Re-assessing TOD index in DVRPC for the max Public Good

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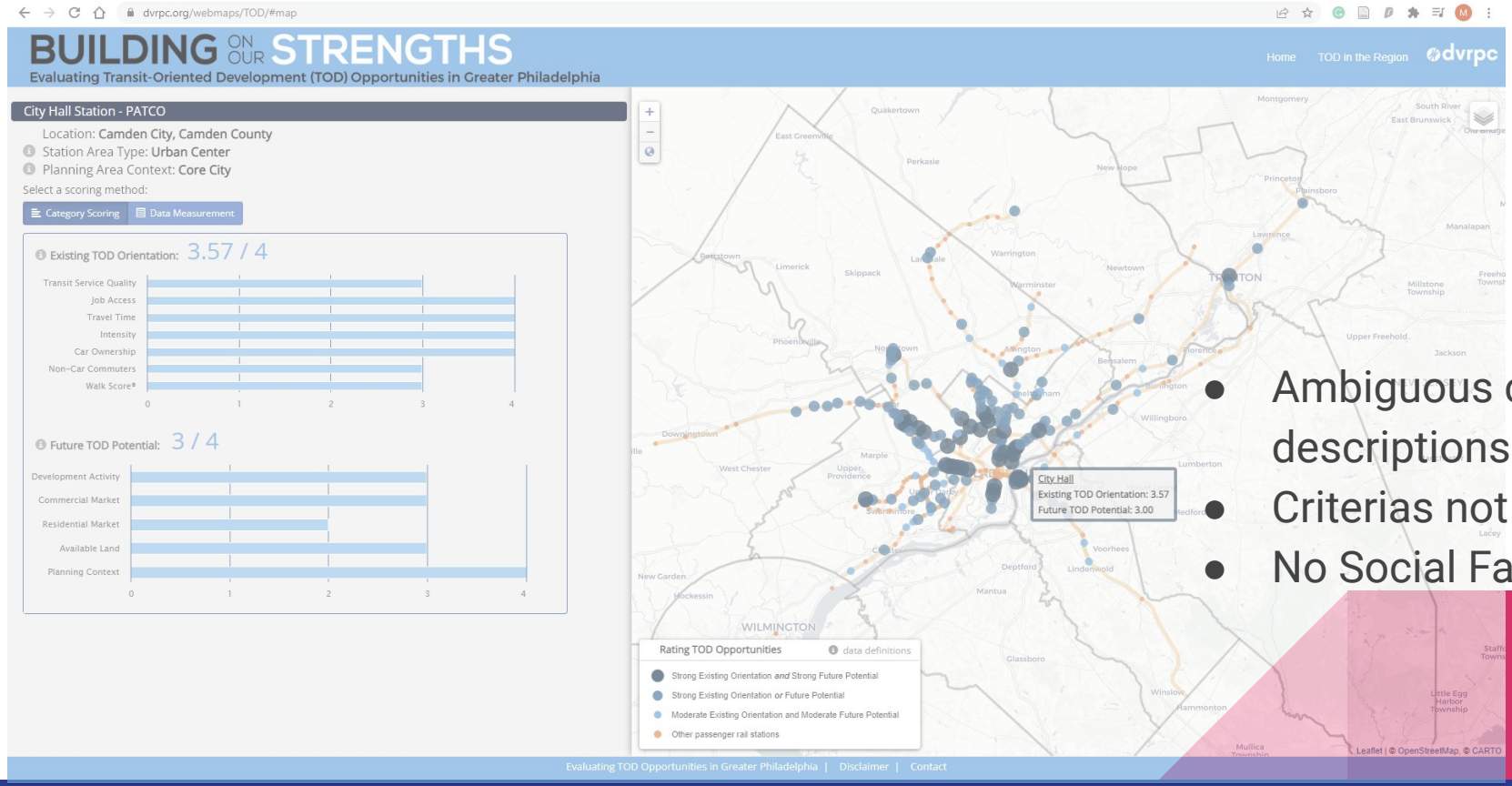
Transit-Oriented Development

"TOD is a type of urban development that maximizes the amount of residential, business and leisure space within walking distance of public transport."

Wikipedia Commons

Problems with the existing DVRPC TOD Index



- Ambiguous criteria descriptions
- Criterias not weighted
- No Social Factors

New Index: TODPhilly

It reassess suitability for TOD redevelopment around all rail stations in Philadelphia MSA (DVR) using Multi-Criteria Decision Analysis (MCDA).

Process

Data Collection

Field Trip

Import and wrangling

Exploratory Analysis

Build MCDA model

Data Wrangling

Analytic Hierarchy Process (AHP)

Validation

Compare

Compare scenarios with actual situations and tweak

Filter

Find available parcels according to the TOD ranking of the stations

MCDA Criterions

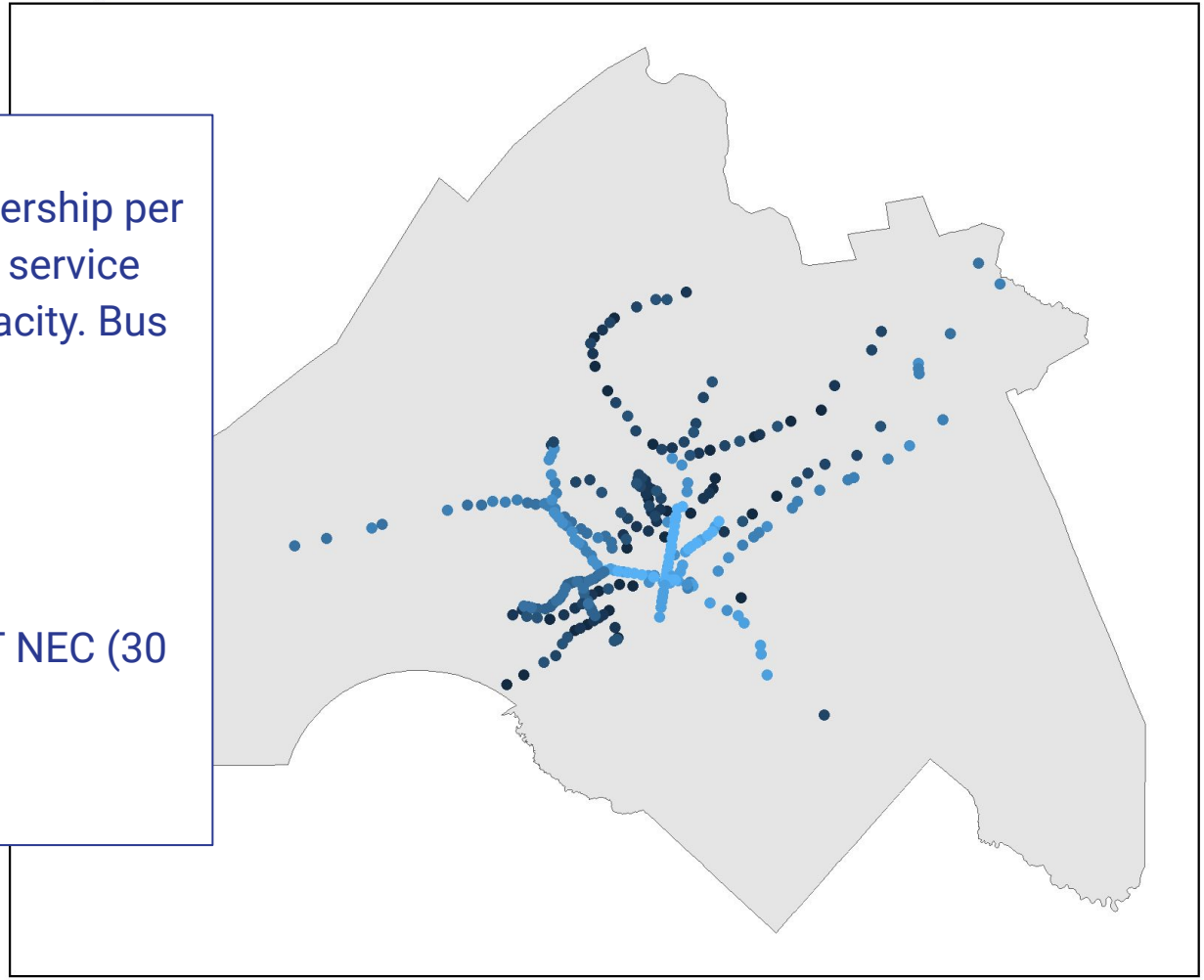
ac_score	accessibility score	ranges of sum_ac cut into 10		
job_sc	Job Score	Score for the district where the station is located	1. Calculate forecasted jobs in 2035 divided by shape area of the district. 2. Divided results into 10 quantiles	From DVRPC Greater Philadelphia Municipal Population and Employment Forecast 2015-2050 https://dvrpc-dvrpcgis.opendata.arcgis.com/
em_surp_sc	Employment Shortage and Sur	Scores for districts where there are huge gaps between populatic	1. Absolute Value of job_surplus (Forecasted jobs in 2035 divided by the forecated population in 2035) 2. Quantile into 10	
pvt_qn	Poverty Rate Score	Scores for the Poverty Rate of the Census tract the station is loca	1. Calculate the poverty rate by diviging poverty population by total population 2. Quantile into 10	
Mdlnm_qn	Medium Income Score	Scores for the median income of the census tract the station is lc	1. Quantile medium income into 10	
not_gen	Not be gentrified	Likelyhood of not being gentrified after the TOD project	1. Gaps between quantiled medium income and quantiled poverty rate 2. Divided by quantiled house ownership rate 3. Quantiled 2 into 10	Tidycensus: ACS 2019
loc_sc	Locality Score	Score assigned to the station based on its municipal level it is lc	1. 10 for stations located in "Cities" 2. 8 for station located in "Boroughs" (Equavalent to Towns in other states) 3. 1-7 for stations located in "Townships" (Usually suburban area in a county) based its negatively quantiled size (the smaller township is, the higher scores are)	Municipal Boundaries (Polygon) https://dvrpc-dvrpcgis.opendata.arcgis.com/datasets/dvrpcgis::municipal-boundaries-polygon/about
slo_sc	Slope Score	Score for the slope around the station	1. Get slope using DEM 2. Cutting range into 10	USGS Earthexplorer
duti_sc	Under-utilized land score	Score for how much of the size of under-utilized land around the	1. Sum of the area for agriculture, underdeveloped (General and Transitional), parking (Undetermined and transportation) land within 800 meter-radius around the station 2. Cutting range into 10	
attr_sc	Land Attractiveness score	Score for how attractive area around the station is.	1. Sum of the area for Commercial, Institutional, Recreational land within 800 meter-radius around the station 2. Cutting range into 10	DVRPC GIS Portal Land Use 2015 https://dvrpc-https://dvrpc-dvrpcgis.opendata.arcgis.com/datasets/dvrpcgis::land-use-2015/explore
unattr_sc	Land Unattractivenss score	Score for how unattractive area around the station is.	1. Sum of the area for Industrial, Military, Utility land within 800 meter-radius around the station 2. Cutting negative range into 10 (the higher the score, the less unattractive it is)	
sc_aph	Final Score using Analytical H	Final Score for how area around the station is suitable for TOD	1. Score is calculated based on the Multi-Criterion Decision Analysis (MCDA) 2. Weighting is based on Analytical Hierarchy Process (APH) 3. See tab "APH Matrix" for more detail	

DVRPC's analysis of Station area

Station accessibility

Accessibility: Number of ridership per hour based on frequency of service and mode rolling stock capacity. Bus ridership were added to “Transportation Center”.

- Rapid Transit
- Light Rail
- Paoli/Thorndale & NJT NEC (30 min freq)



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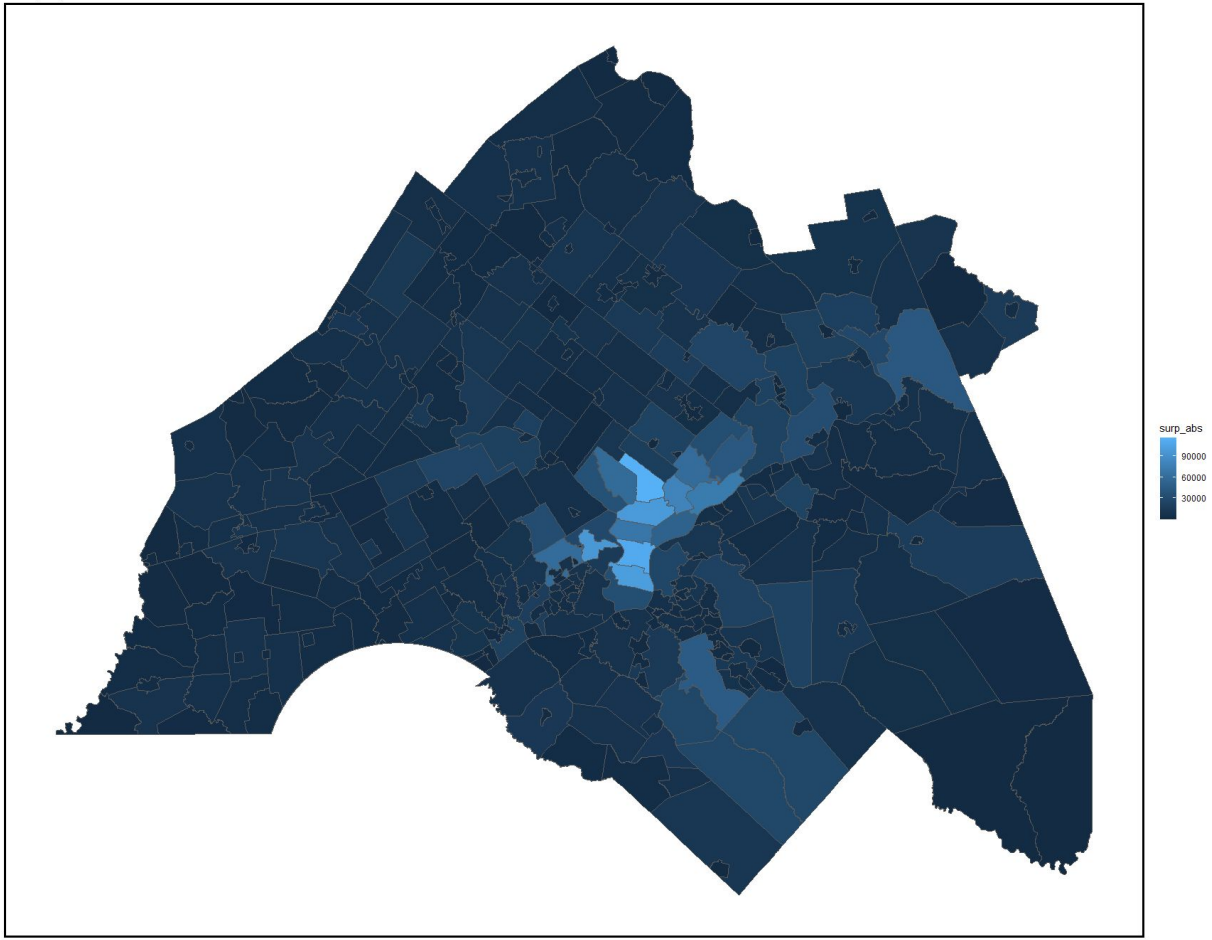
DVRPC's analysis of Station area

Job/Pop Surplus



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Difference between number of jobs and population, weighted by area size

- Quantiled to 10

Equity Factors

- Median Income
  - Important but sometimes Misleading
- Poverty Rate: complementary

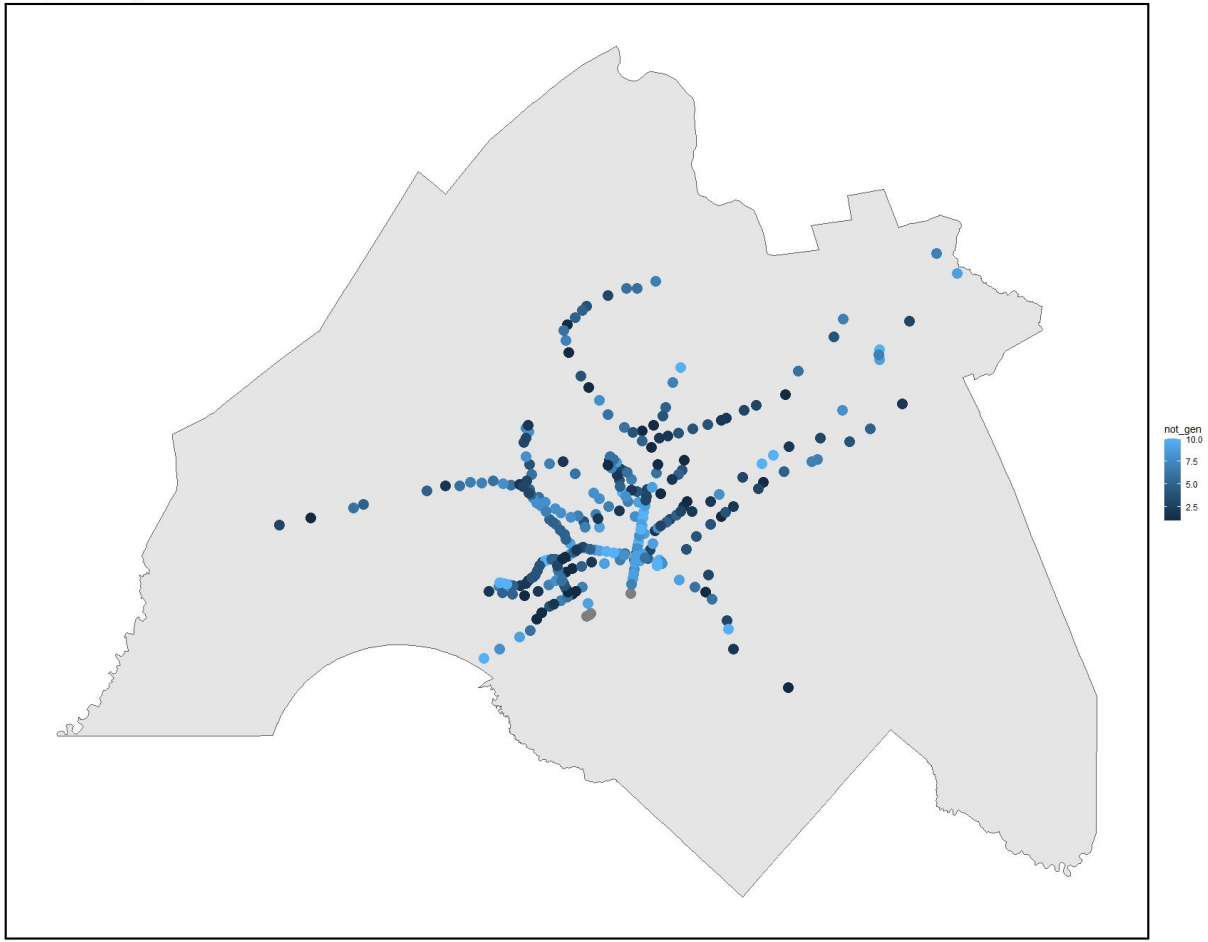
	station	line	MedIncm
165	Villanova	Paoli/Thorndale Line	4236
266	Stadium (Ithan Avenue)	Norristown High Speed Line	4236
74	University City	Glenside Combined	4478
222	30th Street	Market/Frankford Line	4478
109	30th Street Station	Atlantic City Line	5553
158	30th Street Station	SEPTA Main Line	5553
2	34th Street	Market/Frankford Line	5882
102	Temple University	SEPTA Main Line	8077
223	Cecil B. Moore	Broad Street Line	9246
284	Allegheny	Market/Frankford Line	10563
286	Somerset	Market/Frankford Line	10653
285	Huntingdon	Market/Frankford Line	10763
194	Bryn Mawr	Norristown High Speed Line	11845
263	Garrett Hill	Norristown High Speed Line	11845
106	Germantown	Chestnut Hill East Line	12525
46	Broadway	PATCO	12814
147	City Hall	PATCO	12814

Likelihood of not being gentrified

- Affordability:
  - Low income =/ high poverty rate
  - Gaps between quantiled median income and quantiled poverty rate
  - divided by quantiled house ownership rate
  - Reversely quantiled

DVRPC's analysis of Station area

Station by likelyhood of being gentrified



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Likelihood of not being gentrified:

- North Philly
- Southwest Philly
- Kensington Ave
- Pennsauken

Land Use Factors

Convert P+R

Hamilton Station, NJ

More reading: TOD and Park-and-Ride: Which is Appropriate Where?

College Proximity

Princeton Station, NJ

Old Town

Narberth Station, PA

Station with the most underused parcels (total area) nearby:

- Parcels of Agriculture, Underdeveloped (General and Transitional), Parking (Undetermined and transportation) within 800 buffer

station	line
West Trenton	West Trenton Line
Roebling	RiverLine
Eastwick	Airport Line
Florence	RiverLine
Cinnaminson	RiverLine
Airport Terminal B	Airport Line
Airport Terminal A	Airport Line
Delaware Valley College	Lansdale/Doylestown Line
Atco	Atlantic City Line
Temple University	SEPTA Main Line
Chester Transportation Center	Wilmington/Newark Line
Highland Avenue	Wilmington/Newark Line
36th Street	RiverLine
Cherry Hill	Atlantic City Line

DVRPC's analysis of Station area

Station with the most underused parcels

Figure xx

Station with the most attractive parcels (total area) nearby:

- Commercial, Institutional, Recreational

station	line	operator
Princeton	Northeast Corridor	NJ Transit
NRG	Broad Street Line	SEPTA
13th Street	Market/Frankford Line	SEPTA
34th Street	Market/Frankford Line	SEPTA
11th Street	Market/Frankford Line	SEPTA
City Hall	Broad Street Line	SEPTA
8th Street	Market/Frankford Line	SEPTA
Chinatown	Broad Street Line	SEPTA
Race-Vine	Broad Street Line	SEPTA
University City	Glenside Combined	SEPTA
Haverford	Norristown High Speed Line	SEPTA
Wynnefield Avenue	Cynwyd Line	SEPTA
Radnor	Paoli/Thorndale Line	SEPTA
Bryn Mawr	Paoli/Thorndale Line	SEPTA
9th-10th & Locust Street	PATCO	PATCO
Walnut-Locust	Broad Street Line	SEPTA

Station with the least unattractive parcels (total area) nearby:

- Industrial, Military, Utility

ID	station	line	operator
57	Marcus Hook	Wilmington/Newark Line	SEPTA
150	Pennsauken/Route 73	RiverLine	NJ Transit
15	Link Belt	Lansdale/Doylestown Line	SEPTA
311	Warminster	Warminster Line	SEPTA
178	Eddystone	Wilmington/Newark Line	SEPTA
317	Levittown	Trenton Line	SEPTA
242	Erie-Torresdale	Market/Frankford Line	SEPTA
197	Tioga	Market/Frankford Line	SEPTA
83	Curtis Park	Wilmington/Newark Line	SEPTA
255	Chester Transportation Center	Wilmington/Newark Line	SEPTA
68	Burlington South	RiverLine	NJ Transit
308	Church	Market/Frankford Line	SEPTA
69	Holmesburg Junction	Trenton Line	SEPTA
144	Norristown Transportation Center	Manayunk/Norristown Line	SEPTA
8	9th Street	Lansdale/Doylestown Line	SEPTA
146	Eddington	Trenton Line	SEPTA

Weighting: Analytic Hierarchy Process

	ac_score	job_sc	em_surp_s	pvt_qn	MdInm_qr	not_gen	loc_sc	slo_sc	duti_sc	attr_sc	anattr_sc
ac_score	1.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	5.00	0.20	0.20
job_sc	0.33	1.00	0.33	5.00	3.00	5.00	1.00	1.00	0.20	5.00	5.00
em_surp_s	1.00	3.00	1.00	5.00	3.00	5.00	1.00	1.00	3.00	5.00	5.00
pvt_qn	1.00	0.20	0.20	1.00	5.00	5.00	1.00	1.00	1.00	1.00	1.00
MdInm_qr	1.00	0.33	0.33	0.20	1.00	0.20	1.00	1.00	1.00	0.33	1.00
not_gen	1.00	0.20	0.20	0.20	5.00	1.00	1.00	1.00	0.20	0.33	1.00
loc_sc	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.20	0.20
slo_sc	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.20	0.20	0.20
duti_sc	0.20	5.00	0.33	1.00	1.00	5.00	5.00	5.00	1.00	1.00	1.00
attr_sc	5.00	0.20	0.20	1.00	3.00	3.00	5.00	5.00	1.00	1.00	1.00
unattr_sc	5.00	0.20	0.20	1.00	1.00	1.00	5.00	5.00	1.00	1.00	1.00
sum	17.53	15.13	5.80	17.40	25.00	28.20	23.00	23.00	13.80	15.27	16.60

Pairwise Comparison Matrix

	ac_score	job_sc	em_surp_s	pvt_qn	MdInm_qr	not_gen	loc_sc	slo_sc	duti_sc	attr_sc	anattr_sc	Criteria Weights
ac_score	0.06	0.20	0.17	0.06	0.04	0.04	0.04	0.04	0.36	0.01	0.01	0.09
job_sc	0.02	0.07	0.06	0.29	0.12	0.18	0.04	0.04	0.01	0.33	0.30	0.13
em_surp_s	0.06	0.20	0.17	0.29	0.12	0.18	0.04	0.04	0.22	0.33	0.30	0.18
pvt_qn	0.06	0.01	0.03	0.06	0.20	0.18	0.04	0.04	0.07	0.07	0.06	0.07
MdInm_qr	0.06	0.02	0.06	0.01	0.04	0.01	0.04	0.04	0.07	0.02	0.06	0.04
not_gen	0.06	0.01	0.03	0.01	0.20	0.04	0.04	0.04	0.01	0.02	0.06	0.05
loc_sc	0.06	0.07	0.17	0.06	0.04	0.04	0.04	0.04	0.01	0.01	0.01	0.05
slo_sc	0.06	0.07	0.17	0.06	0.04	0.04	0.04	0.04	0.01	0.01	0.01	0.05
duti_sc	0.01	0.33	0.06	0.06	0.04	0.18	0.22	0.22	0.07	0.07	0.06	0.12
attr_sc	0.29	0.01	0.03	0.06	0.12	0.11	0.22	0.22	0.07	0.07	0.06	0.11
unattr_sc	0.29	0.01	0.03	0.06	0.04	0.04	0.22	0.22	0.07	0.07	0.06	0.10

AHP Process:

- Compare each other variables
- Sum
- Pairwise Matrix
- Average

Other Criterions not mentioned:

- Locality
- Slope

DVRPC's analysis of Station area

TOD Index

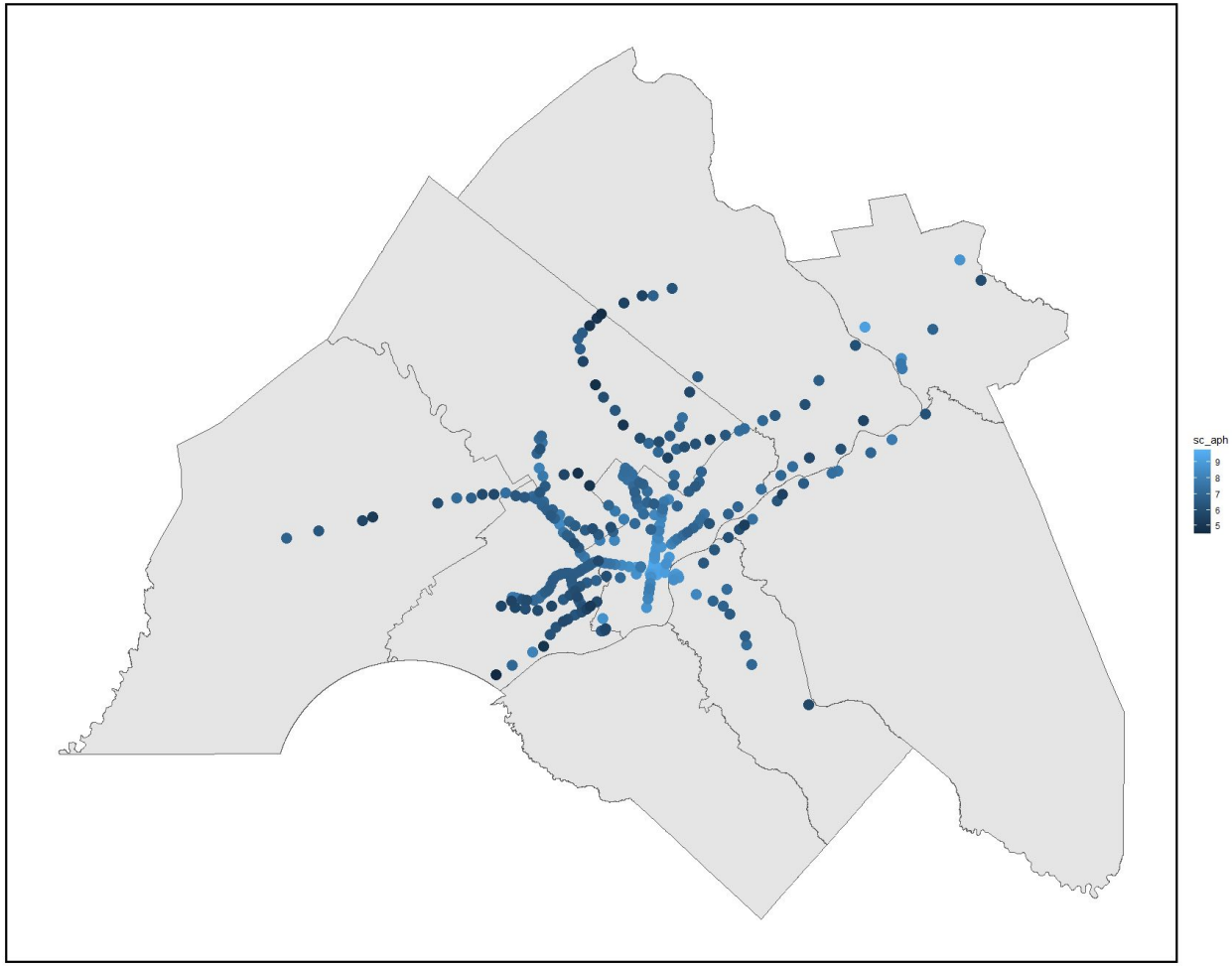


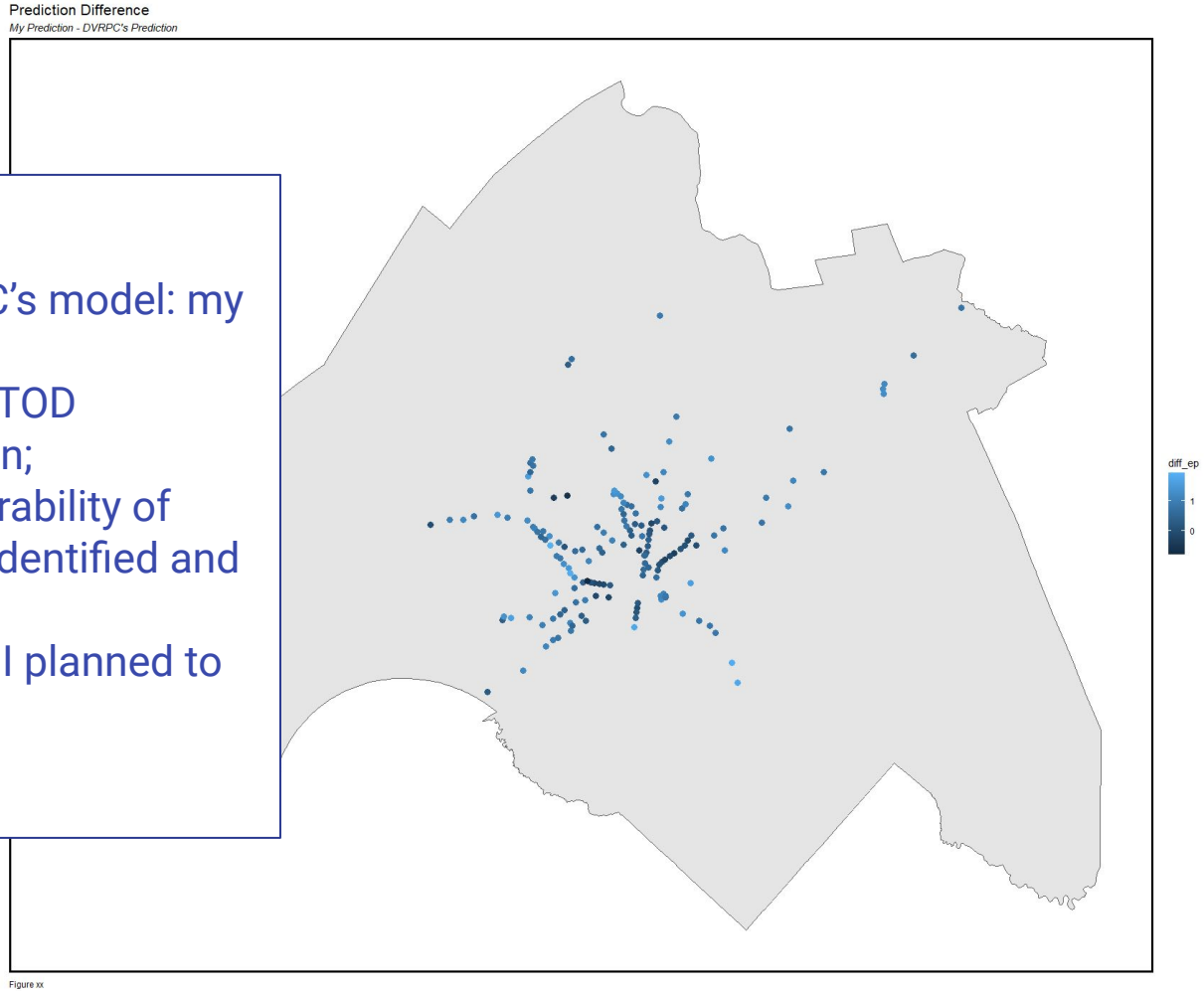
Figure xx

Compare

By Comparing with the DVRPC's model: my model did better job in:

- Identifying stations with TOD potentials in the suburban;
- while stations with vulnerability of gentrification were also identified and were given less scores

Which were the original goals I planned to achieve



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Practice

Typical TOD Projects are larger than 1 acre: here are the underused Parcels larger than 1 acre within TOD Buffers

For stations do not have >1 acre parcels, promote mixed-use development

Rationale for planners:

- Rank the stations' TOD Index
- Locate the Parcel
- Rezone/Redevelop

DVRPC's analysis of Station area

Existing large parcels around the station

Figure xx

Challenge

- Differentiate Stations with same names
- Merge Connecting Stations

City Hall (BSL or PATCO?), Allegheny (RR, BSL or MFL?) NHSL and Paoli/Thorndale Line …

Assign GEOID

Trenton, North Philadelphia, Camden (Walter TC + Broadway), Lindenwold, Pennsauken, Fern Rock, 69th St, 8th St, Center City (MFL 15th, City Hall, RR Suburban), Norristown TC, Jefferson + 11th…

Clean by Hand

- Rationale Developing
- Large Parcel Data Size

Convert to Point Data

Takeaways and Reflections

- Generalizability: variety of transit modes, data availability may impact how this model could be adopted in other MSAs
- 800 meter buffer is too large for TOD
- Even this MCDA model was being thwarted, however, lots of the exploratory analysis result could still provide policymakers a lot of useful information
    - SEPTA could use this to “optimize” its Regional Rail services
- To maximize the TOD benefit, the transit operator should try to increase the accessibility/mobility of the station (by increasing frequency, adding express services etc.)

Thank You and Questions

https://github.com/CPLN-680-Spring-2022/Huang_lechuan_todphilly