Accessibility

Assessing Accessiblity for Different Mode Riders to MBTA Red Line Stations

Introduction

Transit provides people with mobility and enhances the interconnectivity in the city. It also serves as a tool to counter traffic congestion, air and noise pollution associated with driving. Encouraging the use of transit helps a city goes green.

People's use of transit greatly depends on its accessibility. If it takes a long time to access a transit station, the time costs will make potential transit riders shift to other modes. Considering the travel distance of most transit trips, driving is the most probable alternative. To attract people out of their cars and use transit instead so as to cut carbon emissions, understanding current accessibility of transit stations is the first step.

Accessibility to transit services is also a crucial component of social justice. For low income people who cannot afford the mobility brought by owning a car, it is more so. Access to transit stations help them to be connected to more opportunities that are spatially dispersed.

This project studies the accessibility of the 22 MBTA red line stations, by studying how easy it is for pedestrians, bikers, bus riders, and drives to access the stations. This catogorization is based on the mode they use to access the red line stations, i.e. walk-and-ride, bike-and-ride, bus-and-ride, and drive-and-ride.

Methods

1. Clip out towns served by the MBTA red line on the road network dataset.
2. Create station service areas (SSA) for pedestrians, bikers, and drivers.
   a. Generate a field named "Minutes" in the road network dataset for every mode.
   b. Create network datasets for each mode using time as impedance,
   c. Create 10-min walk service area, 10-min bike service area, and 5-min car service area for each station using network analysis,
   d. Join the shape_area of each service area to the station layer,
3. Join parking spaces for cars and bikes in each station to the station layer.
4. Use Count Trips at Points tool in Esri's BetterBusBuffer toolset and GTFS data to obtain the number of transit trips available at bus stops in 10-min walkshed around stations.
5. Calculate a 100-point score for each mode in each station using field calculator. Scores are standardized to 100 by dividing it with the score of the best performer.
6. 3D visualize mode scores using ArcGIS Pro.
7. Identify transit trips of low income households from Massachusetts Travel Survey and map them on census block groups layers.
8. Count low income transit trips (LITTs) in every mode service area (3*22=66 service areas)
9. Find the correlation between LITTs in a service area and the corresponding scores of the mode using Ordinary Least Square tool.

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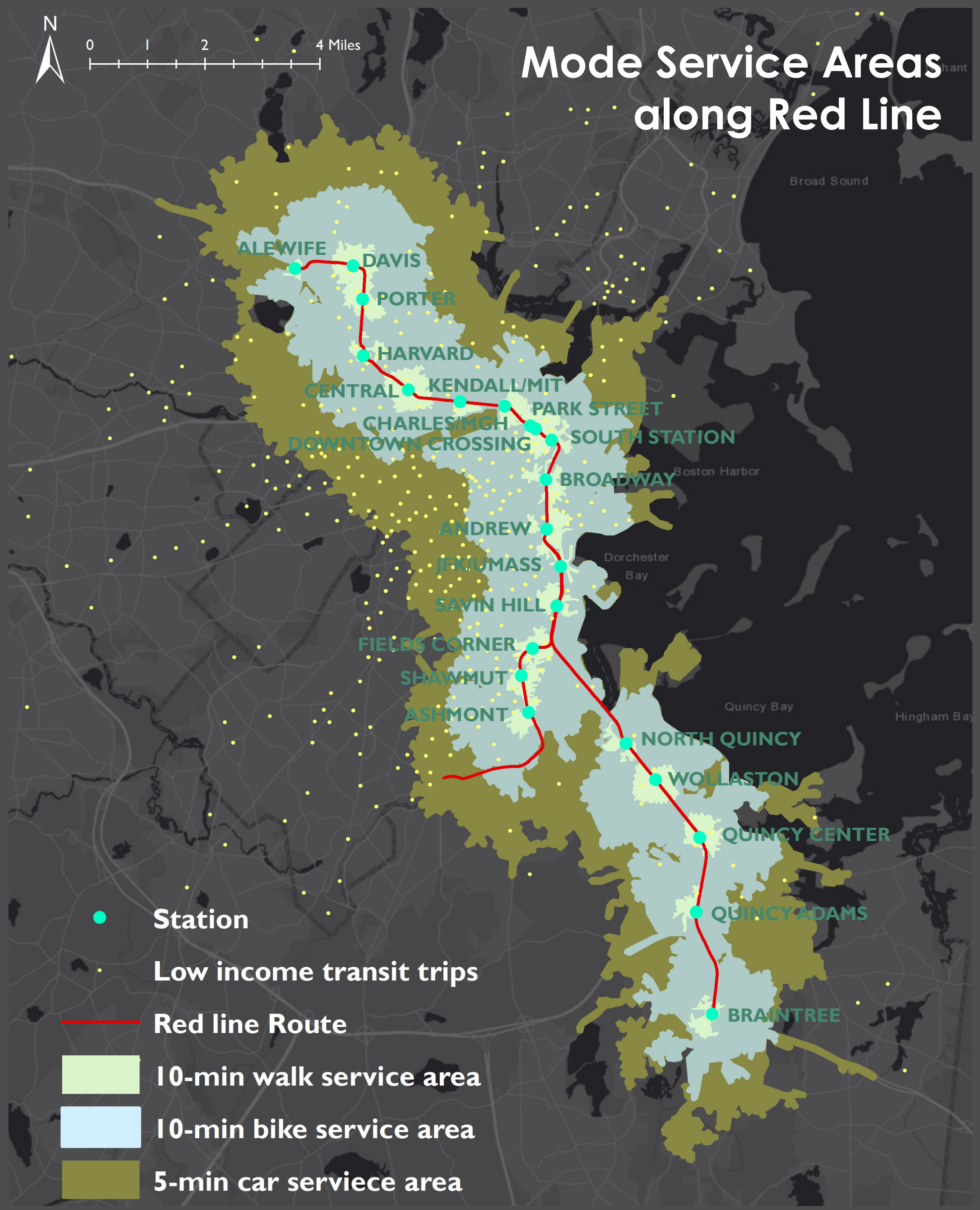


Results

The results show that Central is the most accessible station for pedestrians and park-and-ride users, while Alewife is found the least accessible station for pedestrians and bikers. Davis is the most friendly station for bikers, and it also scores very high for pedestrians. For bus-and-ride patrons, the most desirable stations are the two downtown stations - Downtown Crossing and Park Street, where people can easily catch a bus nearby. South Station - another transit hub - also has high bus frequency. On the other hand, Braintree is a nightmare for them as only 7 trips are available per hour, on average. Though South Station is very accessible for bus users, it is very unaccessible for park-and-ride users, which is a result of its expensive parking rates ($30 per hour).

Using Ordinary Least Square to find the correlation between LITTs and accessibility scores, I find there is correlation between LITTs in walks service area and walk scores, while there is no significant correlation in bike and drive mode. This result is plausible in that, for low-income people, walk is the most common way of travel because unlike driving and biking that needs an initial investment, walking does not incur any costs. The significant correlation between walk accessibility and LITTs also indicates that, to encourage low income people's use of red line, improving walkability in roads surrounding the stations and shortening the time for pedestrians to get to the station may be of help. Since the results is just about correlation and no causality can be assumed, it cannot be said that increasing walkability will necessarily result in more LITTs. Moreover, if the causality is true, improving walkability around transit stations will also contribute to promoting social justice by generating more transit trips and connecting more low income people to opportunities and information.

Correlation items	Coefficient	t-Statistic	p-value	Robust t-statistic	Robust p-value
LITT in Walk Service Area & Walk Scores	0.41	1.23	0.24	2.33	0.04*
LITT in Car Service Area & Drive Scores	-2.35	-0.33	0.74	-0.34	0.74
LITT in Bike Service area & Bike Scores	3.77	1.19	0.25	1.58	0.13

Results of Ordinary Least Squarre Anlysis

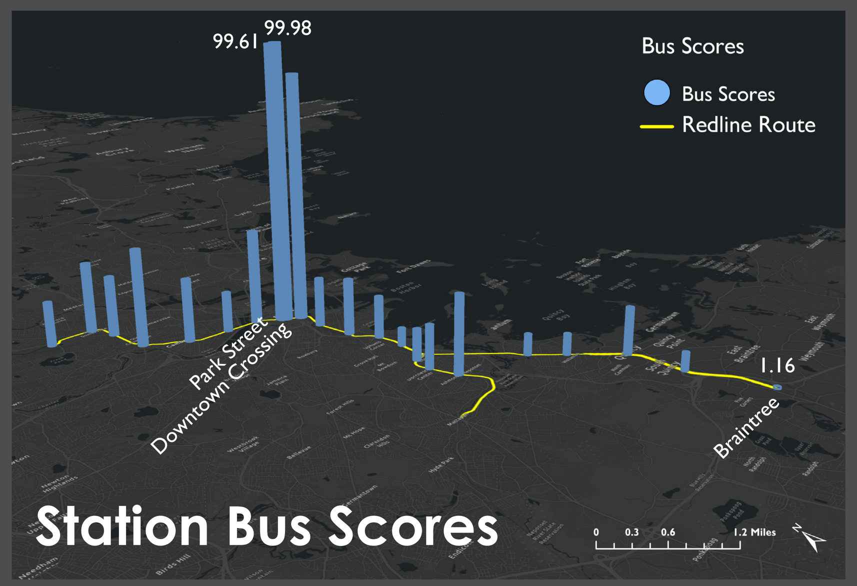
Conclusions

From the results, it is indicated Alewife needs to improve its accessibility to pedestrians and bikers to attract more riders, as it scores last among the 22 stations in the two modes. The correlation between LITTs and walkability also implicates that more fundings should be directed to enhance walkability surrounding transit stops in low-income neighborhoods.

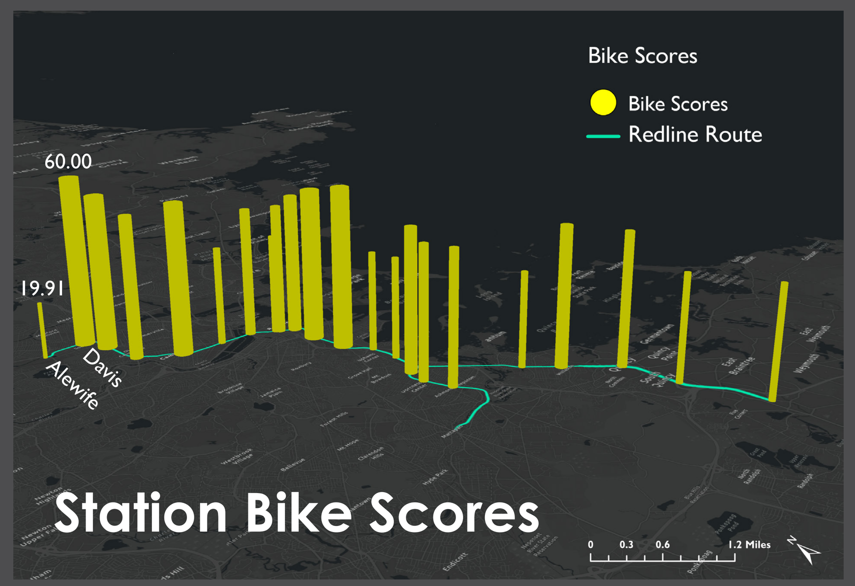
There are several sources that are likely to cause error in this project. When generating the time impedance for making automobile network dataset, speed limits on road segments have been used to calculate the time cost. However, this may lead to downward bias in time costs, as people may not also drive at the speed limit. It should also be noted that the limited sample size of 22 stations will limit the effect of correlation analysis using OLS.

Ideally, road networks should be obtained respectively for each mode to reflect the actual facilities available for each mode users. Sidewalk facilities and classified road networks were originally used for this project, but the datasets were not clean enough to make meaningful network datasets, and Streetmap was used for all modes, which also incurs inaccuracy in assigning mode scores. Future research should be done using mode specific road networks.

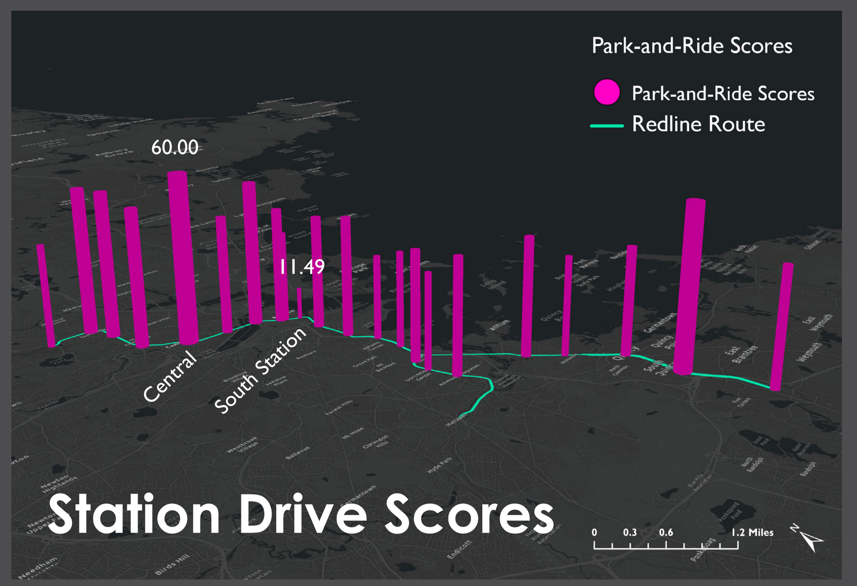
Walk scores are calculated using solely the area of service areas, following this formula:
Walk score=Shape_Area of walk SSA / largest walk SSA*100



Bus scores formula:
Bus score=Available trips per hour for the station / available trips per hour of the best performer * 100

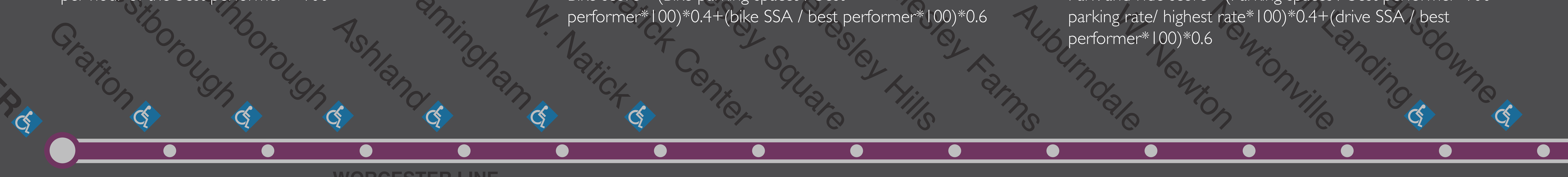


Bike scores formula (parking space is given a weight of 0.4, and bike SSA 0.6):
Bike score= (Bike parking spaces / best performer*100)*0.4+(bike SSA / best performer*100)*0.6



Park-and-ride scores formula (parking space and rates is given a weight of 0.4, and drive SSA 0.6):
Park-and-ride score= (Parking spaces / best performer*100-parking rate/ highest rate*100)*0.4+(drive SSA / best performer*100)*0.6

Data source
Streetmap road network in S drive
MassDOT - MBTA lots
MBTA GTFS data
Massachusetts Travel Survey 2015



All maps use NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001