Potential for Walking and Biking Methodology Update 2022

Measure Goals

The Potential for Everyday Walking and Biking layers display latent demand for active-mode trip making and are implemented in various project prioritization processes. The first editions of the layers were produced in 2017 (by outside consultants) using what is now outdated demand data. This update utilizes StreetLight trip volumes and includes additional metrics to improve the accuracy and overall consistency of the measures. More importantly, bringing this process in-house allows MassDOT to regularly update the demand data and make any additional changes, as needed, to the measure calculation.

Original Method

Biking

- Potential for Everyday Biking Documentation and original layer
- **Potential for everyday biking = (0.7 * Potential Demand + .2 * Transit Access + .1 * Crashes) * (1 + Social Equity)**
    - Demand: Short trip activity from CTPS 2016 demand model
        - Commute trips less than 6 miles, other trips less than 3 miles
    - Transportation access: Distance to transit hubs
    - Safety: Bike crashes
    - Social equity: Minorities, no-vehicle households, low-income households, Limited-English speaking households, people with disabilities, under 18 and over 65

Walking

- Potential for Walkable Trips Documentation and original layer
- **Potential for everyday walking = (0.9 * Potential Demand + .1 * Crashes) * (1 + Social Equity)**
    - Demand: Potential walking demand (Local Access Score)
        - Trips less than 2.5 miles
    - Safety: Pedestrian crashes
    - Social equity: Minorities, no-vehicle households, low-income households, Limited-English speaking households, people with disabilities, under 18 and over 65

Key Methodological Changes

Demand data

We switched from using modeled demand data based on the CTPS travel model and 2012 Household Travel survey, to demand data based on actual real-time travel using Streetlight anonymized cell phone data. This allows us to easily update the measure in the future, especially as post pandemic recovery travel patterns change.

- Used StreetLight zone analysis volumes

- Biking: all trips under 6 miles
- Walking: all trips under 3 miles

Transportation Access

In this update, we made the way transportation access was treated more uniform for both cyclists and pedestrians. Particularly for biking potential, we didn't want to give more points for being too close to the station, because at a certain distance you are more likely to walk than bike regardless.

- Instead of using 1-5-10 minute time buffers and corresponding scores, a uniform score of 1 point is given to all hexes (created from a statewide grid of hexagons) within a 10-minute walk/ride from any transit hub
- Transit access added to the Potential for Walkable Trips

Crash data

We removed crash data from the calculation for this measure. Potential for Walking and Biking is intended to focus on areas with high demand, regardless of actual travel behavior. Crashes only happen where cyclists and pedestrians are already biking and walking, and often high-risk roadways have no travel and aren't flagged by crash clusters. Because of that, we removed crash data from this measure, assuming decision-making should always take safety into account.

- We recommend looking at these layers concurrently with MassDOT's crash-related Risk Factor layers to make decisions based on where there is both demand and safety risks are high for biking and walking.

Social Equity

We replaced residential demographics with trip demographics. Residential demographics ignore trips made by people in areas they do not live in, and low-income people are much more likely to make more trips, trip-chain more, and travel between places they do not live. The change to trip demographics from residential demographics also align this measure with how we generally try to measure equity at MassDOT when possible.

- Replaced census demos with StreetLight trip demos using the traveler attributes add-on (limited to minority and low-income variables)

Final Score Equation

Potential for Every Biking/Walking =

$$(.7 * Demand + .2 * Transportation\ Access) + (1 + Social\ Equity)$$

Technical Process

If you are interested in access to any of the scrips or datasets referenced in the below technical documentation, please reach out to opmi@mbta.com.

Demand Data

Overview

Create a statewide grid of hexagons and use this as the zone set in a StreetLight zone activity analysis. Normalize the trip volumes (vehicle, bike, and ped modes combined) by regional planning agency (RPA), rescale them from 0-1, and use in the final calculations as trip demand scores. Using anonymized cell phone data as the basis for trip demand helps us identify key routes rather than focusing on destinations alone and provides more-up-to-date travel patterns than previous methods.

Preparing Analysis Zones

- Use “Generate Tessellation” tool in ArcGIS Pro to create statewide hexagon grid
    - 500 ft sides (60342.2945 m^2)
- Clip hex grid to a simplified MA border
    - Using real border creates multipart hexes that don’t work with the StL API
- Split statewide hex layer into layers of 500 hexes each for uploading to StL
    - Can use either a Python script or a manual method:
        - Export statewide hex grid table -> create “bin” column that labels each set of 500 polygons -> import table back into ArcGIS
        - Use “Split by Attribute” tool to split hex layer based on bin label
    - Note: if using the home-work location add-on, zone sets can only have 100 hexes each

Demand Data Process

- Use python script in Jupyter to import zones and run analyses through StreetLight API (this takes a few days)
    - Existing data uses April + October 2019, all day types, all day
    - Run vehicle, bike, and ped modes (remember to include calibration for bike and ped)
    - If using the same set of hexes, only need to run the last part of the script (*Create Analysis and after*)
- Use R script to combine demand data from all 3 modes and rescale demand by RPA
    - Ped: use 3-mile distance cutoff
    - Bike: use 6-mile distance cutoff
        - *Note: Bike output was split between two months (April and Oct) in previous run so script accounts for this, depending on results from new run this may need to be adjusted*

Transportation Access

Overview

Create walking and biking sheds around all transportation hubs and assign a point to every hexagon that intersects a travel shed. This process emphasizes the importance of first and last mile accessibility to public transportation. The previous method gave the highest score to areas within a one-minute walk/ride from transit hubs - which seemed to contradict how people actually use bikes in multimodal trips – while this update assigns the same score to all hexes within a 10-minute walking/biking radius of a hub.

Transportation Access Scoring Process

- Import point layer of all MA transit hubs into ArcGIS Pro
- Use the "Network Analyst – Service Area" tool to create travel sheds around each point
  - Change unit of measurement from km to mi
  - Mode = walking distance
  - Travel direction = towards facility
  - Geometry at overlaps = split
  - Geometry at cutoffs = rings
- For bike sheds:
  - Set break value to 1.67 miles (10-minute ride)
- For walk sheds:
  - Set break value to .5 miles (10-minute walk)
- Use the "Spatial Join" tool to join the sheds to all intersecting hexes (repeat for bike and walk sheds)
  - Target features = statewide hex grid
  - Join features = bike/walk sheds
  - Join operation = one to one
  - Match option = intersect
- Use "Table to Excel" tool to export the hex grid
  - *As BikeShedHex.csv and PedShedHex.csv respectively to work with R script below*
- Use R script to rescale the transit access scores by RPA
  - Will use this Hex to RPA mapping

Social Equity

Overview

Use StreetLight's traveler attributes from demand analyses to get trip demographics; sum the percent values for low-income individuals and people of color and rescale the result from 0-1 across the state. A social equity score is included in the calculations to give greater weight to trips made by the MA residents who are most likely to depend on active and public transportation modes and who would most benefit from system improvements. The original layers used Census residential demographics and included several variables that have high margins of error at the block group level (e.g. Limited English Speaking individuals).

Trip Demographics Process

- Use jupyter notebook to:
    1. Create one single trip table by combining demand data: zone analyses, traveler attributes, and trip attributes for each of the three modes
        - *Note: Bike output was split between two months (April and Oct) in previous run so script accounts for this, depending on results from new run this may need to be adjusted (Step 0 in script)*
    2. Calculate demographic volumes for each mode by multiplying out and subtracting volumes for trips over 6 miles (for bike) and 3 miles (for ped)
    3. Merge the calculated volumes for the three modes and add up volumes to get total population counts of people making trips (bike, ped, or veh) under 6 or 3 miles respectively
    4. Recalculate demographic percentages based on new total volumes
    5. Sum percentages for demographics of interest to get MinorityVolPct and Lessthan50kVolPct and rescale resulting values from 0-1 by RPA
        - Will use this Hex to RPA mapping

Final Calculation & Visualization

Merge scaled demand, transit access, and equity scores by hex and calculate the final potential using the decided equation using jupyter notebook.

> *Note: Once demand, transit access, and equity scores were merged it was noticed that some hexes were missing demand (and thus equity) data. Because everywhere data was missing had 0 demand we will leave these hexes as Null in the final map.*

In the original versions, the safety and equity components had essentially no impact on the scores; the final equation for this version was adjusted so that equity has some meaningful impact.

Potential for Walking/Biking = (.7 * Demand + .2 * Transit Access) + (1 + Social Equity)

Visualization/Final Layers

The original method of using heads-tails median is effective, but users would prefer a simplified scale (e.g. “high, medium, low”) rather than the current 9-point one. We identified high potential roadways by looking at the top 10% of roadways based on the Potential for Walking and Biking index. Medium potential roadways represent the top 60% of roadways on the index. Low potential are the remaining 40% of roadways (note that this 40% is a majority of the mileage because these road segments tend to be in rural places and be longer).