

Determining Latent Demand and Mode Shift Potential for Shared Mobility, Micro-Mobility and Active Transportation Across Rural, Suburban, Urban Settings

Afia Ibnat Subah

M.Sc Student

Department Of Civil And Environmental Engineering
Rensselaer Polytechnic Institute

Special Thanks



Karen M. Lorf, NYSDOT



Ali Afshar, PhD, NYMTC



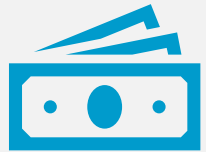
Richard Batchelder, NYSDOT

What is Latent Demand?

Unobserved portion of the
demand curve

“Pent-up” demand that
can be activated by
improvements to
transportation
infrastructure and services

What is Latent Demand?



Marketing Perspective

Latent demand exists when a consumer cannot satisfy a desire due to insufficient funds, lack of product/service availability, or lack of awareness



Psychological Theories

Characterize induced demand as a desire that a consumer cannot satisfy because they are unaware of it or cannot envision the product or service

From A Transportation Perspective



People have unmet needs or desires for travel that can be activated by improvements in transportation options (Lee et al., 1999)



People may not travel to a discount retailer that's farther away if the traffic is too congested, but they might if a new road is built that makes the trip faster and easier (Cervero, 2002)



The concept of latent demand is also linked to "missed trips", which represent unmet needs for travel due to transportation disadvantages (Fields et al., 2021)

What is Active Transportation?



Walking



Bicycling

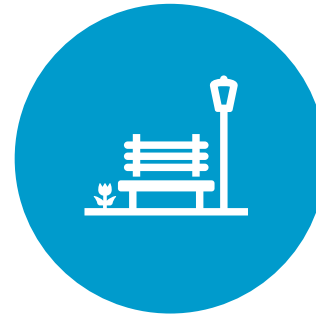


Rolling

My Contribution



Explored the concept of latent demand for active transportation using a GIS-based framework



By integrating demographic, land use, and attractor variables such as schools, colleges, transit stops, parks, etc.



Provided a framework for identifying locations with high potential for walking and biking



Applying the proposed framework to Troy, New York

Methodology



QGIS was used
as the primary
GIS platform to:

LDS: Latent Demand Score



Process the spatial data



Perform calculations



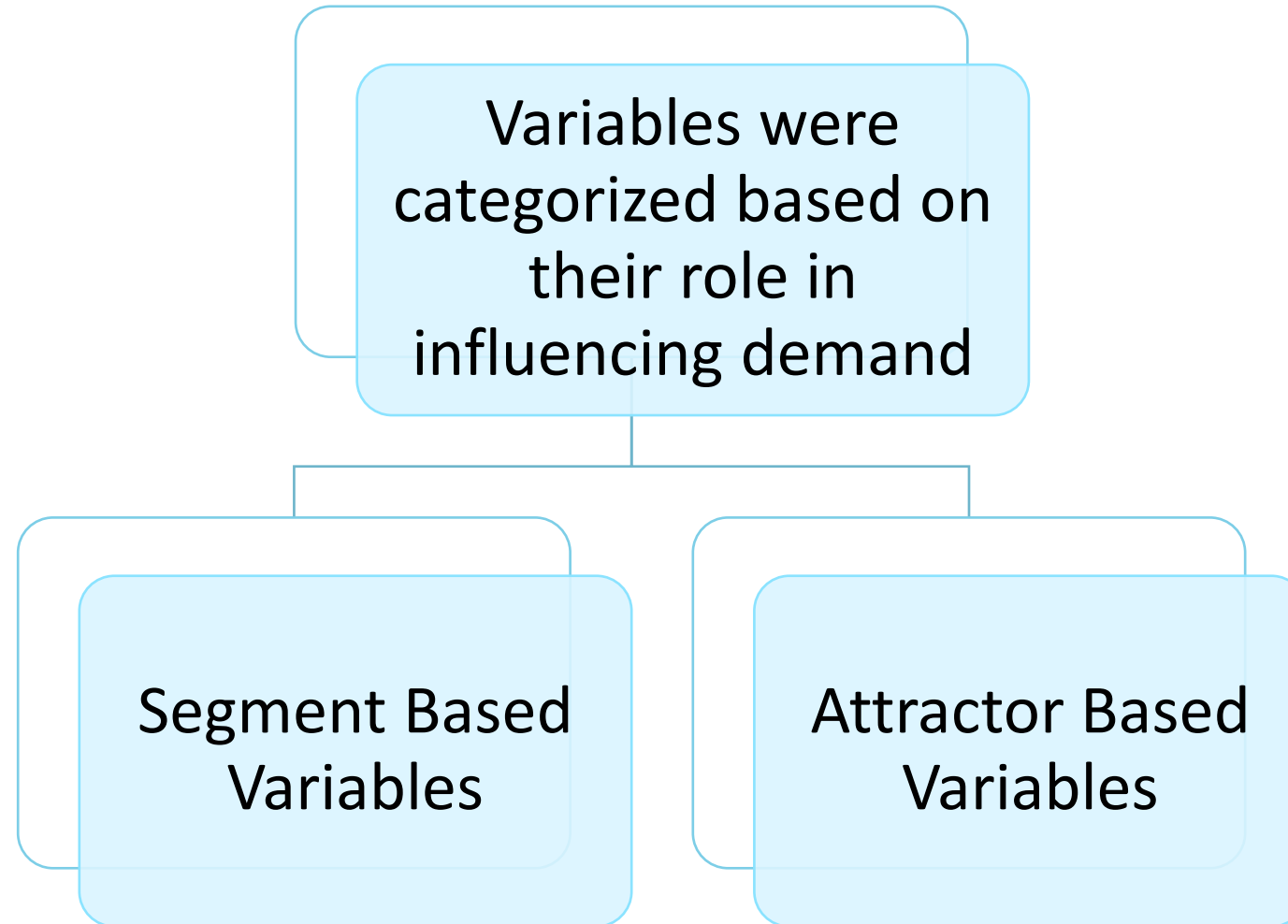
Generate LDS for walking
and bicycling

Selection of Variables

- Population by block group
- Employment by block group
- Locations of schools and enrollment data
- Locations of colleges and enrollment data
- Locations of transit stops
- Locations of recreational facilities (e.g., parks, public golf courses, picnic grounds)



Handling the Variables



Segment Based Analysis: Population and Employment

1

Buffers were created around each road segment using GIS software

GIS: Geographic Information System

2

The portion of surrounding block groups falling within each buffer was then calculated

3

Using this ratio (area within buffer/total block group area), the corresponding share of population and employment for each road segment was estimated



Ensures that latent demand is linked proportionally to the segments' surrounding socio-economic context

Formulation: Population

$$LDS = \sum_{d=1}^n P_d \sum_{z=1}^n Population_z \cdot P_{wb}$$

LDS = Latent Demand Score of a particular street segment

d = Spatial query buffer

n = Total number of buffers

P_d = Effect of travel distance on demand = $e^{-\beta d}$ where, $\beta_{biking} = 1.20$ and, $\beta_{walking} = 1.71$

z = Buffer adjacent to roadway segment

$Population_z$ = Population in the corresponding Buffer

P_{wb} = Percentage of people that either bicycle or walk for shopping and errand trips (67% for bicycle and 100% for walking)

Formulation: Employment

$$LDS = \sum_{d=1}^n P_d \sum_{z=1}^n Employment_z \cdot P_{wb}$$

LDS = Latent Demand Score of a particular street segment

d = Spatial query buffer

n = Total number of buffers

P_d = Effect of travel distance on demand = $e^{-\beta d}$ where, $\theta_{biking} = 1.20$ and, $\theta_{walking} = 1.71$

z = Buffer adjacent to roadway segment

$Employment_z$ = Population in the corresponding Buffer

P_{wb} = Percentage of people that either bicycle or walk for shopping and errand trips (67% for bicycle and 100% for walking)

Segment Based Analysis: Transit Stops



Walking in the United States is strongly associated with access to public transit (Kuzmyak & Dill, 2012a)

1

For transit stops, buffers were created around road segments, and the number of transit stops within each buffer was counted using GIS

GIS: Geographic Information System

2

The Latent Demand indicator was then expressed as the number of transit stops per mile of each road segment

Formulation: Transit Stops

$$LDS = \sum_{d=1}^n P_d \sum_{z=1}^n \left(\frac{NTS}{SL} \right)_z P_{wb} \quad \left(\frac{NTS}{SL} \right) = \text{Transit Stops/miles}$$

LDS = Latent Demand Score of a particular street segment

d = Spatial query buffer

n = Total number of buffers

P_d = Effect of travel distance on demand = $e^{-\beta d}$ where, $\beta_{\text{biking}} = 1.20$ and, $\beta_{\text{walking}} = 1.71$

z = Buffer adjacent to roadway segment

NTS = Number of Transit Stops

SL = Street Segment Length

P_{wb} = Percentage of people that either bicycle or walk for shopping and errand trips (67% for bicycle and 100% for walking)

Attractor Based Analysis: Schools and Colleges



Allows for the estimation of potential demand associated with educational trips

1

Buffers were drawn around each attractor, and the extent to which road segments fell within these buffers was calculated

2

The enrollment figures were then distributed based on the ratio of the segment length inside the buffer to the total segment length

Formulation: Schools and Colleges

$$LDS = \sum_{d=1}^n P_d \sum_{z=1}^n \left(\frac{S_B}{S_L} \right) (Enrollment)_z \cdot P_{wb}$$

LDS = Latent Demand Score of a particular street segment

d = Spatial query buffer

n = Total number of buffers

P_d = Effect of travel distance on demand = $e^{-\beta d}$ where, $\beta_{\text{biking}} = 1.20$ and, $\beta_{\text{walking}} = 1.71$

z = Buffer adjacent to roadway segment

$\frac{S_B}{S_L}$ = Ratio of Street Segment Length in Buffer to Total Street Segment Length

$(Enrollment)_z$ = Enrollment of a particular School or College

P_{wb} = Percentage of people that either bicycle or walk for shopping and errand trips (67% for bicycle and 100% for walking)

Attractor Based Analysis: Parks



Most frequent purpose for both walking and bicycling was recreational or social in nature (Kuzmyak & Dill, 2012a)

1

For recreational facilities, buffers were generated around the facilities themselves

2

The total population residing within these buffers was determined and then distributed across the road segments falling within the buffered areas



Accounts for recreational trip demand linked to proximity to parks and similar amenities

Formulation: Parks

$$LDS = \sum_{d=1}^n P_d \sum_{z=1}^n (Population)_z \cdot P_{wb}$$

LDS = Latent Demand Score of a particular street segment

d = Spatial query buffer

n = Total number of buffers

P_d = Effect of travel distance on demand = $e^{-\beta d}$ where, $\beta_{\text{biking}} = 1.20$ and,

$\beta_{\text{walking}} = 1.71$

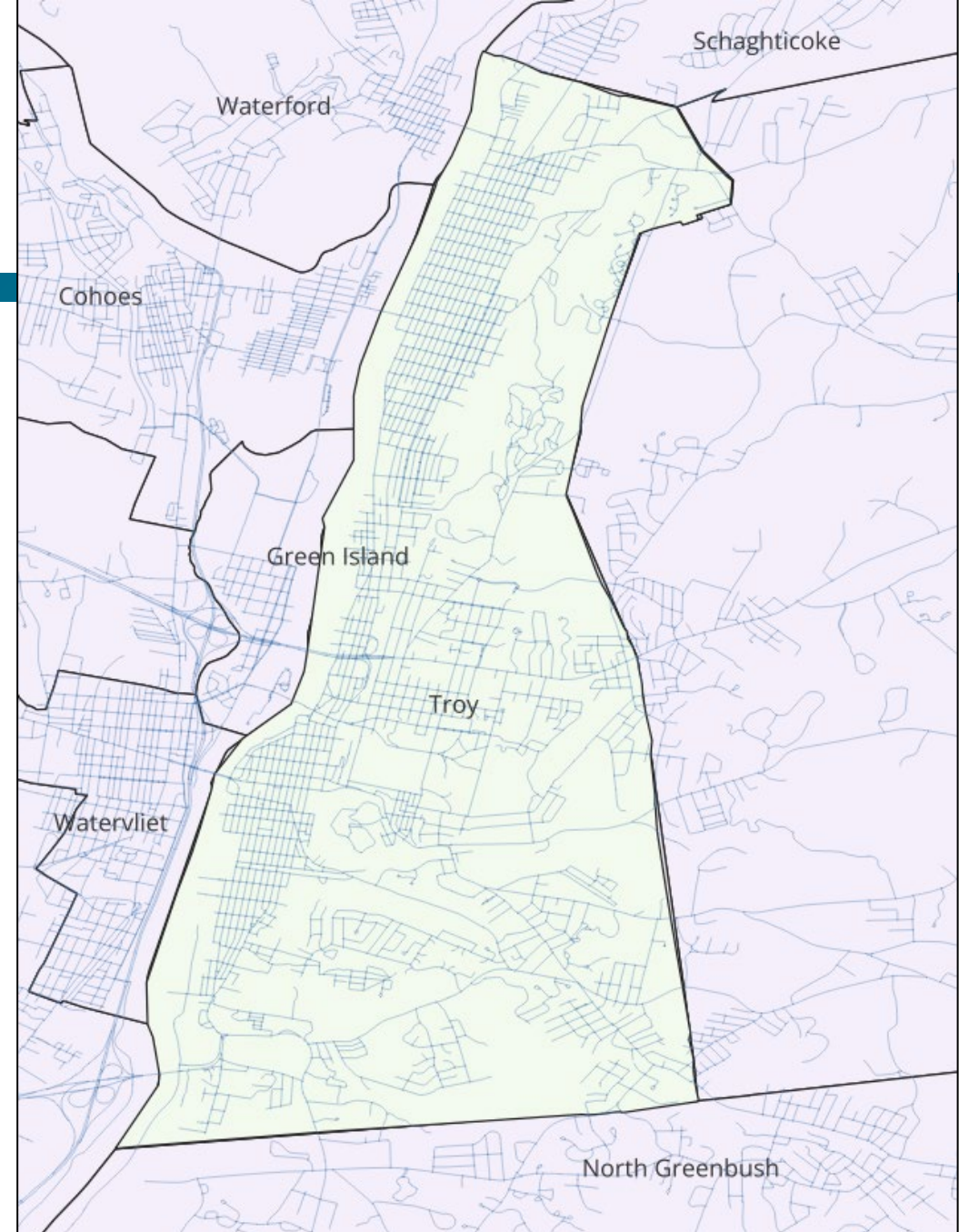
z = Buffer adjacent to roadway segment

$(Population)_z$ = Population within the Buffer of the Park

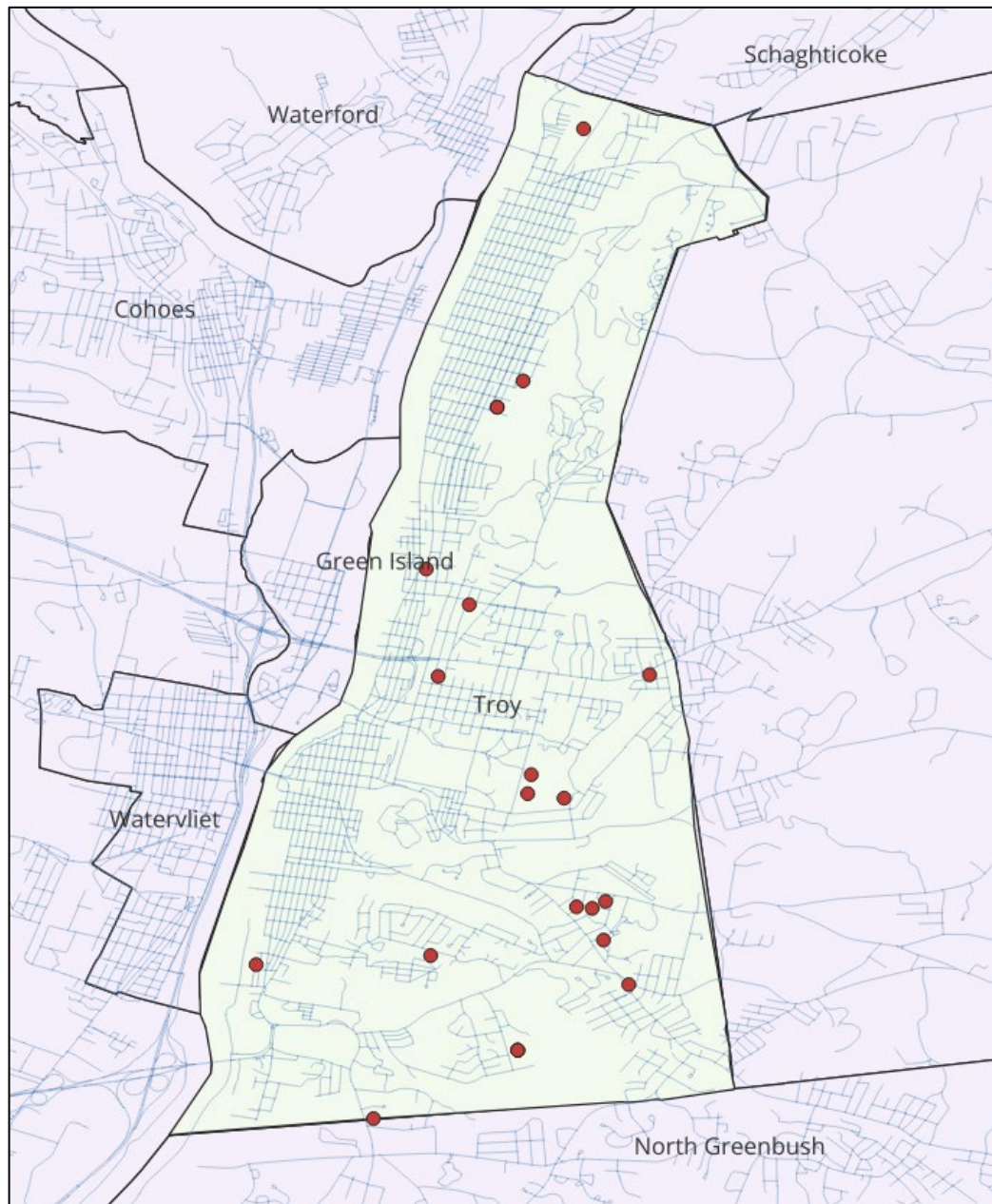
P_{wb} = Percentage of people that either bicycle or walk for shopping and errand trips (67% for bicycle and 100% for walking)

City of Troy: A Case Study

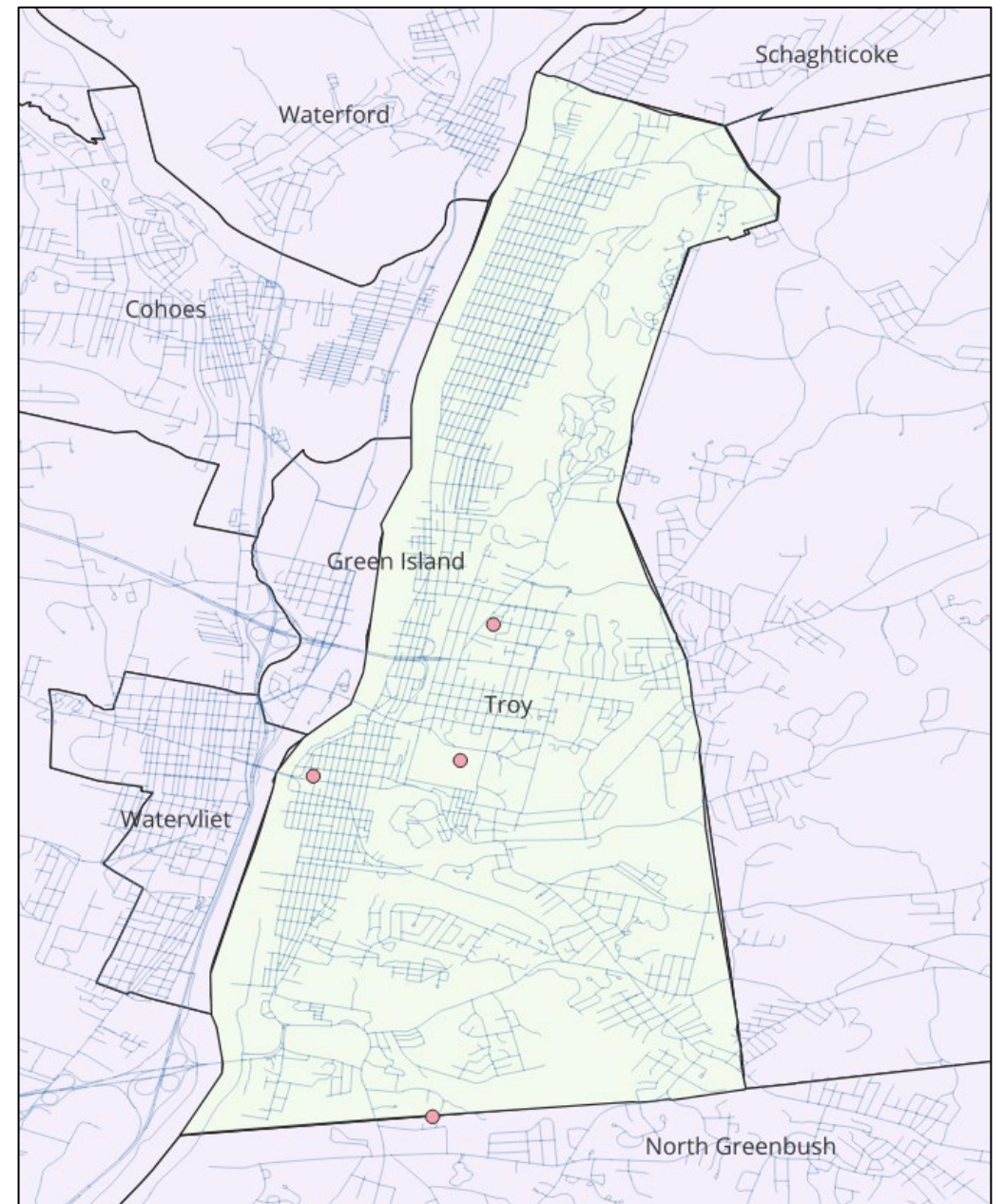
- Mid-sized urban area with a mix of residential, commercial, and institutional land uses.
- The city has a total population of approximately 51,000, a median age of 33 years, and a weighted average age of 37 years (ACS 2023)



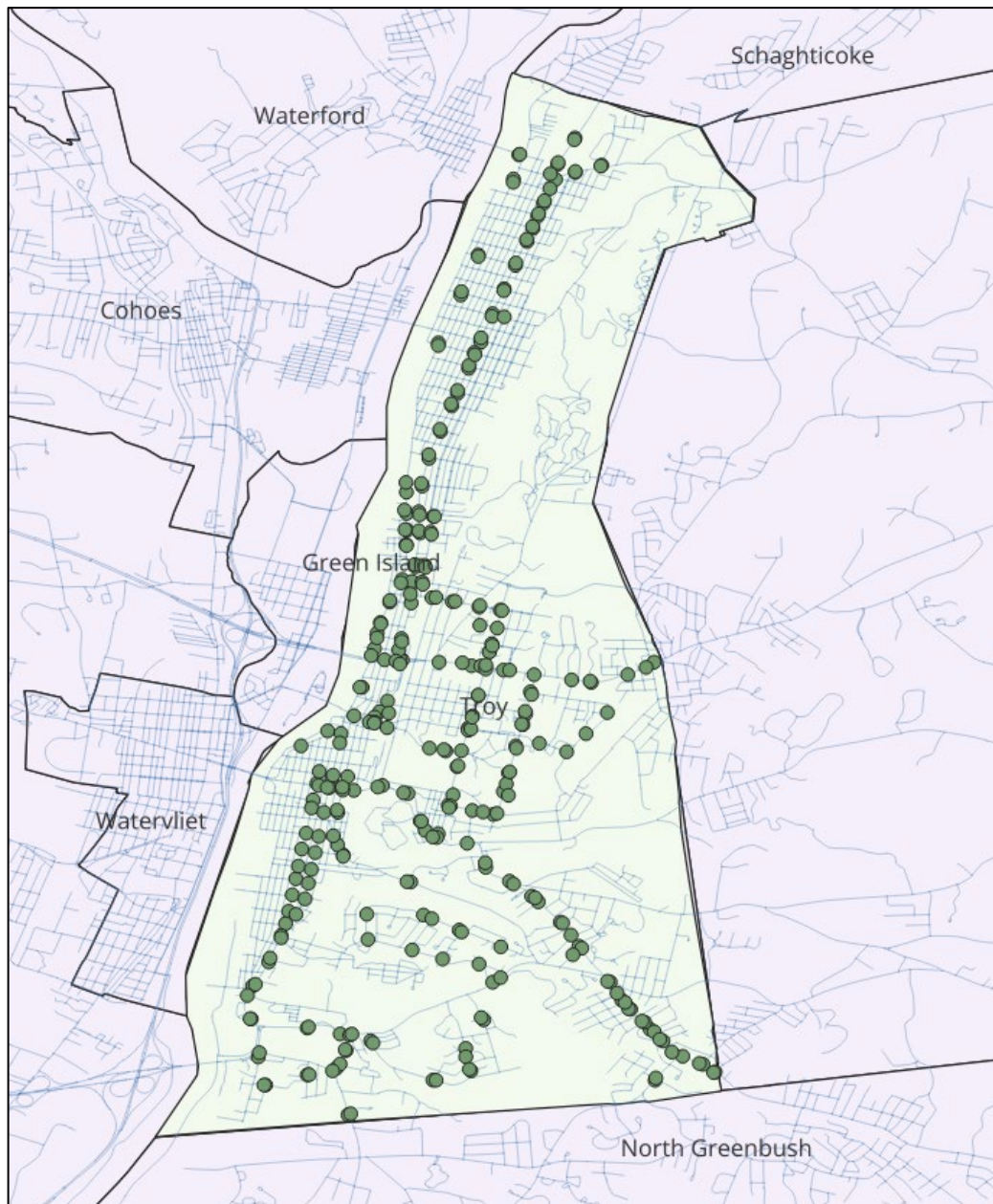
City of Troy and Surrounding Cities with Streets



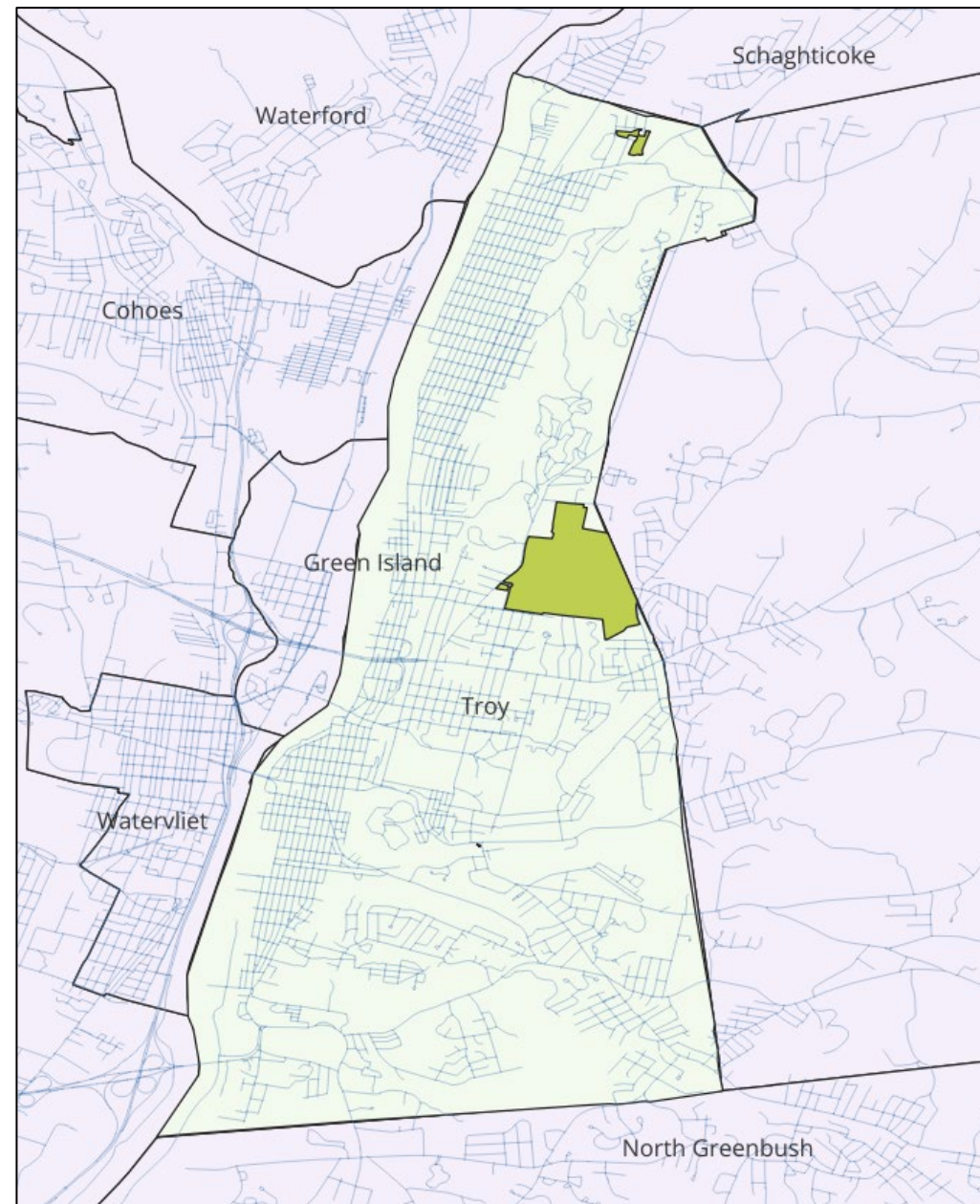
City of Troy and Surrounding Cities with Schools



City of Troy and Surrounding Cities with Colleges



City of Troy and Surrounding Cities with Transit Stops



City of Troy and Surrounding Cities with Parks

QGIS: Software Used



Walking: Top 10 Street Segments

Street Name	Length(miles)	LDS	Normalized LDS
Hoosick St	0.1	65326.83	1
Sage Ave	0.16	54611.64	0.83
5th Ave	0.16	50771.93	0.77
15th St	0.16	50166.77	0.76
12th St	0.08	49625.47	0.75
Hoosick St	0.11	49247.88	0.75
11th St	0.08	49032.61	0.75
Ferry St	0.09	49026.45	0.75
15th St	0.08	48921.88	0.74
14th St	0.08	48865.13	0.74

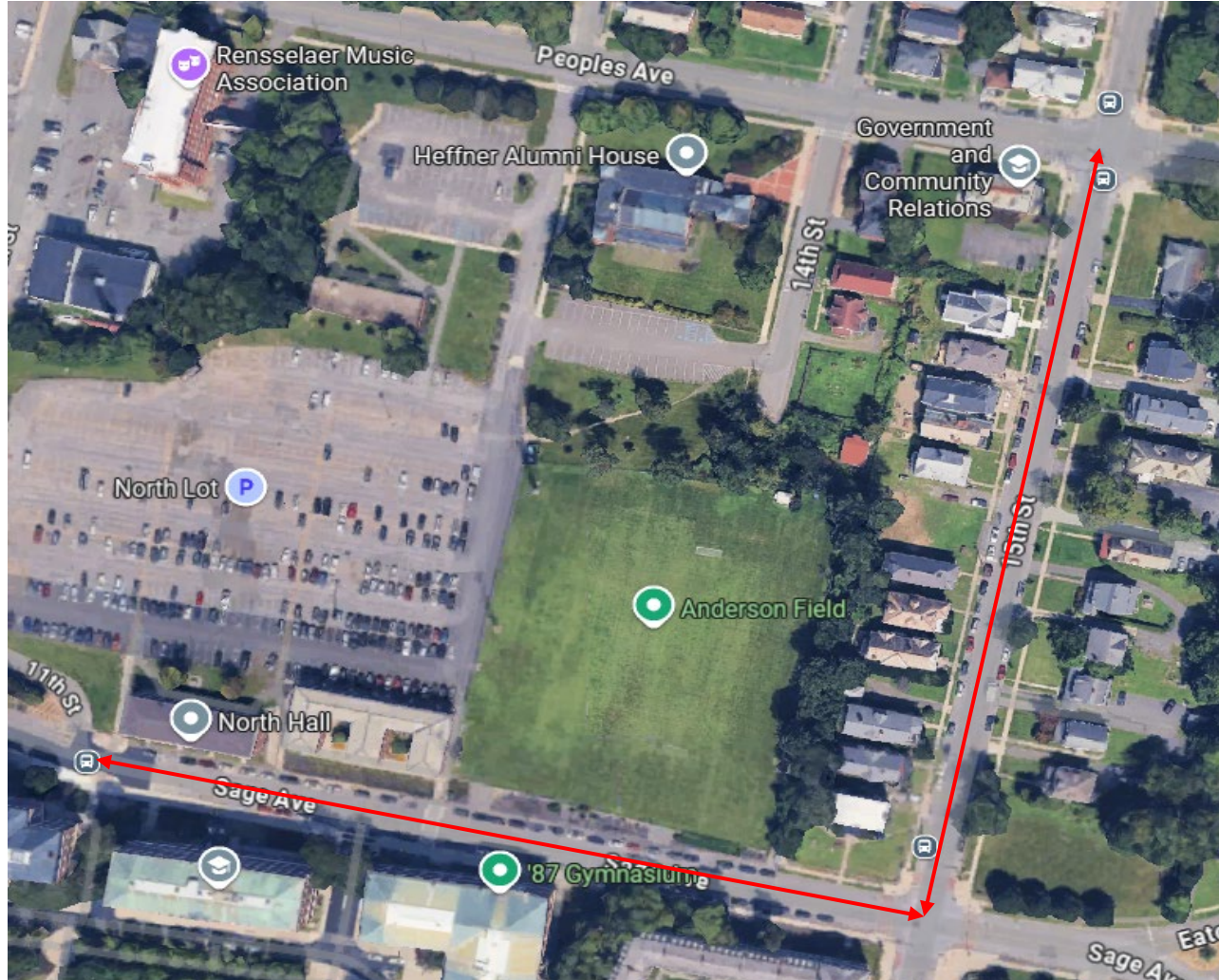
Top Segments with Highest LDS for Walking

Hoosick St

Businesses and Employments



Top Segments with Highest LDS for Walking

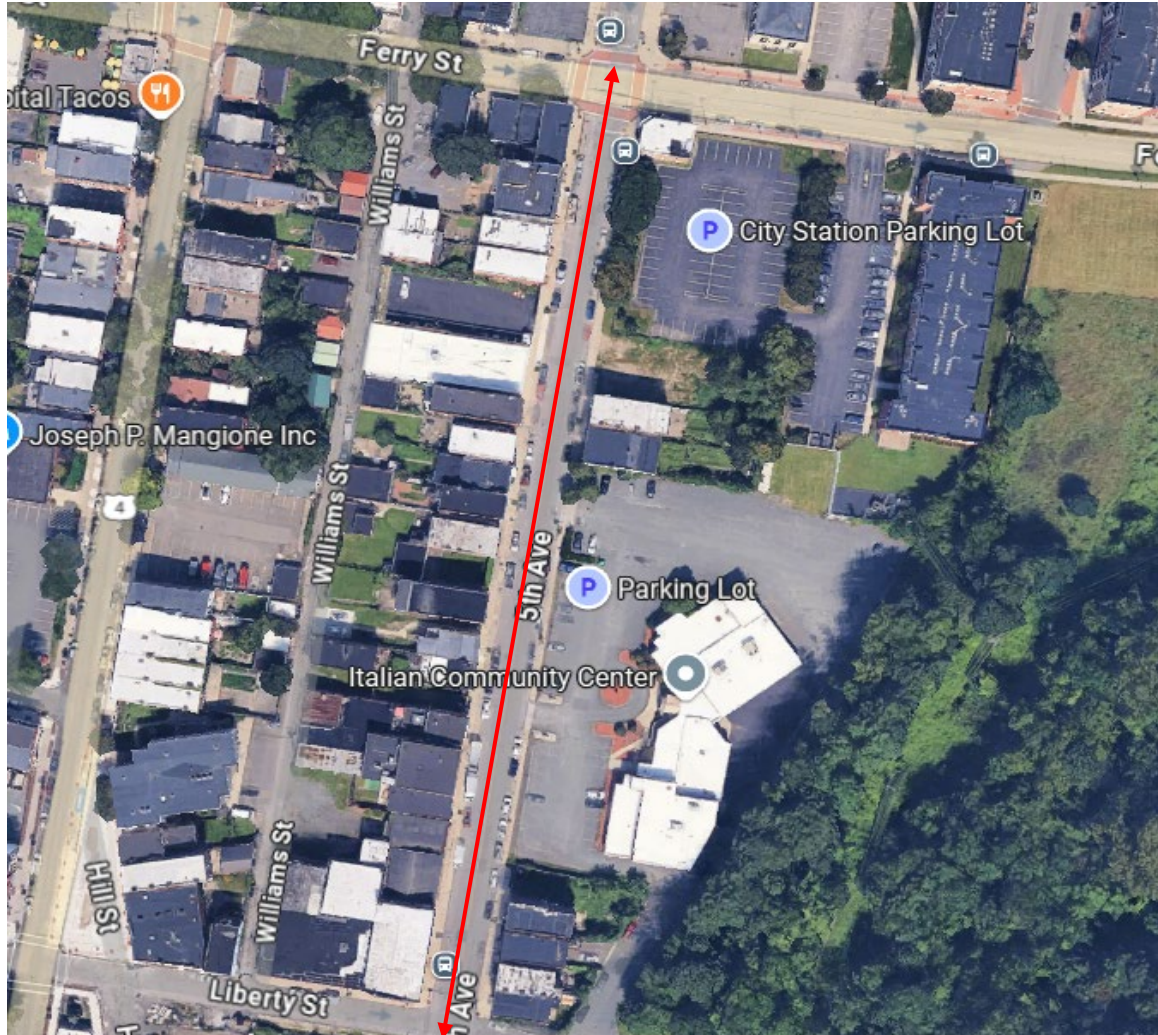


- 15th St and Federal St
- Beside Rensselaer Polytechnic Institute campus

LDS: Latent Demand Score

Image: 15th St and Federal St from Google Maps

Top Segments with Highest LDS for Walking



- 5th Ave is beside City Station
- City Station has apartments designated for students

LDS: Latent Demand Score

Image: 5th Ave from Google Maps

Biking: Top 10 Street Segments

Street Name	Length(miles)	LDS	Normalized LDS
Hoosick St	0.1	63972.33	1
5th Ave	0.16	62171.83	0.97
Linden Ave	0.25	55459.5	0.86
Church St	0.11	52297.91	0.81
2nd St	0.11	49082.83	0.75
Federal St	0.16	49005.38	0.75
Frear Aly	0.11	48625.78	0.74
Ferry St	0.09	48459.04	0.74
1st St	0.11	48446.61	0.74
15th St	0.08	47769.77	0.73

LDS: Latent Demand Score

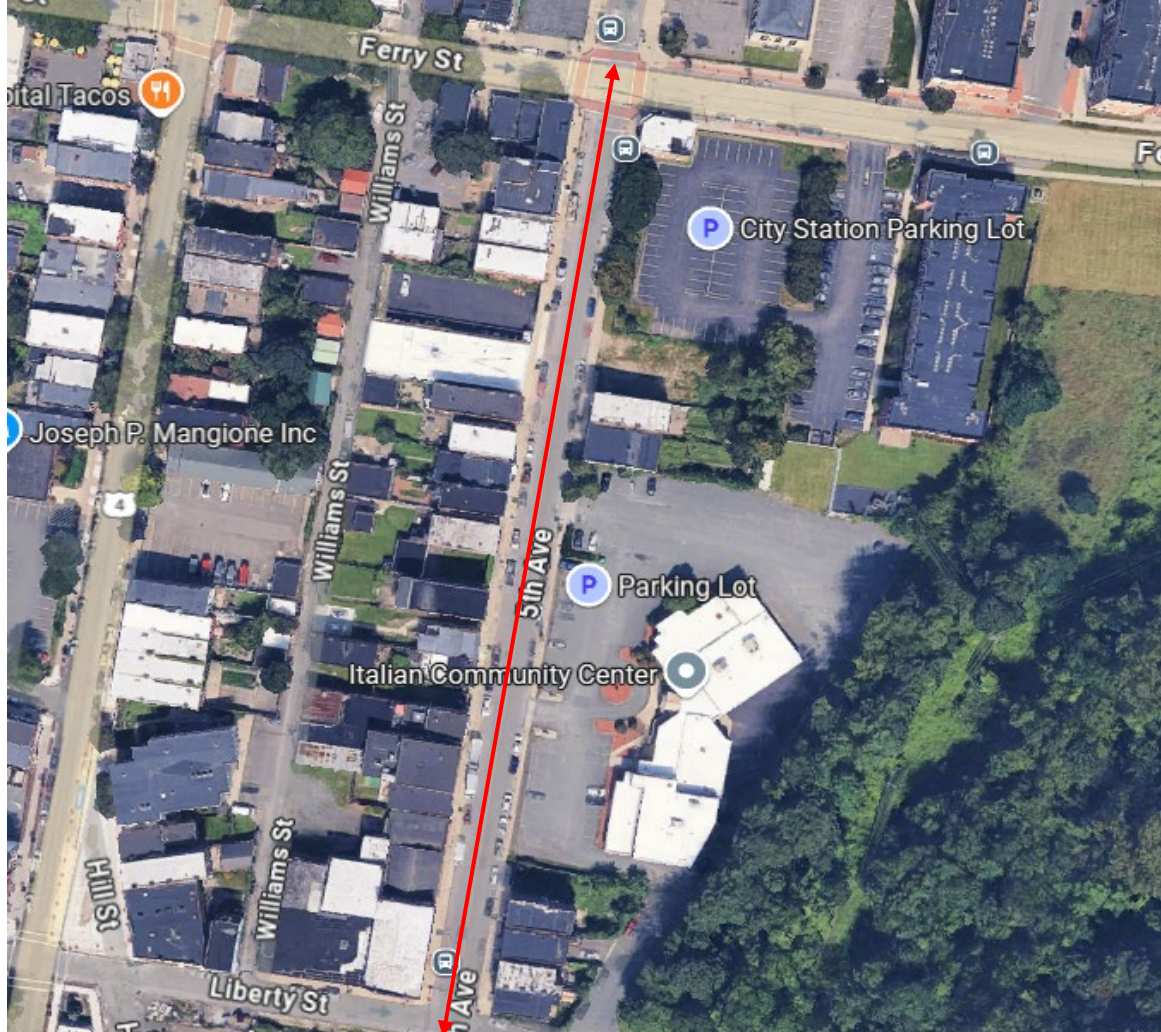
Top Segments with Highest LDS for Biking

Hoosick St

Businesses and Employments



Top Segments with Highest LDS for Biking



- 5th Ave is beside City Station
- City Station has apartments designated for students

LDS: Latent Demand Score

Image: 5th Ave from Google Maps

Top Segments with Highest LDS for Biking



- Linden Ave
- A park and a trail are nearby

LDS: Latent Demand Score

Image: Linden Ave from Google Maps



Scopes for Future Research

- Incorporating factors such as topography, climate, and weather conditions
- Requires more detailed data and field visits for feasibility evaluation as infrastructure should be applied in roadway corridors, not in segments

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Thank You!