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Peoples Partners & Associates

Preparing for the EV Transition in Baltimore City

IBM Data Science Capstone Project

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5/5/2020

Electric vehicles are set to play an increasingly significant part of our transportation infrastructure and this includes charging

Introduction and background

Sustainability efforts are driving a shift to EVs

Today sustainability and climate-conscious behavior have become significant areas of focus for sectors and businesses around the world. One of the sectors which are looking at a substantial shake-up due to this new way of thinking is the automotive sector. This can be seen with the increased push for the electrification of vehicles. Also, a wave of innovation is also sweeping in promising to fundamentally alter the way people use and share personal vehicles by way of self-driving technology.

With this change EV charging infrastructure needs to keep pace

With these changes in the mind, the importance of electric vehicle charging stations is set to increase to meet the demand of this emerging electric fleet of vehicles. For this reason, a prudent business owner today should understand a neighborhood's level of preparedness for this changing transportation landscape to be sure their business remains at the front lines this coming change.

Source: PP&A Analysis

A variety of data sets are collected and cleaned to serve as the basis for the analysis

Data sources

Analytical Process
For this analysis, I will analyze the current state of venues and EV charging infrastructure in Baltimore city to determine which neighborhoods on the front-line in terms of readiness for increased EV traffic. To complete this, I have incorporated the following data elements:

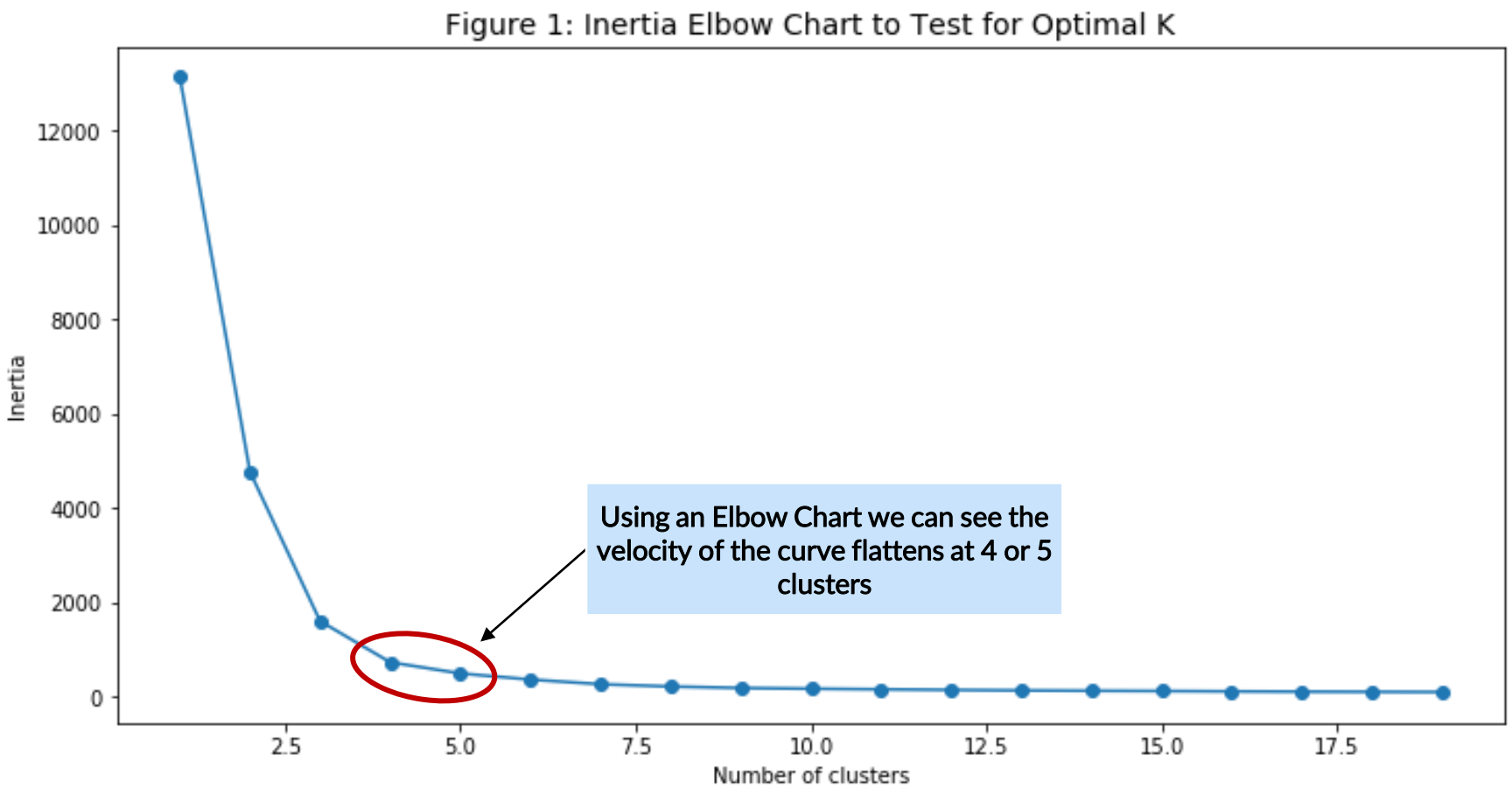
EV Charging Stations	Baltimore City Mapping	Vehicle Registrations	Baltimore Venues
NREL Charging Station Data - This is a data set that is available on a national level that includes a variety of unit-level details about charging stations around the country. These details include charging station type, location, access types, and pricing.	Baltimore City GeoJSON - To map the results of the analysis on a neighborhood basis, I will be using a GeoJSON file containing the polygon shape of neighborhoods in Baltimore. Also, the polygon shapes will be used to derive neighborhood locations for charging stations	Maryland Vehicle Registration Data - To get an understanding of the current state of EV penetration as well as to home in on the location of EVs in the Baltimore area, MVA vehicle registration is used	Foursquare Venue Data - This data set will be used to find venue types near the center of the respective Baltimore venues to support a K-Means Clustering exercise.

Source: PP&A Analysis

The analysis is based on a K-Means machine learning algorithm used to build neighborhood clusters in Baltimore city

Analytical methods

Elbow Chart – Determining the Optimal K Value



After the data collection processes, a K-mean machine learning algorithm was applied to a combined dataset to derive neighborhood clusters. Based on the Elbow chart analysis an optimum K of 5 was selected for the analysis

Source: PP&A Analysis

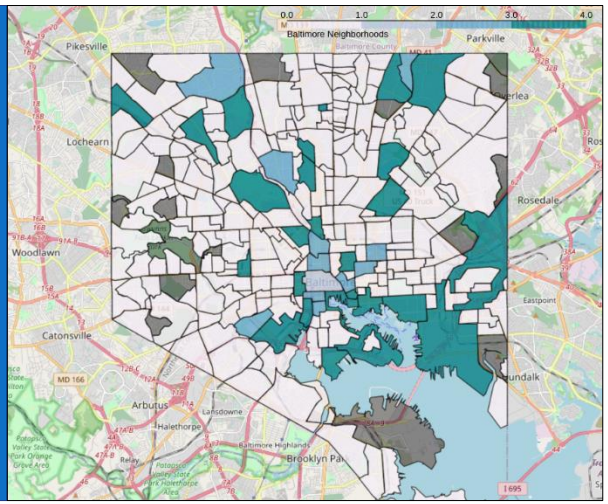
Using the K-Means machine learning clustering algorithm has yielded 5 clusters of neighborhoods in Baltimore City

Analysis summary results

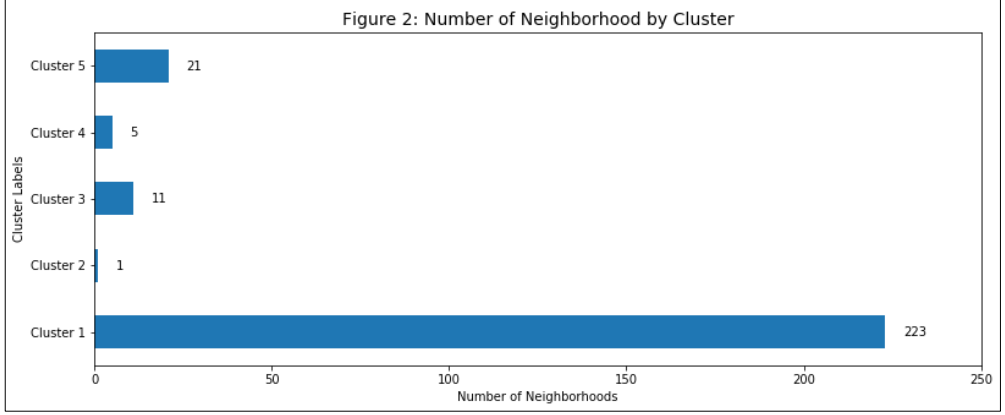
Cluster Analysis Results

- Taking a look at the results of the cluster analysis, 261 Baltimore City neighborhoods have been grouped into 5 clusters
- Clusters are heterogeneously spread across the city
- As per figure 2 below, most neighborhoods fall within in the first cluster with a total of 223 neighborhoods
- Figure 3 then shows a total of 451 public charging stations which can been found within the respective clustered neighborhoods

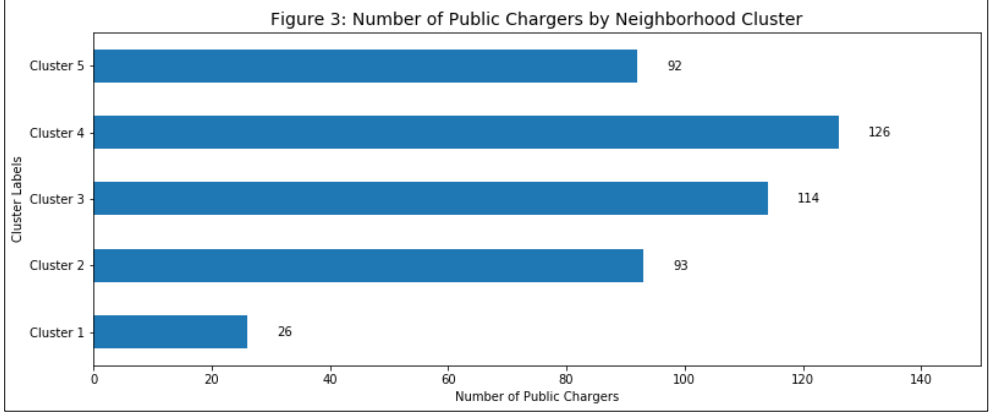
Baltimore City Neighborhood Cluster Map



Number of Neighborhoods per Cluster



Number of Public EV Charging Stations by Cluster



At first glance it seems that clusters 2 to 5 have a comparable degree of EV charging stations when looking at the number of neighborhoods and the amount of charging stations only

Source: PP&A Analysis

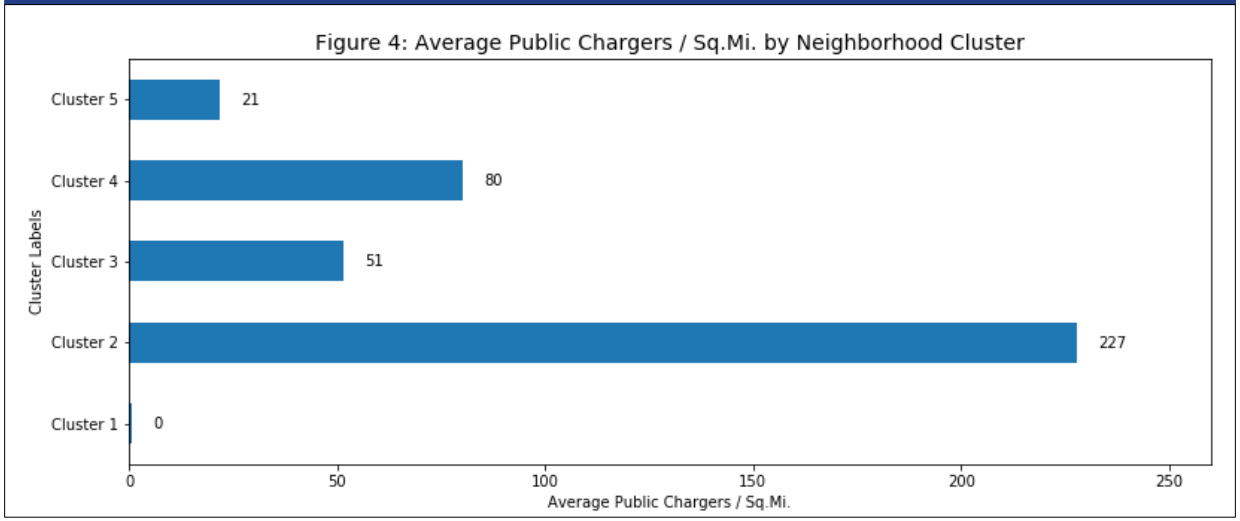
When looking at a neighborhood clusters readiness for the EV transition one can look at a cluster's EV charger density

Analysis summary results

Cluster Analysis Results

- To properly understand the presence of EV chargers in a respective neighborhood, a measure of EV charger density must be incorporated into the analysis
- Neighborhoods are of different sizes in terms of area and it is necessary to incorporate this perspective
- To achieve this perspective, the number of chargers in the analysis should be divided by the respective total area of the neighborhoods in the cluster.
- When doing so, as seen in figure 4, the analysis shows that on an EV charging station by square mile basis, significant differences exist between the clusters

EV Charger Density by Cluster (EV Chargers / Sq. Mi.)



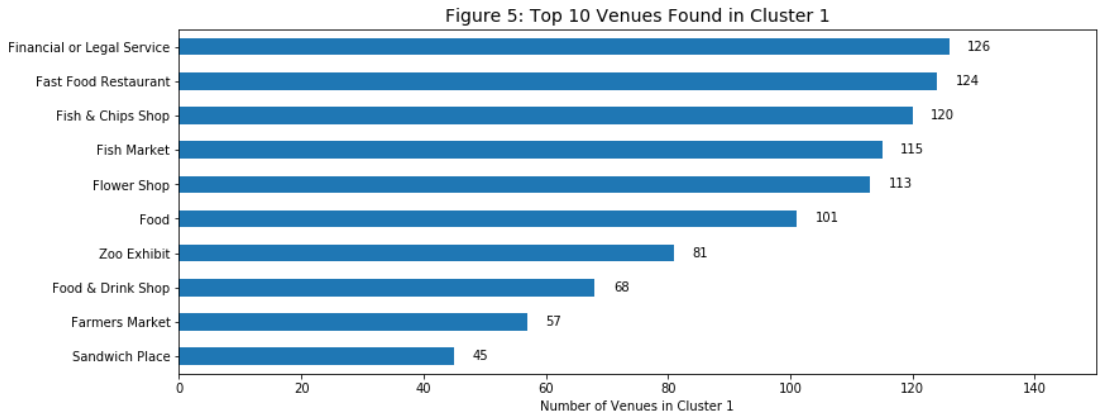
Cluster 2 shows the highest density of EV chargers with a EV charger to area density of 227 EV per square mile

Source: PP&A Analysis

Cluster 1 is the largest cluster with the largest volume of neighborhoods, but characterized with very few charging stations

Cluster 1 descriptions

Cluster 1 Description



- Cluster 1 contains 223 neighborhoods out of the total 261 neighborhoods.
- Cluster 1 contains a total of 26 of public EV chargers out of the total of 451 public EV chargers
- In addition 27 private EV charging stations can be found in Cluster 1.

Cluster 1: 10 Neighborhood Preview

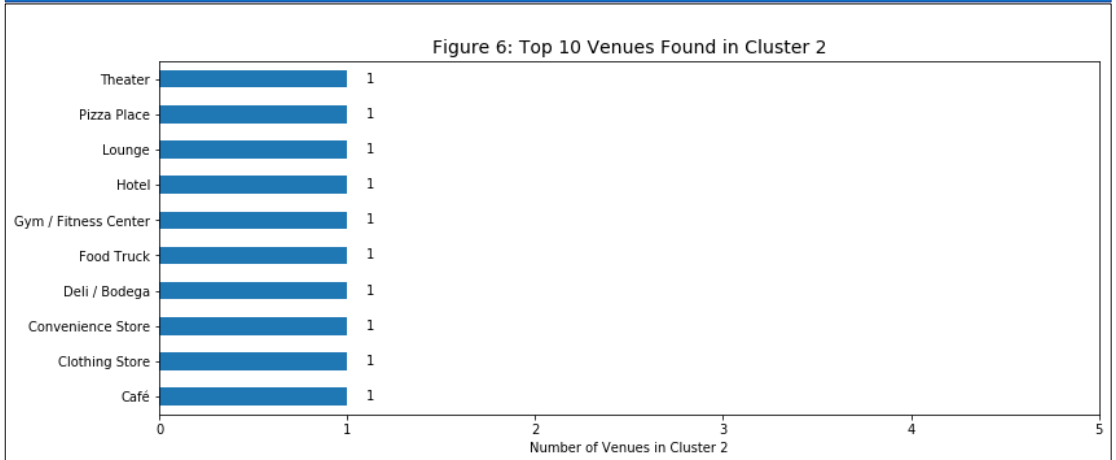
Neighborhood	Area (Sq. Mi.)	Total Public Chargers	Public Chargers / Sq. Mi.
Wyman Park	0.11	0	0.00
Frankford	2.13	0	0.00
Franklintown	0.60	1	1.62
Garwyn Oaks	0.13	0	0.00
Heritage Crossing	0.09	0	0.00
Medfield	0.26	0	0.00
Lauraville	0.59	0	0.00
Carrollton Ridge	0.22	0	0.00
Concerned Citizens Of Forest Park	0.08	0	0.00
Lakeland	0.55	0	0.00

Source: PP&A Analysis

The Downtown neighborhood has been uniquely characterized as cluster two and has the highest EV charging station density

Cluster 2 descriptions

Cluster 2 Description



- Cluster 2 contains 1 neighborhood out of the total 261 neighborhoods
- Cluster 2 contains a total of 93 of public EV chargers out of the total of 451 public EV chargers
- In addition 3 private EV charging stations can be found in Cluster 2

Cluster 2: Neighborhood Preview

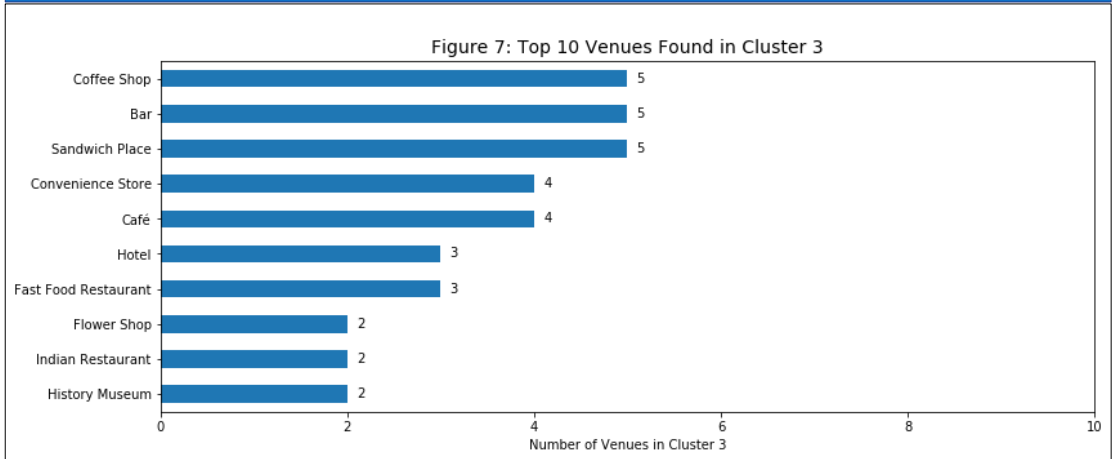
Neighborhood	Area (Sq. Mi.)	Total Public Chargers	Public Chargers / Sq. Mi.
Downtown	0.41	93	227.99

Source: PP&A Analysis

Cluster 3 appear to cater to a more affluent population in smaller areas which are comparably equipped with EV charging stations

Cluster 3 descriptions

Cluster 3 Description



- Cluster 3 contains 11 neighborhoods out of the total 261 neighborhoods
- Cluster 3 contains a total of 114 of public EV chargers out of the total of 451 public EV chargers
- In addition 1 private EV charging stations can be found in Cluster 3

Cluster 3: 10 Neighborhood Preview

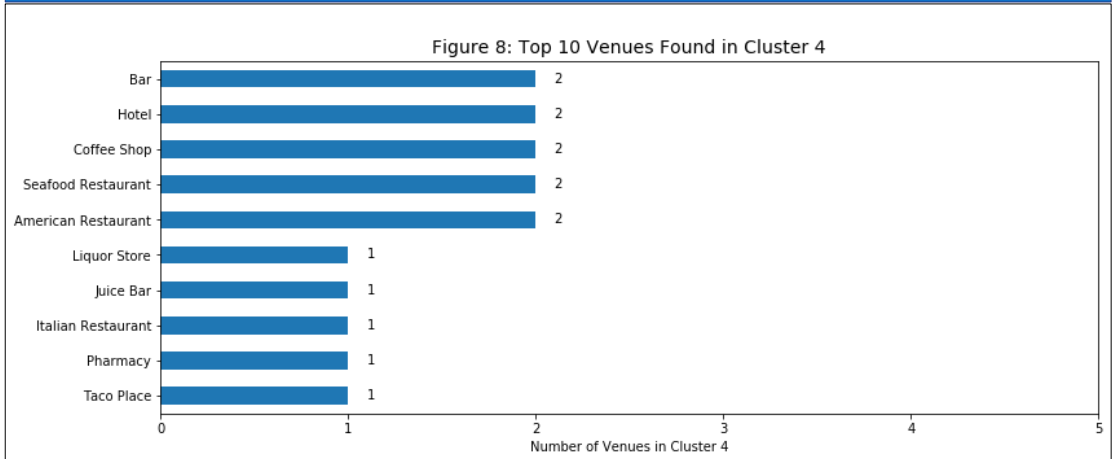
Neighborhood	Area (Sq. Mi.)	Total Public Chargers	Public Chargers / Sq. Mi.
Carroll Park	0.34	10	29.03
Mt Pleasant Park	0.25	8	31.58
Hampden	0.62	14	22.75
Dunbar-Broadway	0.17	14	81.49
Jonestown	0.14	8	59.42
Mid-Town Belvedere	0.22	12	54.25
Middle East	0.20	10	50.43
Mount Vernon	0.22	10	44.06
Mount Washington	1.24	8	6.44
Otterbein	0.10	8	77.93

Source: PP&A Analysis

Cluster 4 only includes 5 neighborhoods which are typically seen as areas with a high recreational amenities and high charger density

Cluster 4 descriptions

Cluster 4 Description



- Cluster 4 contains 5 neighborhoods out of the total 261 neighborhoods
- Cluster 4 contains a total of 126 of public EV chargers out of the total of 451 public EV chargers
- In addition 4 private EV charging stations can be found in Cluster 4

Cluster 4: 5 Neighborhood Preview

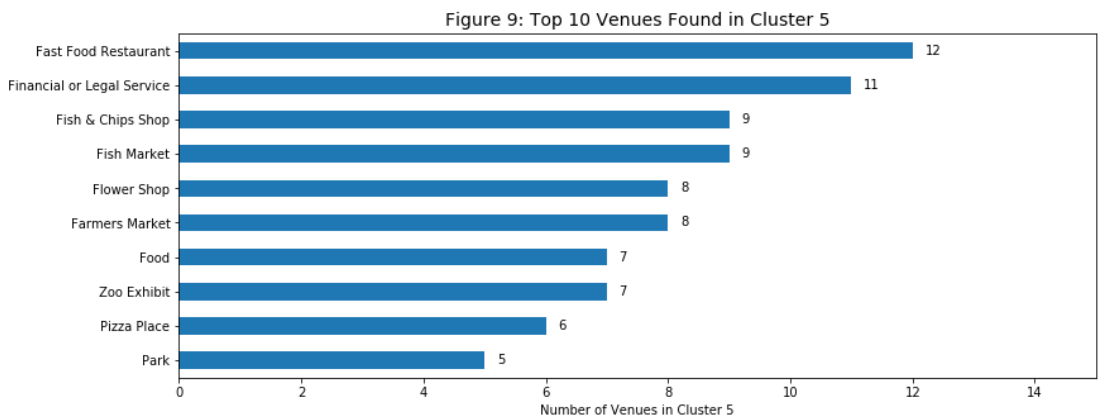
Neighborhood	Area (Sq. Mi.)	Total Public Chargers	Public Chargers / Sq. Mi.
Canton Industrial Area	2.49	21	8.43
Fells Point	0.29	23	79.73
Locust Point Industrial Area	0.93	32	34.27
Inner Harbor	0.24	21	86.87
University Of Maryland	0.15	29	191.78

Source: PP&A Analysis

Cluster 5 does with 21 neighborhoods, does have charging infrastructure however not to same degree as 2, 3, and 4

Cluster 5 descriptions

Cluster 5 Description



- Cluster 5 contains 21 neighborhoods out of the total 261 neighborhoods
- Cluster 5 contains a total of 92 of public EV chargers out of the total of 451 public EV chargers
- In addition 3 private EV charging stations can be found in Cluster 5

Cluster 5: 10 Neighborhood Preview

Neighborhood	Area (Sq. Mi.)	Total Public Chargers	Public Chargers / Sq. Mi.
Canton	0.57	3	5.25
Carroll - Camden Industrial Area	0.70	6	8.52
Johns Hopkins Homewood	0.26	5	19.47
Loch Raven	0.57	4	7.00
Port Covington	0.33	4	12.03
Pulaski Industrial Area	1.97	4	2.03
Bolton Hill	0.23	4	17.54
Central Park Heights	0.44	4	9.02
Charles North	0.14	4	28.78
Clifton Park	0.56	6	10.69

Source: PP&A Analysis

Baltimore City is making strides to build out EV charging infrastructure, however the road ahead is still long

Summarizing Thoughts

The Current Level of EV Charging Stations will Need to Increase

As EV become ever more prevalent, I would anticipate that the overall number of charging stations will continue to increase for the foreseeable future. The overall number of stations see in Baltimore is just north of 450 public stations which currently serves the ~1,800 EV and plugin hybrids registered as of 2020 in both Baltimore City and Baltimore County. This of course does not include EVs registered outside of these zones and with the current total number of registered vehicles in Baltimore City and Baltimore Count at close to 1 million vehicles, there is still plenty room to grow as the conversion to EVs continues. The effective distribution of EV charging stations will also evolve into a key consideration when planning for the expansion of future infrastructure build-outs.

A Pragmatic Build Out Plan should be Supported by Prioritizing Neighborhoods which will likely see the greatest Use in the Short to Mid-Term

This analysis should be viewed as a starting point and should be refined to better reflect additional differences of neighborhoods such as demographics, crime rates, and more targeted venue selection. With these additional refinements applied to the machine learning methodologies employed, I would expect to derive an improved clustering result for the purpose of highlight priority areas for quicker EV infrastructure buildout. As a business owner, looking to come to Baltimore, parking and transportation convenience translates into ease of access for customer. As pockets of EV charging activity are already emerging, a business owner can and should begin considering proximity to charging infrastructure when deciding where to place a stake in the ground.

Source: PP&A Analysis

DIFFERENT IS NOT ENOUGH, IT'S TIME TO BE BETTER

PP&A

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BIG DATA

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SELECTED INDUSTRIES IN FOCUS:

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- Energy / Environment
- Public Sector
- Pharmaceuticals / Health Care
- Technology
- Telecommunications

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