RESEARCH

Need for Speed Manila: A Geospatial Analysis of where to run fast and furious around the streets of Metro Manila

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Abstract

Metro Manila has always been flooded by vehicles plying its roads on a daily basis to the point of a non-existent rush hour scenario on major thoroughfares. This results in roads, national highways or not, to be congested inside of Metro Manila for hours on end. The pandemic has brought about adjustments to the commuting behavior in Metro Manila, allowing specific points in time where roads have minimal to no traffic present. In order to take advantage of the traffic ease, the researchers have used Geospatial Analysis to understand Metro Manila's road map and generate corresponding maps where motorists can freely drive without worrying much about traffic.

Keywords: Clustering; Geospatial Analysis; Metro Manila; KMeans; Unsupervised Machine Learning

Introduction

While the streets of Metro Manila is flooded with vehicles left and right, the current pandemic has greatly reduced the amount of traffic plying the roads every day. However, traffic is still there especially during the day thanks to commuters and people who still go to the office for their professional obligations. Before the pandemic, traffic congestion in Metro Manila was considered as the "world's worst" [1] according to a survey conducted by Waze back in 2015.

On the other hand, when the lockdown was imposed last March 2020, "roads cleared, no unending lines of vehicles, cleaner air and no sound pollution echoing through virtually every corner of the metropolis" [2]. Although clearer roads were enjoyed by private vehicles, the seemingly traffic-free state of Metro Manila appears to be short-lived. As the government started easing up on quarantine restrictions, traffic started piling up again, making Metro Manila's lack of transport capacity evident once more. The only times where motorists can enjoy traffic-free driving is when they travel during curfew hours. According to an article written by CNN Philippines [3], the mayors of Metro Manila has agreed upon new curfew hours starting May 1, 2021 from 10pm to 4am. This indicates that motorists who have essential duties during this time period are guaranteed to experience minimal to no traffic at all. In line with this, the researchers want to utilize Geospatial Analysis to further understand the streets of Metro Manila and generate insights on how to further improve the driving experience of motorists during curfew hours when traveling around the area..

Data and Methodology

In exploring the data for this report, the Open Street Maps available in Jojie was used for the reference dataset where users can extract information depending on the string query sent to the database. Locations were taken from Jojie's OSM database, while the road properties were taken from OSMNx.

Workflow

The general workflow for the formation of this report is shown below:

1. **Data Extraction**
2. **Data Creation**
3. **Exploratory Data Analysis**
4. **Map Generation**
5. **Results Analysis**

Data Extraction

In order to get the data for the Geospatial Analysis of Metro Manila's streets, the researchers extracted the required information using SQL to access the database.

Data Creation

Before using the data for analysis, the researchers have performed several data processing technique wherein after consolidating the data from the database, the researchers have filtered streets that have nearby police stations, as well as medical facilities to ensure that driver safety comes first.

Exploratory Data Analysis

Upon filtering out only the police stations and medical facilities, the figure below shows that Quezon City and Parañaque have specific locations where there are little to no police stations, making those locations an avenue for high speed drivers to enjoy their travels.

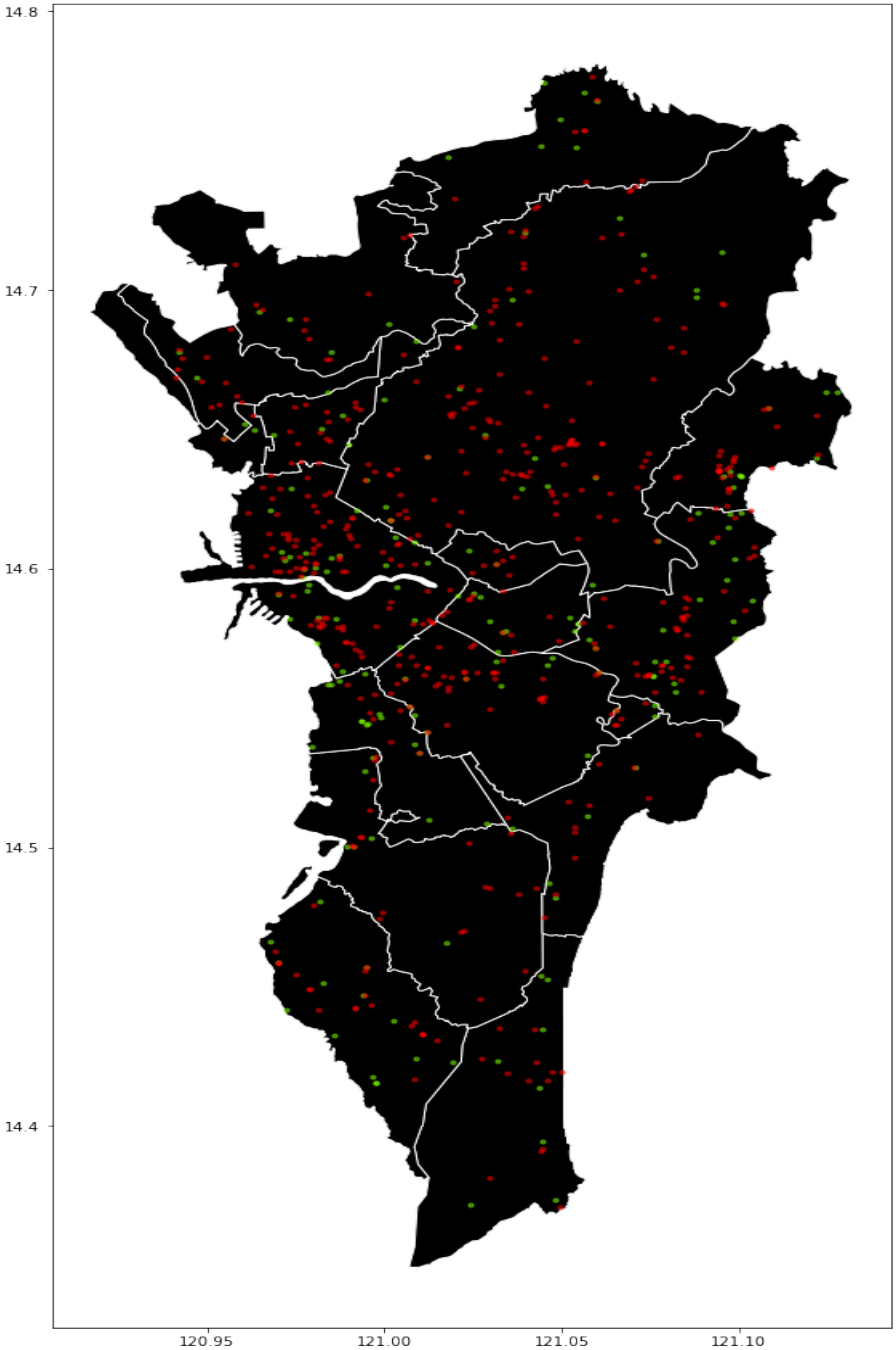

Figure 1 Metro Manila map highlighting locations of police stations and medical establishments

However, knowing those two cities having little enforcement around, that does not only mean that drivers should go around only in those areas. The group further analyzed the map, extracting the edges of the generated geodataframe and filtering out specific road types afterwards.

Map Generation

The initial processing that the group has done is to replace maxspeed values into 40 where a speed range of between 20 to 40 is present, and later on dropping NaN maxspeed values as well.

In order to generate the maps, the group used KMeans clustering to determine the characteristics of roads that have similar attributes to one another. This is based on their maxspeed, as well as their distances from police stations, medical facilities, and road type. Once the final dataframe has been generated, the Calinski-Harabazs score was used to identify how many clusters were needed to be used to generate ample results.

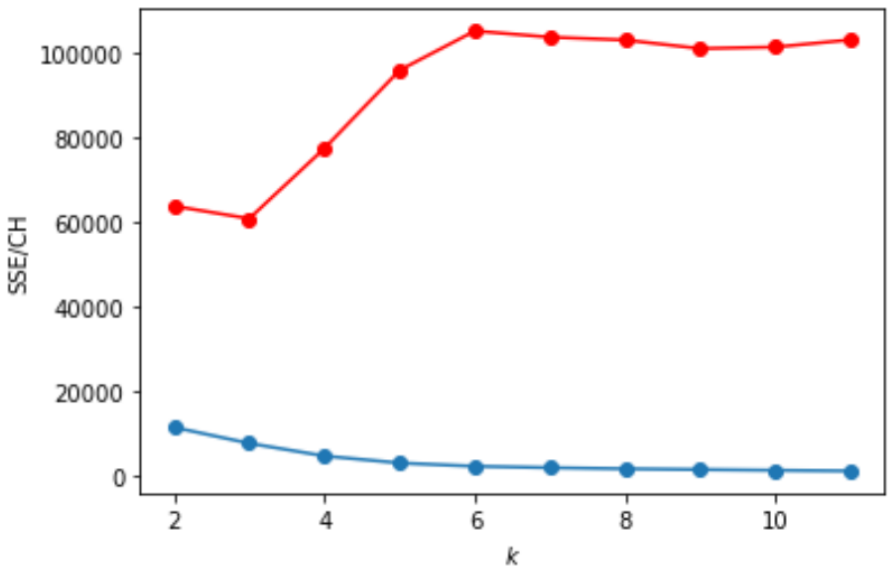

Figure 2 Calinski-Harabazs Score to decide how many clusters should be generated for the algorithm

From the metric presented above, the group used 6 as the optimal number of clusters to be generated for the clustering algorithm. The results are as follows:

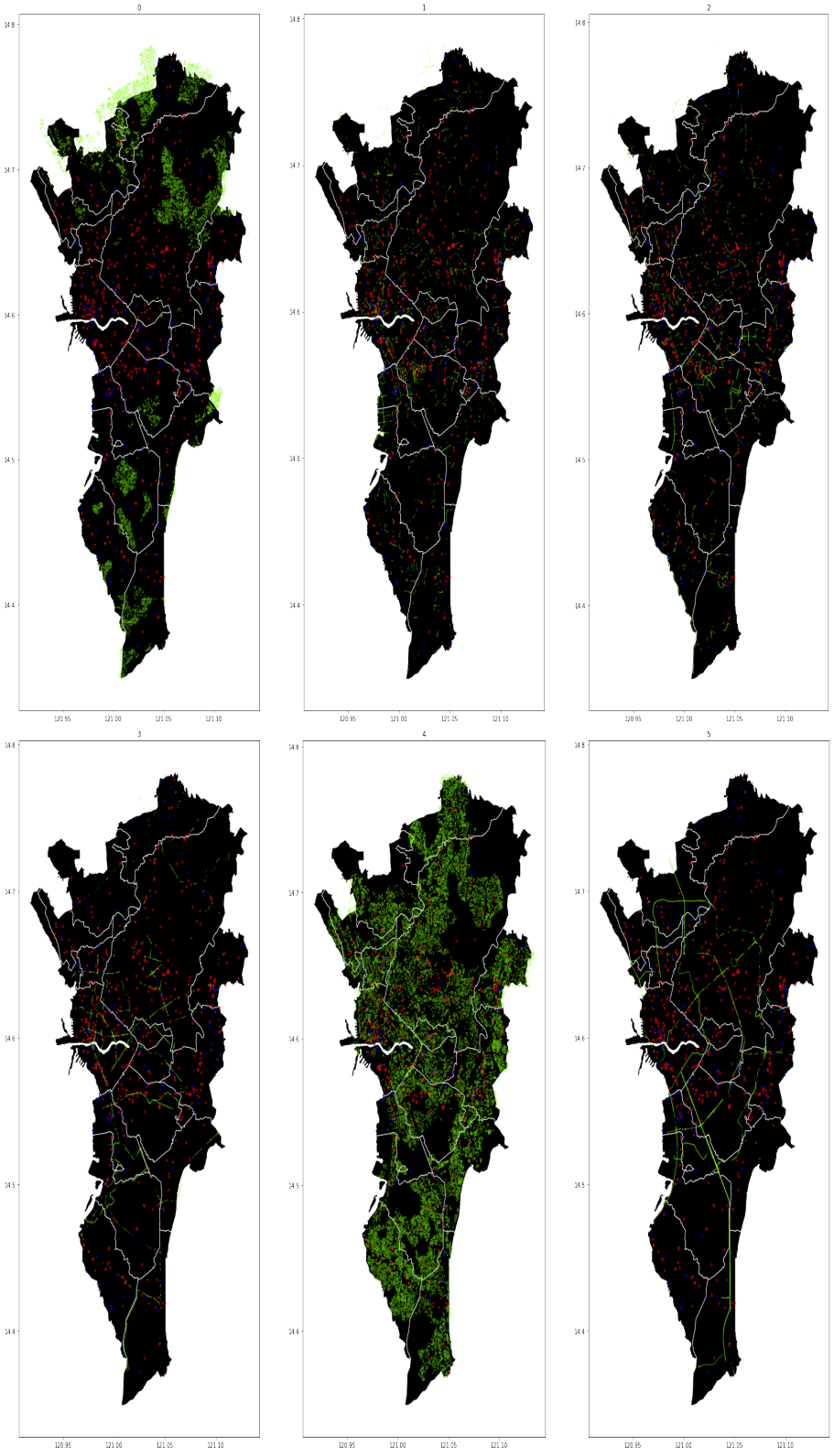

Figure 3 Generated Clustering Results

Results Analysis

From the generated clusters, the road profiles are seen as the following:

1. **Cluster 0** represents residential areas having narrow roads and are far from both police and medical establishments.
2. **Cluster 1** represents narrow roadways that have equal distances from police stations and medical establishments.
3. **Cluster 2** represents only partial areas of the main roads, having short distances but wide spaces for cars that are both far from police and medical establishments.
4. **Cluster 3** on the other hand, takes into account majority or all parts of the main road, making these routes long and wide which is suitable for fast travel and is equally distant from police and medical establishments.
5. **Cluster 4** represents residential areas as well but are close to both police and medical establishments, opposite from cluster 0.
6. **Cluster 5** represents highways. Similar to cluster 3, these are long and wide roads that can benefit from fast travel. In addition to that, areas in cluster 6 are also closer to medical establishments as compared to police stations.

To demonstrate how the roads are generated in the entire map of Metro Manila, clusters 2, 3, and 5 have been used to display the road network generated from the clustering algorithm.

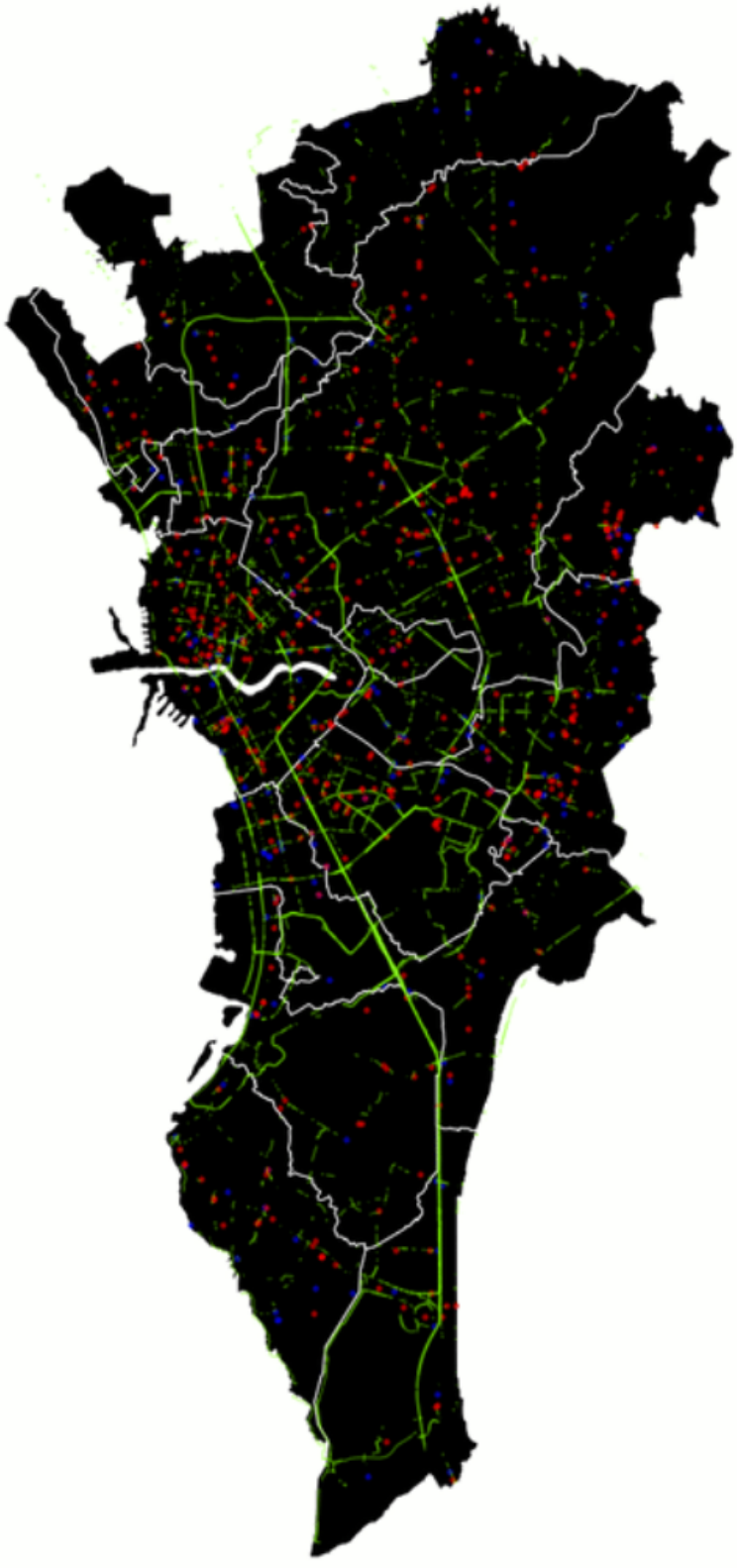

Figure 4 Finalized Graph of Clustering Results

After generating the insights on the clusters, the visualization is plotted out in Folium, where users can see the police stations and medical establishments accordingly. The coordinates of the Asian Institute of Management is used as the starting point where the establishments and roads with their corresponding names can be identified from the generated dataset.

Figure 5 Folium integration with the Clustered Road Networks

Conclusion

The group was able to identify clusters for drivers to pick on what type of roads to take to ensure a comfortable drive around Metro Manila for racing purposes, each with their own corresponding distances to either police stations or medical establishments. Should accidents come their way, they can either easily file for a police report or get immediate medical attention wherever possible.

Recommendation

Given that the assumption of the group is for the drivers to travel during curfew hours, future researchers can integrate additional traffic data so that this approach can be applied on normal working hours and even a possible deeper study focusing on which streets to go to or avoid during rush hour, considering their distances to other establishments of interest.

Since there are identified clusters that have areas that are far from medical establishments and police stations, further study on their social welfare and crime rate can be considered given their proximity to these essential services. These can provide insights on where to put new medical establishments or police outposts.

On the other hand, there are also clusters that have police stations and medical establishments with a lot of exposure to the identified roads. Future researchers can study whether or not the capacity of these medical facilities and police stations are also overwhelmed or are actually being met on a daily basis.

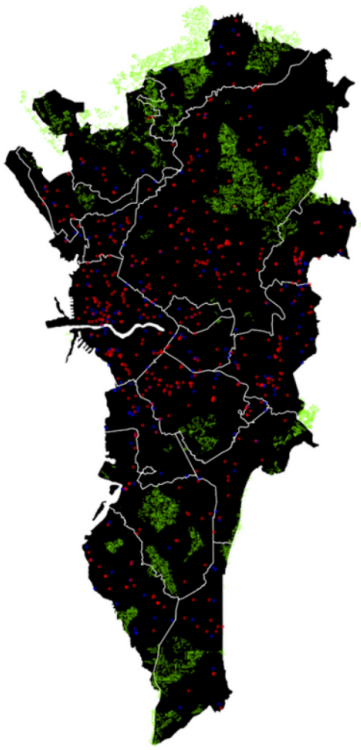

Figure 6 Underserved Roads

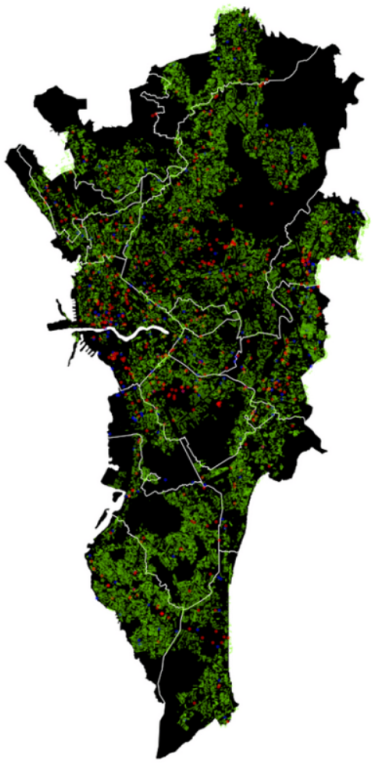

Figure 7 Establishments exceeding capacity

Acknowledgements
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3.