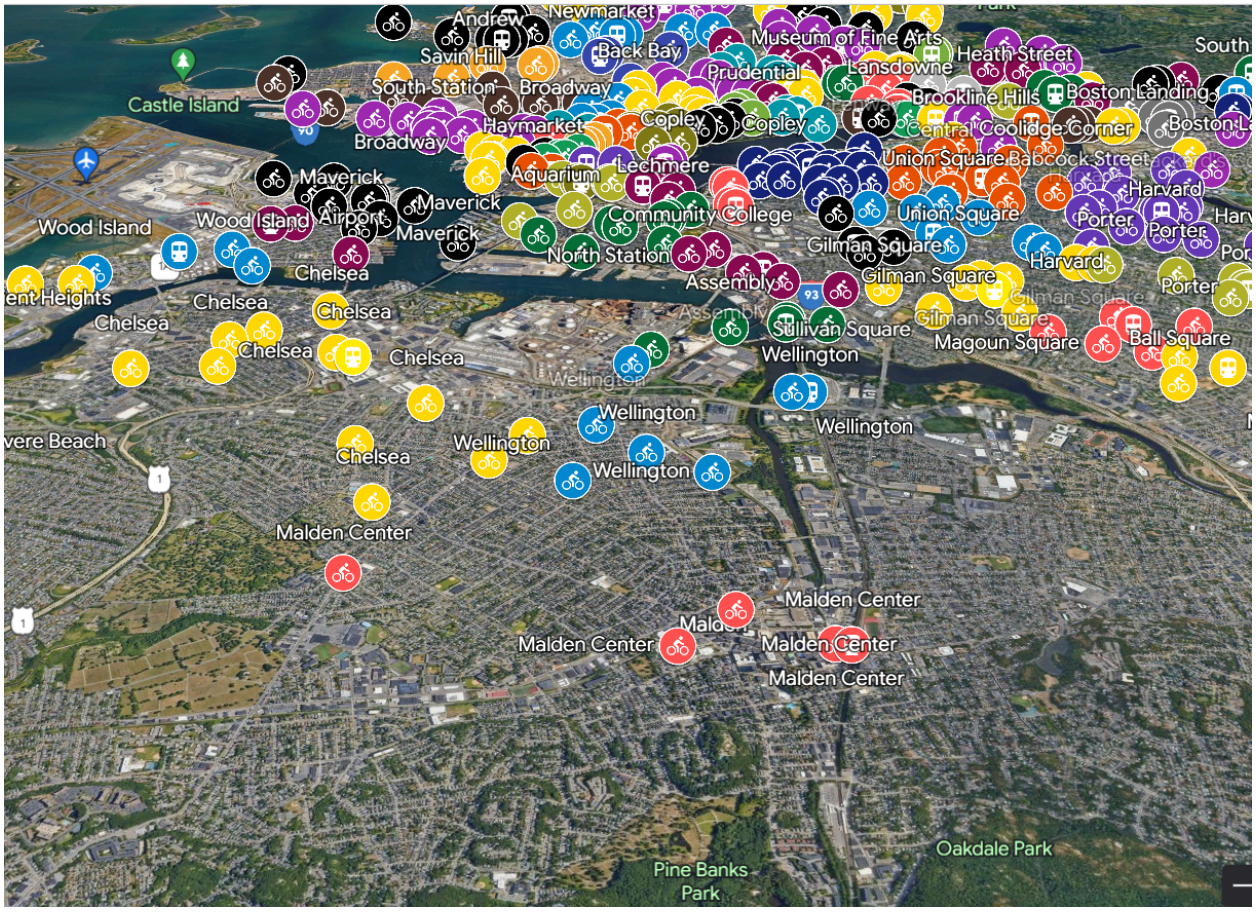
Data collection is integral to the final project. Since it is statistical analysis and further predictive modeling, data quality is everything. To ensure that, the data that has been chosen was carefully selected. Credible sources such as the Boston Mayor's website, Massachusetts.gov, etc have been used. A dataset of the coordinates of bike sharing stations in and out of Boston will come from BlueBikes, which is the authorized bike sharing station coordinator in the area. HubLuv is a philanthropic organization that partners with key players in Biking in Boston to advocate and implement better biking infrastructure and celebrate biking for all. The MBTA V3 API, the MBTA's official way of obtaining information about public transportation in Boston,

was also used to extract station coordinates and trip times. Another important aspect to remember is the existence of previous ICONS projects in the area.

To analyze the data that was collected, it will be input into a spreadsheet. Then all necessary data points will be transformed into vectors. To understand which people are within the 30 minute window. Then data on the most used station in the Boston transit station, will be called the destination station, which is the end of someone's commute for this research, that station will be South station. Next the estimated travel distance across every line to that main station will be found, by using the MBTA V3 API. By doing so will provide each station with a "target time", which is the time that people that use that station have to commute to that station before they exceed the 30 minute window. From those results a circle with a radius equal to the distance that it takes the average person to bike the remaining minutes. Next all the bike stations within that circle, and the measured time it takes to bike from the bike rack to the station by dividing the distance by the average biking speed, will be identified. From there, each bike station will have its own "time rating". From this data, we will extract the locations with the least access to the 30 minute window, and try to understand what it is about these areas that leads them to have poor transportation access.

Results & Broader Impacts

District	Count of bike docks in District
Boston	250
Cambridge	79
Somerville	33
Newton	15
Salem	15
Brookline	14
Everett	14
Arlington	6
Watertown	6
Chelsea	6
Revere	4
Medford	3
Malden	3
Grand Total	**448**



Here is the interactive map:

https://www.google.com/maps/d/u/0/edit?mid=1oYnkv2ccYg3iWD35LEdSa37bJmMXyXk&usp=sharing

Here's a breakdown of accessibility of bike stations by smaller neighborhoods:

closest station	Count of closest station
Kendall/MIT	20
Harvard	16
South Station	14
Salem	14
Alewife	14
Central	12
Chelsea	11
Boston Landing	10
Maverick	10
Roslindale Village	9
Porter	9
Massachusetts Avenue	8
Broadway	8
Newtonville	8
Gilman Square	8
Union Square	7
Community College	7
North Station	6
Back Bay	6
Copley	6
Wellington	6
Sullivan Square	5
Four Corners/Geneva	5
Tufts Medical Center	5
Arlington	5
Magoun Square	5
Green Street	5
Talbot Avenue	5
Uphams Corner	5
Forest Hills	5
Aquarium	5
Davis	5
Jackson Square	5
JFK/UMass	5
Ashmont	4
Assembly	4
Roxbury Crossing	4
Harvard Avenue	4
Morton Street	4
Hyde Park	4
Revere Beach	4
Andrew	4
Ruggles	4
Lechmere	4
Stony Brook	4
Malden Center	4
Medford/Tufts	4
Wood Island	3
Shawmut	3
Boston College	3
East Somerville	3
Ball Square	3
Newton Centre	3
Lansdowne	3
Brigham Circle	3
Science Park/West End	3
Hynes Convention Center	3
Longwood Medical Area	3
Orient Heights	3

Orient Heights	3
West Medford	3
Brookline Hills	3
Government Center	3
Newmarket	3
Boston University Centra	2
Brookline Village	2
Chinatown	2
Boston University East	2
Airport	2
Coolidge Corner	2
South Street	2
Boylston	2
Washington Street	2
Blue Hill Avenue	2
Fields Corner	2
Babcock Street	2
Savin Hill	2
Newton Highlands	2
Kenmore	2
Northeastern University	2
State	2
Packard's Corner	2
Warren Street	2
Park Street	2
West Roxbury	2
Prudential	2
Saint Mary's Street	2
Tappan Street	1
Cleveland Circle	1

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Bowdoin	1
Haymarket	1
Longwood	1
Blandford Street	1
Fairmount	1
Cedar Grove	1
Fenway	1
Heath Street	1
West Newton	1
Milton	1
Charles/MGH	1
Highland	1
Auburndale	1
Kent Street	1
Chiswick Road	1
Downtown Crossing	1
Washington Square	1
Museum of Fine Arts	1
Waverley	1
Bellevue	1
Beverly	1
Central Avenue	1
Amory Street	1
Summit Avenue	1
Mattapan	1
Symphony	1
Grand Total	**448**

It makes sense that districts further away from the city's center have longer commute times, but we can conclude from the breakdown by area that some districts have disproportionately small access to the 30 minute window when compared to their distance from South Station. We believe it is important that, to achieve equity, that people have equal access to public transportation. One of the biggest problems in transportation access is the first and last

mile problem, where the first and last miles of a commute are the most influential in a person's trip. The first mile issue can be addressed by increasing the area of the 30 minute window, as closing the gap between people's homes and the closest stations would increase the accessibility of public transportation. For all the existing Bike Sharing Systems in and around Boston, the average distance to the closest station from bike docks is 0.621 miles, which is 14 mins or walk or 3 min cycle to the station. Therefore increasing bike use by being a cheaper and more convenient alternative than private transport, thus reducing emissions and providing all of the benefits of the 30 minute window.

The above breakdown by area is an estimated ranking of most accessible stations and least accessible stations. HubLuv should provide least accessible stations business solutions through biking or other measures to increase accessibility thereby encouraging more people to use public transit. Expected increase in bikers seasonally will reduce carbon emissions but more importantly the positive affects health will increase. The impact of these findings from the research conducted and the results produced, will allow for people living within low income communities in greater Boston to commute to work within 30 minutes. Which will benefit their mental health, as well as help them be more productive at work. (Vitality Health) Cycling is a great physical activity, and if people are able to cycle for even a small amount of time each day can provide a benefit to their physical health. It will also help relieve the high pollution levels that occur in urban cities such as Boston. By decreasing private transportation, and increasing public transportation and cycling will promote better actions to continue to reduce emissions, which benefits the people living there as well as the environment.

One of the benefits of working with a model such as the 30 minute window model is that it can be applied to the other stations in greater Boston, so that throughout the entire city there

are enough bike stations available for people to incorporate cycling into their daily lives, and commutes. While there are other factors that need to be considered such as the stability of the roads, and the conditions the routes are in to get to a subway station. These methods could be extremely useful, to increase cycling in Boston, reduce emissions from driving, and encourage the usage of the various public transit options that are available in Boston. Cycling fills the gap in accessing any of these options from a person's home, to anywhere in Boston. The next step would then be to broaden this idea to other urban areas, such as New York. Where even more people use public transit. Also the infrastructure for cycling is a bit better, it may be much easier to implement this model. Overall by investigating this issue, and using this model, it will act as a guide to helping to reduce the emissions that are produced by transportation, all over.

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