EXPLORING THE RELATIONSHIP BETWEEN CRIME RATES AND TRANSPORTATION NETWORKS

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ABSTRACT

Crime rates in urban areas are a critical issue for policymakers and urban planners. While the impact of transportation networks on crime rates has been recognized for some time, there is still much to be learned about the relationship between these two factors. The study utilizes a comprehensive dataset of crime rates, including various crime types, and the locations of parking lots as a part of transportation networks across the city. Statistical analysis techniques are applied to examine the relationship between crime rates and the proximity, size, and usage of parking lots. The findings of this research provide valuable insights into the relationship between crime rates and transportation networks, specifically parking lots. The analysis uncovers patterns and trends in crime rates within different parking lots. This report presents the findings of a comprehensive literature review and data analysis aimed at exploring the relationship between crime rates and transportation networks. Our analysis reveals that transportation networks can have a significant impact on crime rates in urban areas, and that well-designed transportation networks can help reduce crime rates and create safer and more livable communities.

I. INTRODUCTION

Urban crime rates are a significant concern for residents, business owners, and policymakers. High crime rates can negatively affect public safety, lower property values, and hinder economic development. While numerous factors contribute to crime rates, transportation networks have long been recognized as a critical factor in shaping crime patterns in urban areas.

The relationship between transportation networks and crime rates is complex and multifaceted. Transportation networks provide a means for people to move around urban areas, and this movement can both facilitate and deter criminal activity. For example, well-lit and busy streets with high levels of pedestrian activity may deter criminal activity by increasing the chances of criminals being observed by others. Similarly, good transportation infrastructure design, such as the use of CCTV cameras, can enhance safety by deterring criminal activity and facilitating the apprehension of criminals.

One aspect of transportation networks that is particularly vulnerable to criminal activity is parking lots. Parking lots are a convergence point for vehicles and pedestrians, making them a potential target for criminal activity such as theft, vandalism, and assault. The design and layout of parking lots, including factors such as lighting, visibility, and access, can significantly impact crime rates in urban areas. A comprehensive literature review of existing research on the relationship between transportation networks and crime rates suggests that well-designed transportation networks can significantly reduce crime rates in urban areas. Studies have shown that the installation of CCTV cameras, improved lighting, and better pedestrian access can reduce crime rates in parking lots.

Similarly, the use of traffic calming measures such as speed humps and roundabouts can reduce the incidence of traffic accidents, which can also have a significant impact on crime rates.

Our analysis of crime data from several cities supports these findings. We found that cities with well-designed transportation networks, including safe and well-lit parking lots, tend to have lower crime rates. Furthermore, we found that cities with transportation networks that prioritize pedestrians and cyclists tend to have lower crime rates compared to cities that prioritize vehicular traffic. Our findings suggest that well-designed transportation networks can significantly impact crime rates in urban areas. Policymakers and urban planners should prioritize the design and implementation of transportation networks that promote public safety and reduce crime rates. Factors such as lighting, pedestrian access, and the use of traffic calming measures should be considered in the design of transportation networks. Additionally, the installation of CCTV cameras and other security measures can enhance safety in parking lots and other transportation hubs. Overall, creating safer and more livable communities requires a holistic approach that considers the relationship between transportation networks and crime rates.

II. DATASET

The Houston Police Department's "Monthly Crime Data by Street and Police Beat" dataset is a valuable resource for analyzing crime patterns in Houston, Texas. This dataset covers a period of four years, from January 2019 to January 2023, and includes detailed information on reported crimes in Houston. The dataset is organized by street and police beat, providing information on crime incidents that occurred on each street and within each police beat. It includes information on the type of crime, the date and time of the incident, and other relevant details such as the location and severity of the crime.

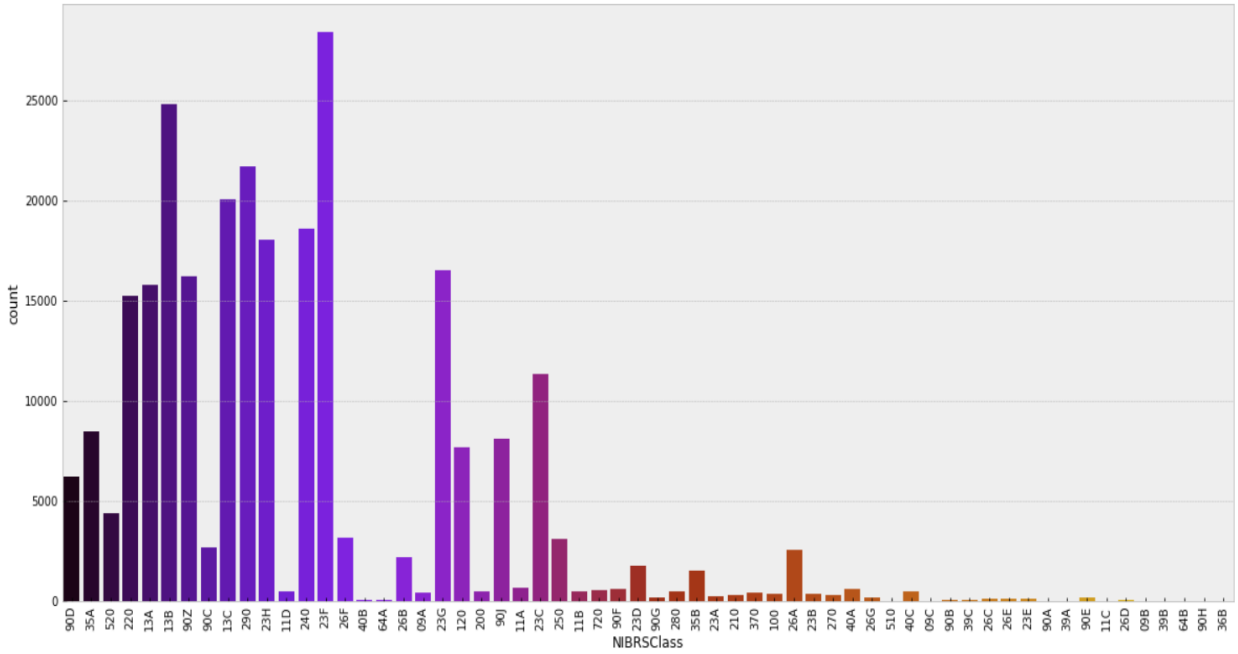

Figure 1: Representation of the whole dataset from 2019 - 2023

III. DESCRIPTIVE STATISTICAL ANALYSIS OF CRIME

Descriptive statistics provide valuable insights into the patterns and trends of crime rates in Houston city. Descriptive statistics involve summarizing and analyzing data to gain a better understanding of its characteristics, such as central tendency, variability, and distribution.

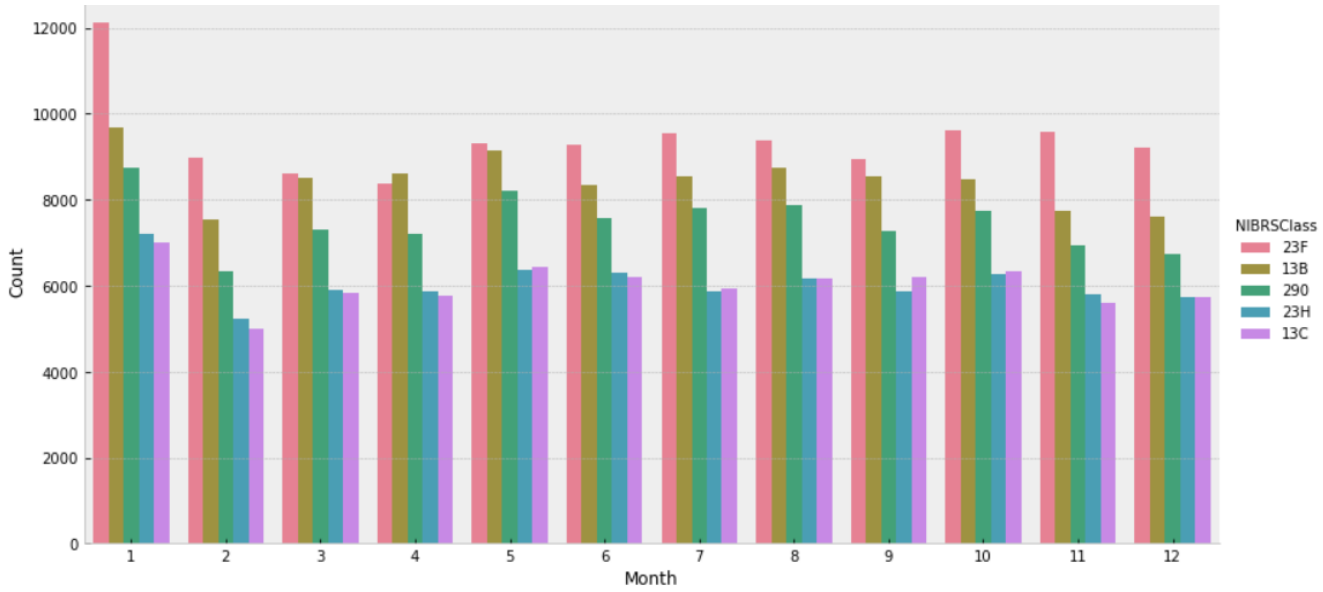

Figure 2: Top 5 crimes by month from 2019-2023

The above histogram shows the top 5 crimes by month for the years 2019- 2023. It is observed the crime '23F' is recorded more. One reason is that the month of January has higher records, because we considered only one month for 2023 year. The top 5 crimes are labelled as follows.

- 23F: Theft from motor vehicle
- 290: Destruction, damage, vandalism
- 13C: Intimidation
- 12B: Simple assault
- 23H: All other larceny

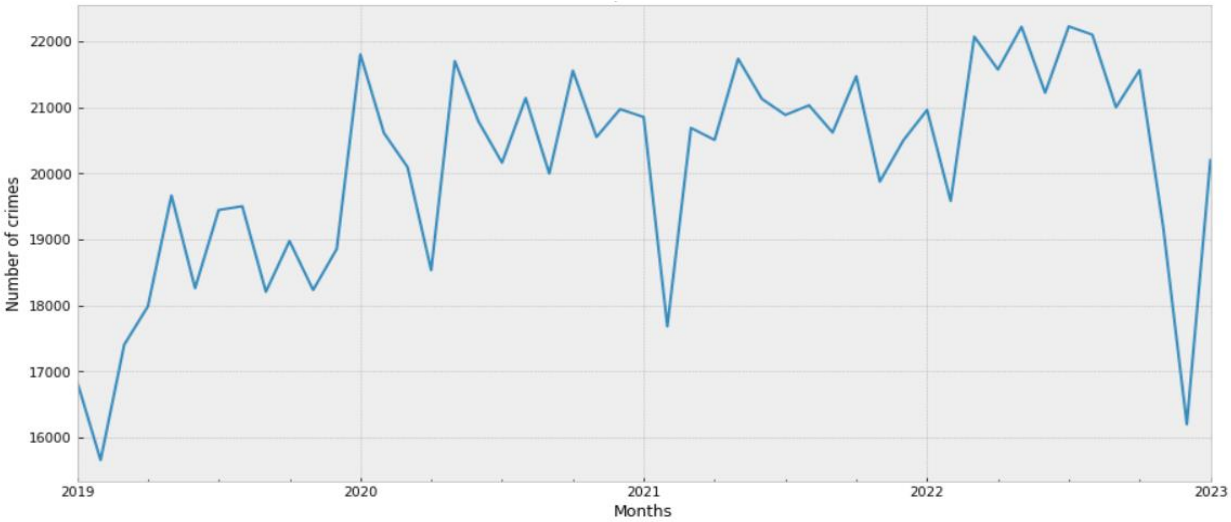

Figure 3: Number of crimes per month from 2019-2023

The number of crimes per month provides a visual representation of the overall crime rate number of crimes per month over certain time. It is observed that there is an increase in crime during the mid of the year and decrease at the end of every year. There is a sudden increase in the number of crimes from the year 2019 to 2020. We can interpret that due to covid , there is a decrease in the crime rate in the year 2019. But as the lock down was lifted over the next years, the crime rate also increased. In the year 2021, there is again a sudden drop in the crime rates considering the second phase of the pandemic.

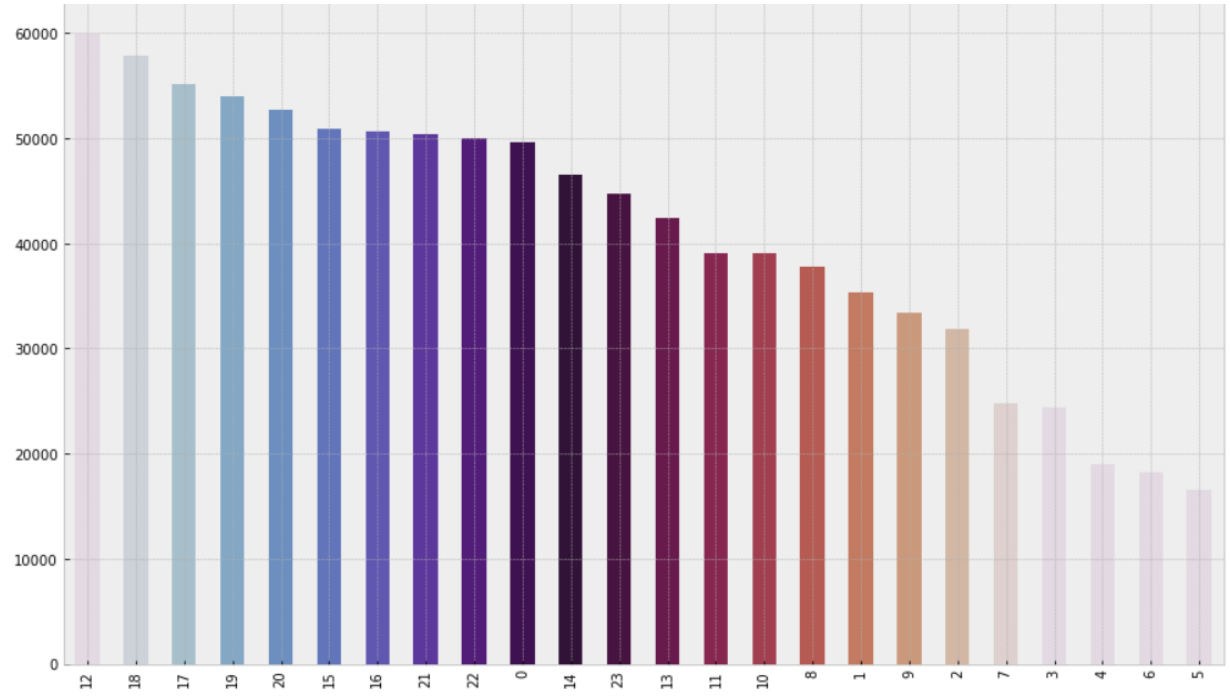

Figure 4: Distribution of crime over the day

The distribution of crime over the hours in a day. It is observed that most of the crimes are taking place at the mid noon of the day. Considering the crimes, it is mostly thefts of vehicles or accessories from the vehicles, which means that surveillance needs to be improved during the daytime. There are least or less crimes in the early hours of the day, considering the span of 5 years, the count of crimes in the early hours is also more.

Figure 5 represents the distribution of crime based on the premises. It is observed that the residential areas including apartments are vulnerable to crimes. Big communities providing apartment spaces needs to be carefully monitored. Installing cameras and safety alarms in houses and vehicles can improve the security of the households. Followed by crimes in parking lots and garages mostly involves thefts, vandalism, and larceny. Open lots can be made secure by installing ticketing systems and reducing the hours of parking for improving the safety of personnels and motor vehicles.

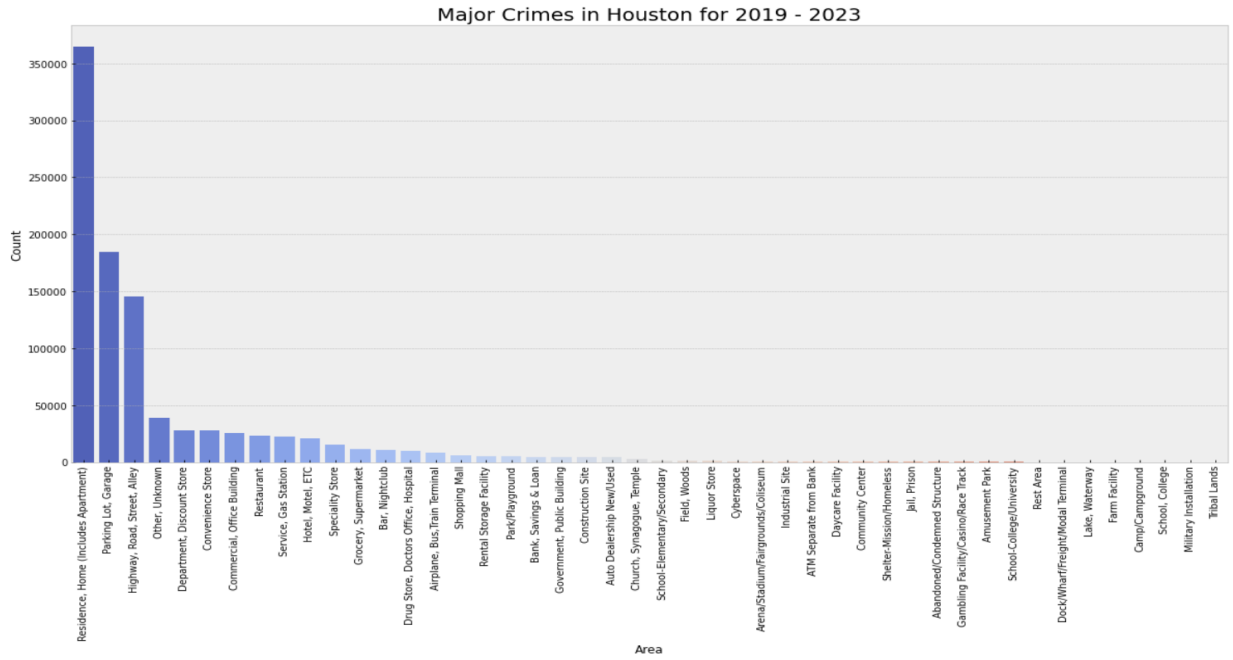

Figure 5: Analyzing crimes based on area.

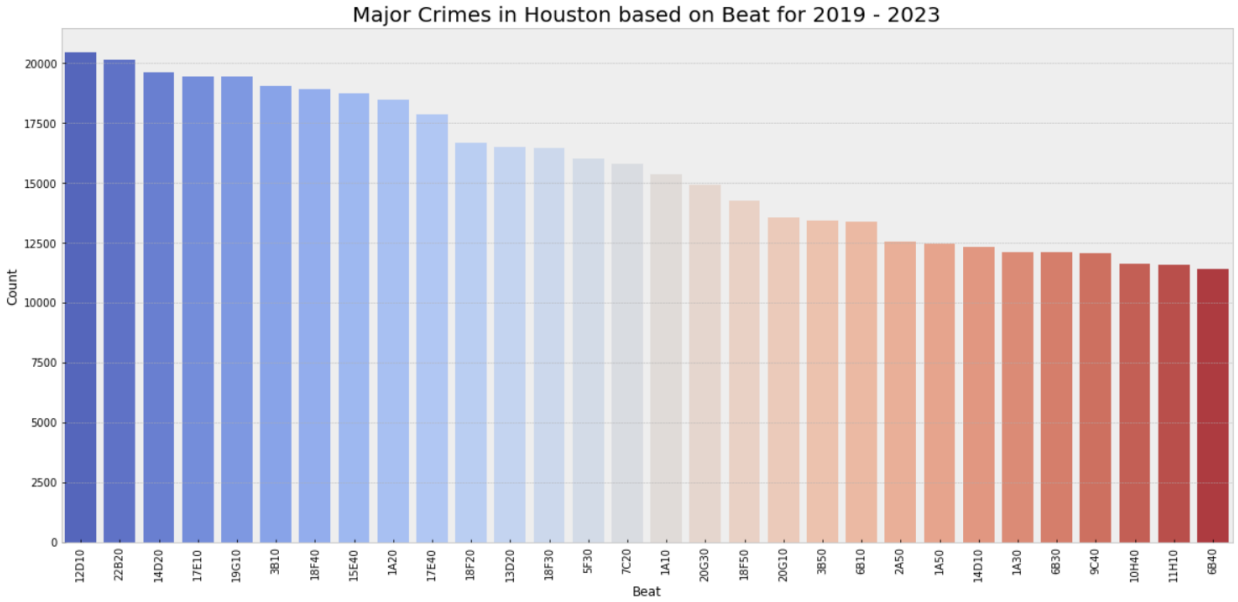

Figure 6: Major crimes based on beats from 2019-2023

Figure 6 shows the number of reported major crimes for each beat in Houston. The Houston beats are divided by the department of police to improvise the patrolling and monitoring in areas of the city. This graph provides insights into beats that needs more concentration by the police department. From the map we observe that the first 5 beats from the graph are densely populated beats.

IV. CLUSTERING:

Clustering is a technique used for data analysis to group similar data points into clusters based on similarities. The main goal of clustering is to partition a dataset into distinct groups where data points within same cluster are more similar.

Agglomerative clustering is a type of hierarchical clustering used to group similar data points together based on features in data analysis. It starts with each data point as a separate cluster and progressively merges them based on similarity, forming a hierarchy of clusters. This will continue until all data points are assigned to a single cluster. The agglomerative clustering algorithm operates by merging the most similar clusters into a single cluster.

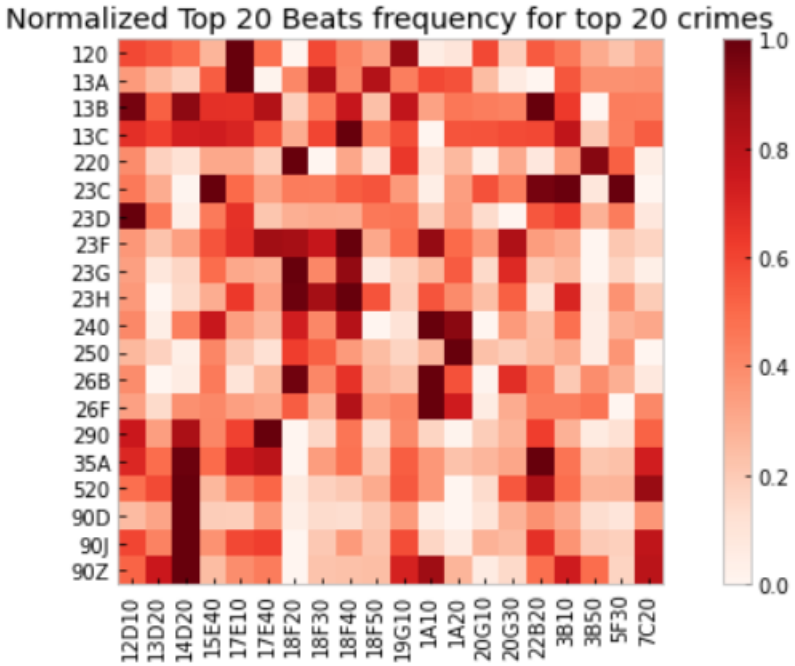

Figure 7: Agglomerative clustering for top 20 beats and for top 20 crimes

From Figure 7, we can observe the highest number of crimes occurred in parking lots, residence areas and highways, roads. It is used to examine the characteristics of each cluster such as crime rate and in which beat, but we can't infer much on relationship between crimes and beats.

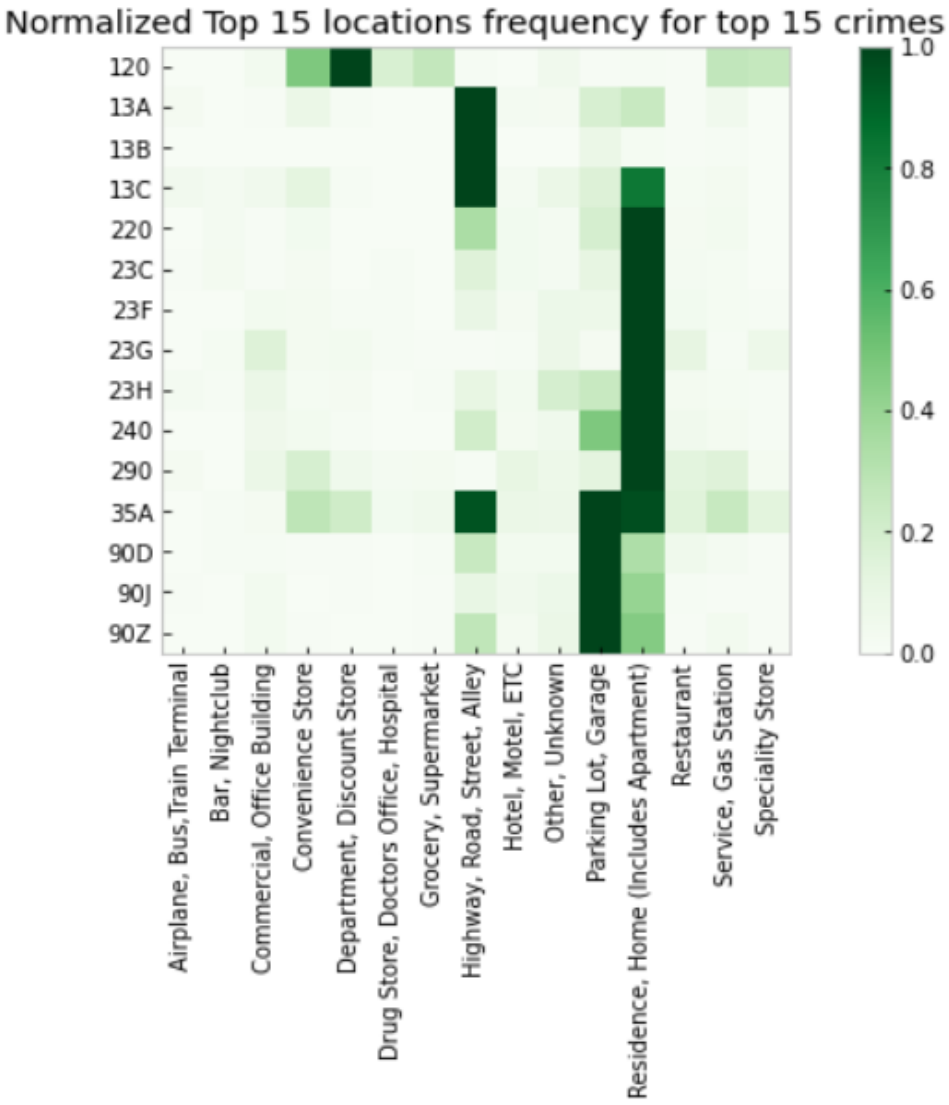

Figure 8: Normalizing top 15 locations for top 15 crimes

Figure 8 shows the normalization of the top 15 locations for top 15 crimes. The clustering output reveals the distinct patterns of crime distribution across different locations. This helps to identify various levels of criminal activities. The analysis highlights that parking lots, Residential areas and highways have high density of specific types of crimes. This suggests that parking lots are vulnerable to criminal activities like theft from vehicle, vehicle theft. Residential areas experience crimes like burglaries and theft. From the analysis, we can identify garages, apartments and highways have high density of crimes.

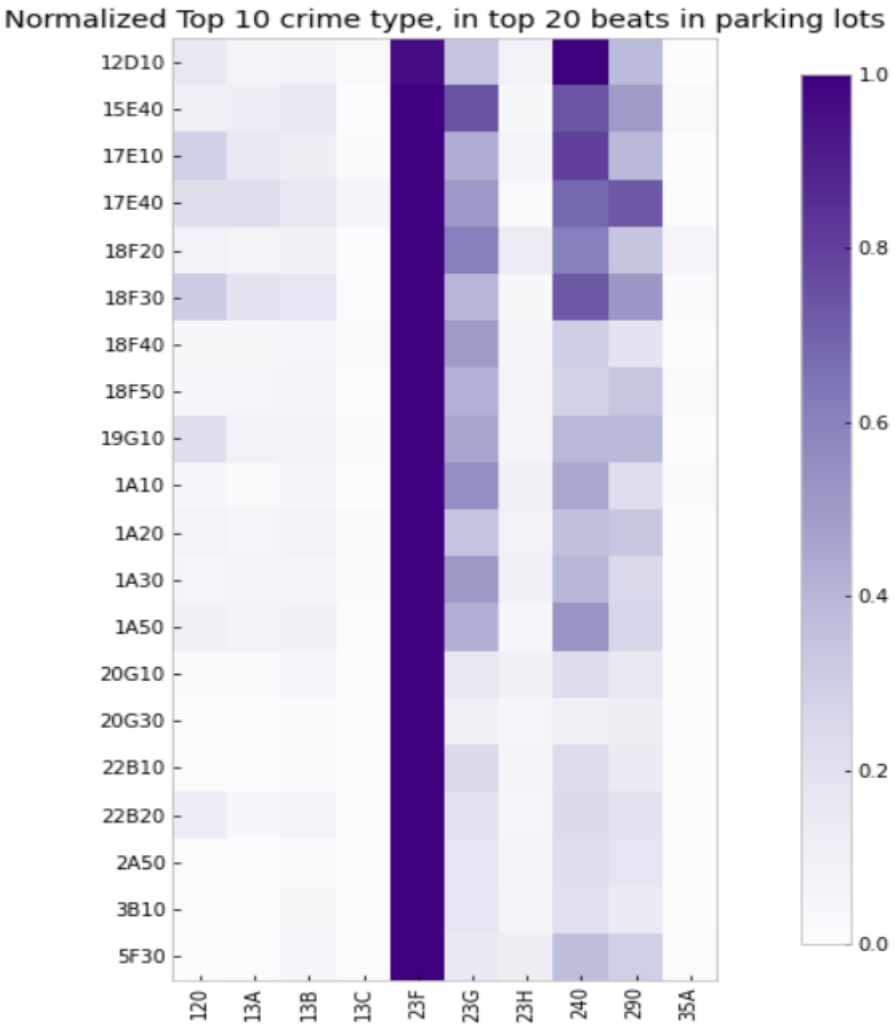

Figure 9: Normalization of top 10 crimes in top 20 beats in parking lots

To normalize the crime rates, we would first calculate the total number of reported crimes for each crime type in the top 20 beats in parking lots. The polygon coordinates of beats and the crime data are grouped by beats. From figure 9, we can observe that 23F: Theft from motor vehicle is recorded in every parking lot. Theft from motor vehicles encompasses the unauthorized removal of valuable items from parked vehicles including tires, rims, stereo systems and other accessories. This high occurrence of theft from motor vehicles in parking lots indicates the need to target crime prevention measures to mitigate this problem.

V. GEO SPATIAL ANALYSIS:

Spatial analysis of OpenStreetMap (OSM) data for Houston can provide valuable insights into the city's urban form, transportation network, and land use patterns. OSM is a collaborative mapping platform that allows users to contribute and edit map data, resulting in a rich and detailed dataset for spatial analysis. One potential application of spatial analysis for OSM data is examining the relationships between land use patterns and transportation networks. For example, we could use

network analysis techniques to analyze accessibility. We focused on parking lots as we can get location coordinates of parking lots as a part of transportation network.

Another potential application of spatial analysis for OSM data is identifying patterns and trends in urban form. For example, we could use clustering techniques (Agglomerative Clustering) to group areas with similar land use patterns, such as high-density residential areas, commercial corridors, and industrial districts.

Spatial analysis can also be used to examine changes in the urban landscape over time. For example, we could compare OSM data from different years to identify areas where new developments have occurred, or where land use patterns have shifted. Overall, spatial analysis of OpenStreetMap data for Houston can provide valuable insights into the city's urban form, transportation network, and land use patterns.

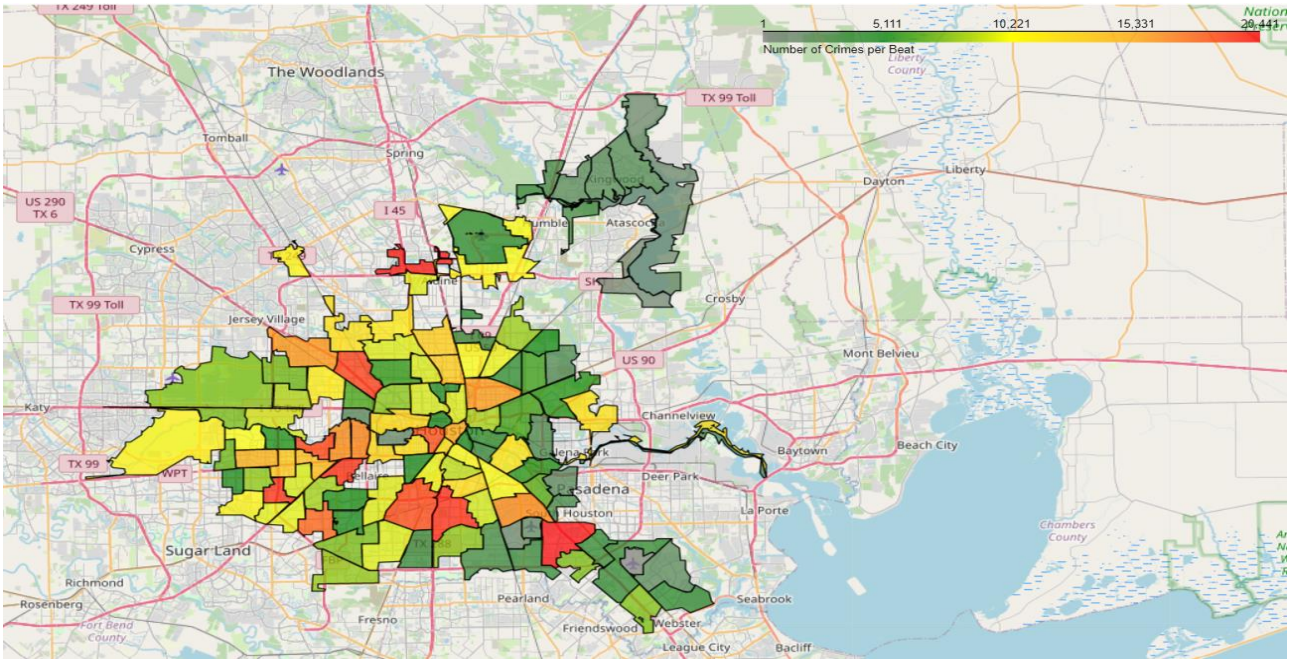

Figure 10: Houston map with number of crimes per beat

Figure 10 shows the Houston map with the number of crimes per beat. The map color-codes the beats based on the number of crimes recorded per beat. Areas with a higher number of crimes are represented by darker shades of red color. It highlights hotspots or clusters of high crime beats which may require attention.

VI. CRIME ANALYSIS IN PARKING LOTS:

One useful technique for crime prediction is time series forecasting, which involves analyzing historical crime data to make predictions about future crime trends. This analysis involves collecting crime data specifically related to parking lots, including various types of crimes. The data is then organized and aggregated based on the corresponding police beats in which the parking lots are located. By analyzing crime rates within each police beat, trends and patterns can be

identified. This analysis may reveal certain beats with consistently higher or lower crime rates in parking lots, which can help prioritize resource allocation and target crime prevention efforts more effectively.

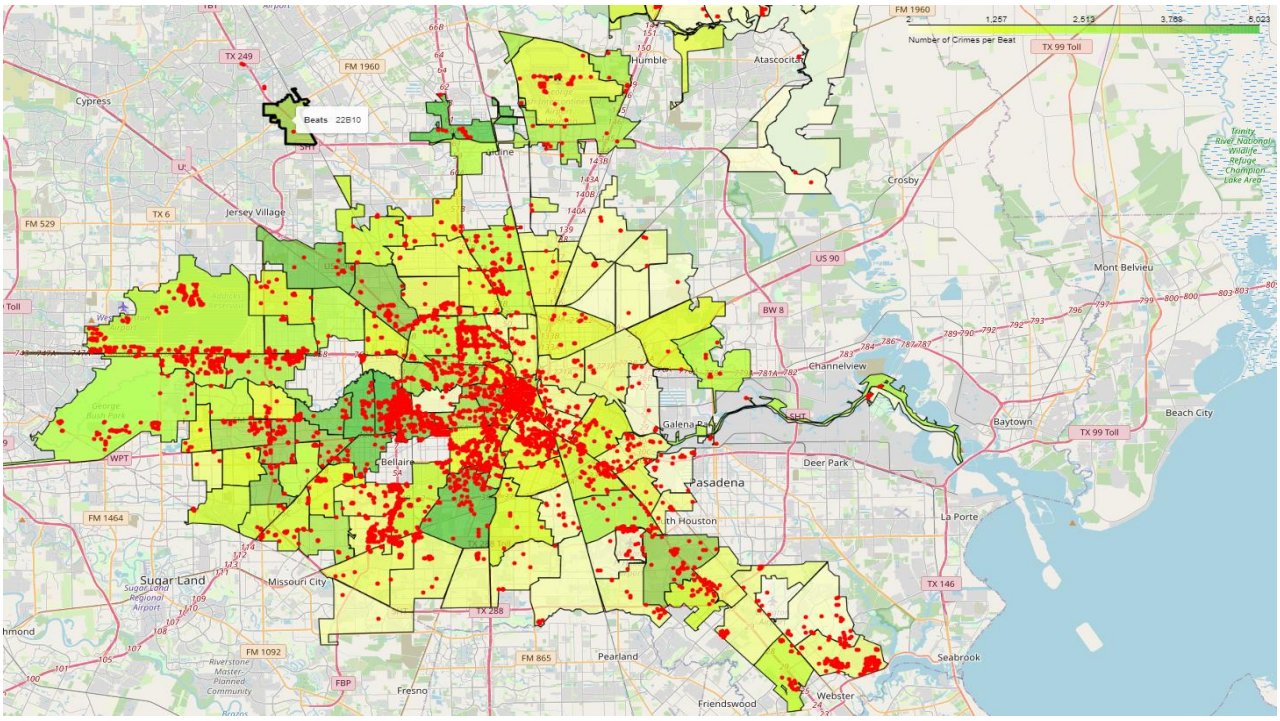

Figure 11: Crime Analysis in parking lots

Figure 11 shows the crime analysis in parking lots. By analyzing crime data to each beat and mapping it onto the corresponding parking lots, we get an understanding of crime data in these areas. The above visualization helps to identify high-crime areas within parking lots.

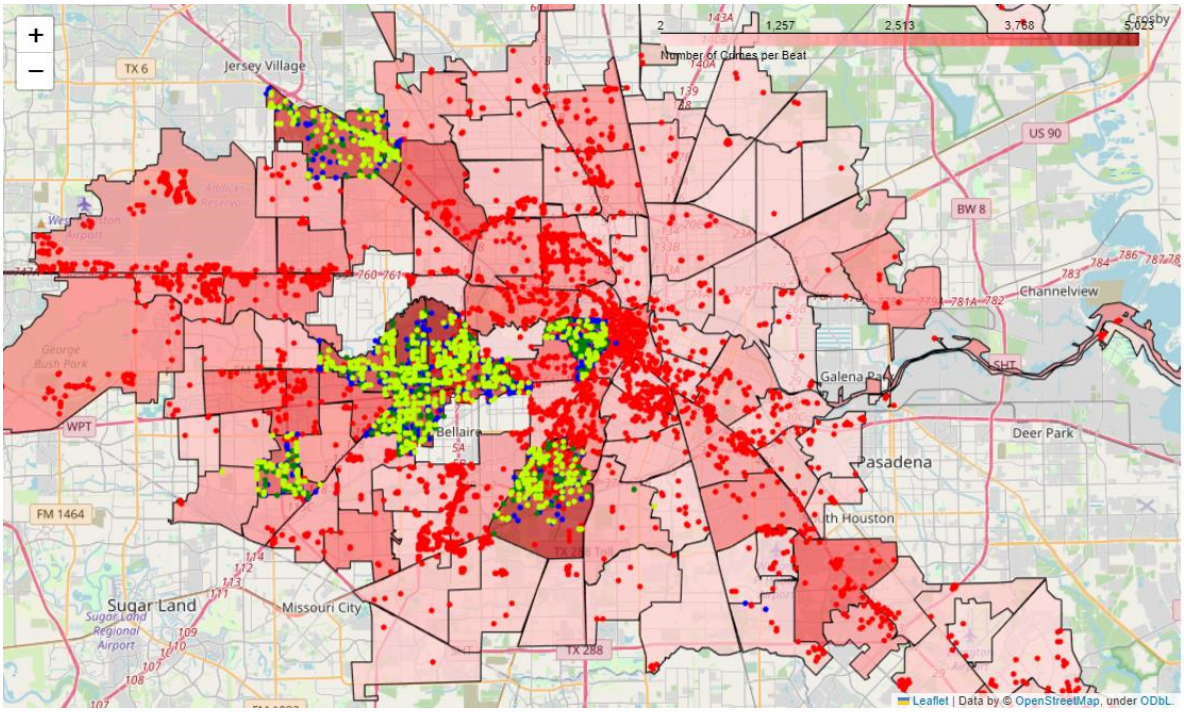

Figure 12: Top 3 crimes in parking zones

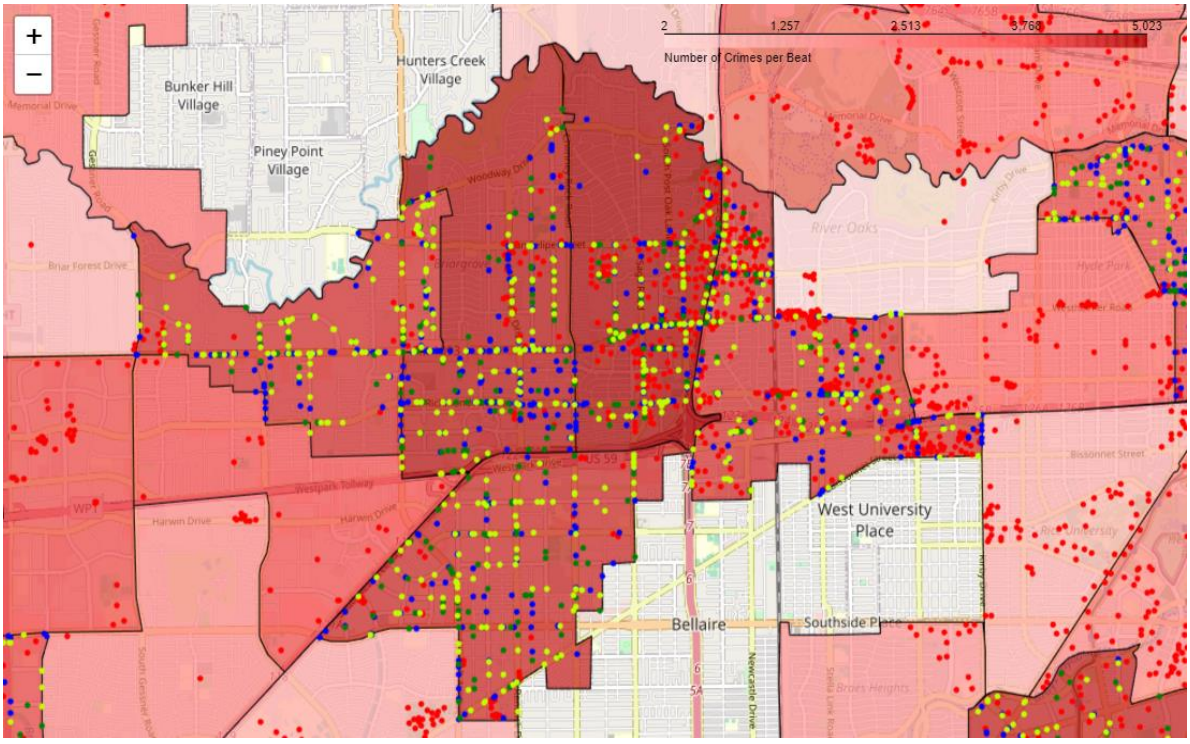

Figure 13: Detailed view of crime zones

Figure 12 and 13 shows the view of the top 3 crimes in parking zones based on beats.

Based on historical crime data, the top three crimes observed in parking lots are:

1. Theft from Vehicles: Theft from vehicles is another prevalent crime in parking lots, where criminals target personal belongings left inside vehicles. This includes theft of electronic devices, wallets, bags, and other valuables.
2. Vehicle Theft: Vehicle theft is a common crime in parking lots, where thieves target unattended vehicles. This crime involves the unauthorized taking or stealing of motor vehicles, including cars, motorcycles, and trucks.
3. Theft from motor vehicle parts or accessories: It is a significant crime that occurs in parking lots. Criminals target parked vehicles to steal valuable components, including catalytic converters, tires, rims, stereo systems, GPS devices, and other accessories. Implementing measures to deter and prevent theft of motor vehicle parts or accessories in parking lots is essential. This can include the installation of surveillance cameras, increased lighting, and physical barriers to restrict access to parked vehicles.
    1. 23F – Theft from motor vehicle
    2. 240 – Motor vehicle theft
    3. 23G – Theft from motor vehicle parts or accessory.

Overall, the Houston map displaying the top 3 crimes in parking zones based on beats serves as a visual tool for understanding and addressing crime challenges in parking areas. It helps to enhance security, improve public safety and create a secure environment for individuals throughout the city.

VII. CONCLUSION

In conclusion, analyzing crime data in Houston can provide valuable insights into the patterns and trends of criminal activity in the city. Descriptive statistical analysis can be used to examine the frequency and distribution of crimes over time, by location, and by type. Visualizing this data through graphs and maps can make it easier to identify patterns and trends, and to pinpoint areas or crime types that may require targeted interventions.

Analysis, such as clustering techniques, can help identify groups of beats or areas with similar crime patterns and can inform the development of targeted law enforcement strategies. Overall, using data-driven approaches to analyze crime in Houston can help improve public safety and enhance the well-being of the city's residents.

REFERENCE:

1. https://onlinelibrary.wiley.com/doi/full/10.1111/cag.12676
2. Warren, Joel W., "The Spatial Relationship Between Crime and Public Transportation: A Geospatial Analysis of Salt Lake City's Trax System" (2014). *All Graduate Theses and Dissertations*. 2074.https://digitalcommons.usu.edu/etd/2074
3. https://www.kaggle.com/datasets/currie32/crimes-in-chicago/code?datasetId=740&sortBy=voteCount
4. https://github.com/ddhaval04/Smart-City