University of Massachusetts Amherst

H. Analysis of Transportation Accessibility in Downtown Boston

Abet Hossen, Emily Larkin, Jude Aladmawy, Julia Hatzis

Integrated Concentration in Science

Introduction

- Quantifying accessibility to public transportation can help identify areas that need increased access to transportation
- Identify accessibility differences between neighborhoods within downtown Boston based on economic differences
- Discerning inequities among individuals to reduce their transportation carbon footprint and the extent of their degree of choice dependent on demographic factors

Methods

Bus Score[6]

$$5 - 5\left(\frac{4.06 \text{ stops} - X}{4.06 \text{ stops}}\right)$$

X – the average number of bus stops within 0.5 miles of road

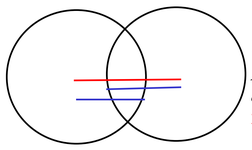
If the average expected number of bus stops within 0.5 miles of road was greater than 4.06 stops, then a score of 5 was given.

Metro Score[9]

$$5 - 5\left(\frac{Y - 0.44 \text{ miles}}{1 - 0.44 \text{ miles}}\right)$$

Y – the average observed minimum distanced between metro stops

If the average distance between metro stops was less than the expected minimum distance between stops, then a score of 5 was given.



1320 ft = ¼ mile

Assume overlap distance ~ 320ft

2320 ft ~ 0.44 miles

Walking Score

Score	Description
5	The area is walkable and has sidewalks where people can walk. In addition, the destination is within a reasonable distance of 1 mile or less
4	The area is mostly walkable with sidewalks for most of the area. In addition, the destination is between 1 mile and 1.75 miles away.
3	The area is somewhat walkable with sidewalks for most of the area. In addition, the destination is between 1.75 and 2.5 miles away.
2	The area is walkable with some sidewalks in the area. In addition, the destination is between 2.5 and 3.5 miles away.
1	The area is not walkable and has few or no sidewalks for most of the area. In addition, the destination is 3.5 miles or more away.

Bike Score:

Criteria	Weighting
Length (sufficient distance of lane) [LA]	0.14
Safety of commuter [S]	0.36
Location of path [LO]	0.21
Lack of Traffic Congestion [T]	0.07
**Distance to destination [D]	0.21

Area Scoring
5 - Criteria is very desirable in area
4 - Criteria is desirable
3 - Criteria is moderately desirable
2 - Criteria is somewhat desirable
1 - Criteria is not desirable in area

Transportation Accessibility Score:

Accessibility = Bus + Metro + Walk + Bike

	Walking Score	Bike Score	Metro Score	Bus Score	Accessibility	Grade
North End	5	3.43	0	1.67	10.1	10.1/20 = F
West End	5	4.1	5	5	19.1	19.1/20 = A
Bay Village	5	1.41	0	1.67	8.08	8.08/20 = F
China Town	5	3.53	5	3.69	17.22	17.22/20 = B+
Back Bay	5	4.93	5	5	19.93	19.93/20 = A
Downtown	5	5	5	5	20	20/20 = A
Beacon Hill	5	4.5	5	1.67	16.17	16.17/20 = B-
Total	35	26.9	25	23.7	110.6	

Figure 1. Calculated scores for each neighborhood in downtown Boston with the overall accessibility score for each area. Each score was calculated separately then summed to achieve the total accessibility score. Note that each score was ranked out of a possible 5 points.

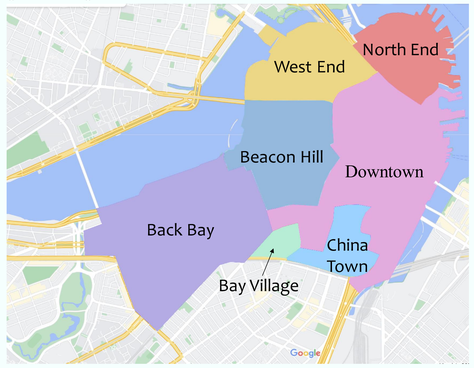
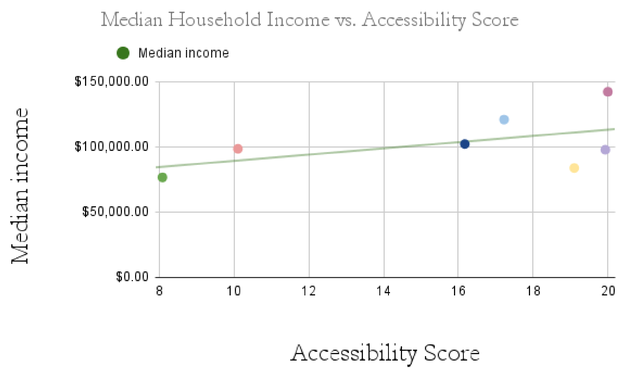


Figure 2. Map of the different neighborhoods within the downtown region of Boston. Colors coordinate with Figure 1.

Accessibility Score for Downtown Boston

Average Walk Score: 5
Average Bike Score: 3.84
Average Metro Score: 3.57
Average Bus Score: 3.39
TOTAL: 15.8 points
Score: 15.8/20 = C+

Grade	Range (%)
A	93-100
A-	90-92
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	0-60



Area	Median income[5]	Accessibility Score
North End	$98,523.99	10.01
West End	$83,810.73	19.1
Bay Village	$76,652.24	8.08
China Town	$120,954.21	17.22
Back Bay	$97,762.64	19.93
Downtown	$142,172.41	20
Beacon Hill	$102,168.30	16.17

Figure 3. Plot of Median Household Income versus Accessibility Score. The median household income for each neighborhood (as shown in the table above) was plotted against the calculated accessibility score. The median income[5] and the accessibilities score for each neighborhood are shown in the table to the right of the chart.

Data Collection

Data Type	Source
Walking Score	Google Maps Sidewalk View
Biking Score	Boston Bicycle Network Map
Metro Score	Google Maps
Bus Score	Google Maps

Figure 4. The data type and source for each type of data. Each score was calculated using a different type of map to examine the different routes that exist within the downtown Boston area.

Discussion

- Downtown Boston appears to have good accessibility to transportation for an urban district
- The overall grade for Downtown Boston was low due to two low scores in Bay Village and North End
- Plot of median household income versus time shows a positive relationship, indicating little to moderate relation
- The neighborhood with the lowest score was also the neighborhood with the lowest income

Conclusions

- Transportation accessibility and household income has a weak relationship
- The accessibility scoring can be a tool to help distinguish areas lacking in a specific type of public transportation
- Increasing accessibility to public transportation will allow individuals to better reduce their carbon emissions

Sources

1. "Boston's Carbon Emissions." *Boston.gov*, 11 Dec. 2017, https://www.boston.gov/departments/environment/bostons-carbon-emissions
2. Brooks, Rebecca Beatrice. "History of the Boston Subway: The First Subway in America." *History of Massachusetts Blog*, 16 Mar. 2017, https://historyofmassachusetts.org/boston-first-subway-america/
3. City of Boston. "Getting Around Boston." *City of Boston*, https://www.cityofboston.gov/students/transportation/#:~:text=Boston%20is%20a%20friendly%2C%20walkable,%2C%20trolley%2C%20or%20water%20transportation
4. *Climate Projection Consensus - Boston*. https://www.boston.gov/sites/default/files/file/2019/12/03_climate_ready_boston_digital_climateprojectionconsensus.pdf
5. "Overview of Boston, Massachusetts (City)." The Demographic Statistical Atlas of the United States - Statistical Atlas, https://statisticalatlas.com/place/Massachusetts/Boston/Overview
6. *Street-Side Factors 3 - Transportation Research Board*. https://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_19-b.pdf
7. Stevensonon, Frances. "Does Bike Commuting Impact Your Carbon Footprint? and How Much?" *Our Streets Minneapolis*, 2 July 2018, https://www.ourstreetsmpls.org/does_bike_commuting_affect_your_carbon_footprint_and_how_much
8. Timperley, Jocelyn. "How Our Daily Travel Harms the Planet." *BBC Future*, BBC, 17 Mar. 2020, https://www.bbc.com/future/article/20200317-climate-change-cut-carbon-emissions-from-your-commute
9. Walker, Jarrett. "Basics: The Spacing of Stops and Stations." *Human Transit*, 2 Sept. 2016, https://humantransit.org/2010/11/san-francisco-a-rational-stop-spacing-plan.html

We thank sponsors of iCons and our research:

Chleck Family Foundation

Edward Marram & Karen Carpenter

IMPACT NANO

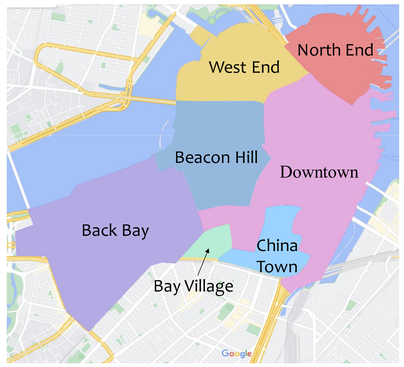
Waters

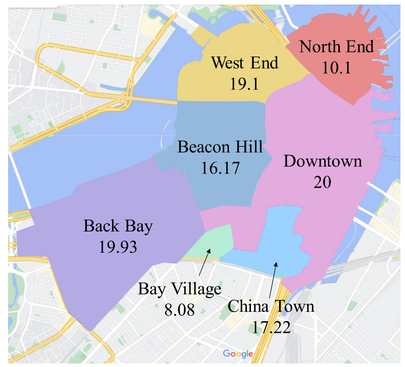
ZIPHER Medical Affairs, LLC

VENTUREWELL

Mahoney Family Sponsorship

Museum of Science


North End
West End
Beacon Hill
Downtown
Back Bay
China
Town
Bay Village


West End
19.1
North End
10.1
Beacon Hill
16.17
Downtown
20
Back Bay
19.93
Bay Village
8.08
China Town
17.22