Amplifying Communities: Electric Vehicle Car Sharing in Low-income Areas

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Projection: NAD_1983_CORS96_StatePlane_Massachusetts_Mnld_FIPS_2001_FtUS

Data Sources: Bostonopendata.com, Mass.gov, American Fact Finder, Census.gov

Introduction

Currently, the U.S. is desperately trying to reduce carbon emissions with the transportation sector being the largest contributor at roughly 40%. While new technology, like renewables, have drastically reduced emissions, the transportation sector still has not found a viable option to reducing emissions. Instead, the emissions from the transportation sector are continually increasing year after year. I will not try to offer a revolutionary overhaul of the transportation sector that would take decades to achieve and substantial investment. I will provide a small recommendation that can decrease transportation emissions at a small city-wide scale.

This project is aimed at finding a suitable location for an electric vehicle car sharing service, with a particular interest in low-income community. This approach was sought because of the small investment needed that can make a substantial difference. Car sharing is the practice of renting a car hourly to meet transportation needs within a particular network. It is often used for ancillary transportation needs like doctors appointments or leisure activities, but can also be used for commuting services to meet everyday needs. The need for car sharing is often found with individuals that do not own a car or car-owning individuals that do not use a car frequently. Car sharing offers an automotive form of transportation that can replace the need for owning a car and subsequently reducing the emissions from car ownership.

I have chosen to make the car sharing service as an all electric fleet. This is to build on the emissions saved as it will reduce that number of car owners in a region while adding little to no additional emissions from the previous non-car owners that would be using the service.

Additionally, I have chosen to target the low-income community as they typically face increased disparities at meeting reliable transportation needs. As such, they contribute a disproportional amount of emissions since typical commutes entail high polluting forms of transportation, like buses.

Methodology

To find a suitable location for such a service I needed to find a city that has not had a car sharing service before that could be easily implemented. Boston, MA was chosen for its success with the car sharing service Zipcar, no previous electric car sharing service for low-income residents, and wide-ranging data availability.

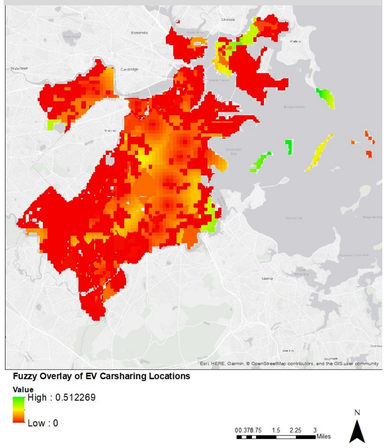
To assess the success of an all electric car sharing service for low-income communities, I had found seven different variables that would provide inputs to create final maps outlining that best locations to place said service. Those inputs were:

- Public charging stations
- Number of vehicles per household
- Multi-Unit Dwellings
- Low-income census tracts
- Zipcar membership (2013)
- Distance to train station
- Time of commute

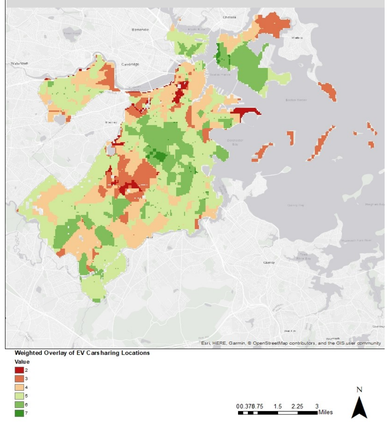
Each input was chosen for a particular reason and each serve as a challenge to implementing such a service.

Four of the seven maps can be seen below and were created using different methods such as Euclidean distances and joining data to census tracts obtained from census.gov. Once each map for the seven variables were created, two different final maps were created to be compared and contrasted with each other. Fuzzy Overlay was created by using fuzzy membership for all quantifiable maps, the categorical maps were included without fuzzy membership, to create a heat map of the best location to place the car sharing service. The weighted overlay map shows the best place to put the car sharing locations, but has assigned different weights to the inputs (i.e. car ownership was assigned the highest weight as it is most impactful).

Fuzzy Overlay Map



Weighted Overlay Map



Results

The Results show that there are multiple places that an electric vehicle car sharing service would be suitable throughout the Greater Boston Area. When comparing the two final maps, two areas become instantly noticeable; East Boston and an area in Dorchester near the coast.

The community East Boston would be the best choice for such a car sharing location given the high values associated within each map. The East Boston community fuzzy overlay map shows, excluding the 0.0 scores, ranges of values from 0.18-0.31. With a maximum score of 0.51, the East Boston community has shown the highest values associated with a specified area in Boston. The weighted overlay shows similar scores with a range of scores from 3-7. The majority of East Boston pointing towards the higher values of 6 and 7.

The Dorchester community also shows similar value ranges indicating the car sharing service would be successful. The values range from 0.24-0.29. The range of values for the weighted overlay are 4-7. Although the range of values express higher success in Dorchester, the communtiy shown is small, indicating the membership would be limited and potentially not sustainable. Therefore, the East Boston community should still be considered more successful given the larger population and target area.

The high values demonstrate the communities have relatively good access to public charging stations, poor access to public transportation, low Zipcar membership, low car ownership, high times of commute, and a high number of low-income individuals and housing. Those assumptions can be tested with the input maps below.

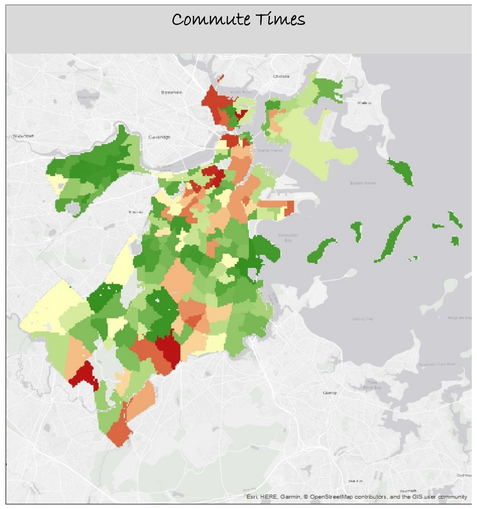
Conclusions

When comparing the two final maps, the weighted overlay should be seen as the more reliable map when making a final judgement of where the car sharing location should be placed. The weighted overlay, as mentioned, is able to assign weights to the input maps to make the map more reliable. Inputs such as Multi-Unit Dwellings and Low-income census tract were not assigned a high weight due to the map either representing a 1 (low-income) or 0 (non low-income). Therefore regardless of what weight is assigned, if it is not a low-income area it will not be considered regardless of weight. By assigning those inputs a low weight, the car ownership and distance to public transit, that were identified as being impactful variables, were able to be assigned higher weights.

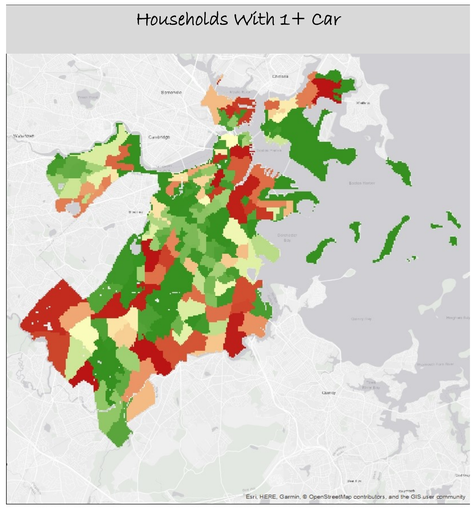
While I do find my maps to be conclusive that a electric vehicle car sharing service in low-income communities would be effective and successful, I do believe the maps could be improved. Although seven variables that were identified as being necessary to gauge to success, I know more variables could be identified to make the suitability analysis more effective. For instance, bus routes could also be identified along with distance to train stations as another input. Bus stations were not chosen as they are seemingly evenly distributed across Boston and may create a uniform map. If some measure besides distance to bus station were to be quantified, then buses may be an applicable input. Additionally, other quantifiable inputs like vehicle theft could be input to assess a level of liability the company implementing the car sharing service could expect, and try to avoid such areas.

Further research could be done to assess cost analysis of a low-income car sharing service. The model could include traffic data to show the most efficient times to use the car sharing service to avoid high costs since we are trying to make it applicable to low-income individuals. Cost paths could also be implemented to help identify areas that have low accessibility, creating higher commute times in those areas.

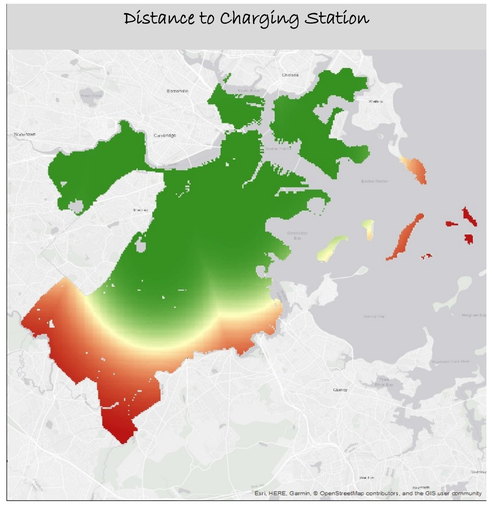
Commute Times



Households With 1+ Car



Distance to Charging Station



Distance to Train Station