Pandemic Conditions and Their Influence on Crime Rates in Boston Neighborhoods: A Comparative Analysis of 2018, 2020, and 2022

Introduction

The world witnessed significant societal changes in the past few years due to the Covid-19 pandemic. The effects of lockdowns, social distancing, and the transition to remote work and education are being explored across numerous domains. A field that has seen substantial transformations due to the pandemic is criminology. Crime rates and types of offenses have been influenced by the changing social dynamics, necessitating research to understand these impacts better. This study aims to analyze and comprehend the changes in crime rates and patterns in Boston's neighborhoods during the pandemic. The analysis was conducted by comparing crime rates in Boston neighborhoods in 2018, 2020, and 2022.

Using Python libraries and Boston's open-source crime incident data, we examined crime trends, spatial distribution, and the potential correlation between specific crimes and pandemic conditions. Emphasis was placed on the analysis of certain types of crimes hypothesized to have been impacted by the pandemic such as "Fraud," "Residential Burglary," and "Aggravated Assault."

This study provides insights into the changing crime patterns during the pandemic and its aftermath, enhancing our understanding of the societal impacts of these extraordinary times.

Methodology

The pandas [1] and NumPy [2] libraries were the primary data manipulation and analysis tools. These libraries were used to load, clean, and transform the 2018, 2020, and 2022 crime data [3]. The data were loaded from CSV files into pandas DataFrames and then concatenated into a single DataFrame for analysis. The OFFENSE_CODE_GROUP attribute for the 2020 and 2022 datasets was initially missing, leading to the creation of a dictionary from the 2018 data to fill in the missing values in the other two datasets. Cleaning of the data involved adding missing columns with default values, such as the 'SHOOTING' column in the 2018 data. The 'OCCURRED_ON_DATE' column was converted to a DateTime format for better handling and manipulation. Rows with missing geographic coordinates (Lat and Long) were checked and dropped to maintain the integrity and reliability of the spatial analyses conducted later. The geographic scope was also narrowed to a more reasonable area around Boston to eliminate potential outliers from the data.

The geopandas [4] library was combined with Shapely and Sklearn for spatial analyses. Geographic coordinates (latitude and longitude) were used to construct a GeoDataFrame, and a kernel density estimation was applied to estimate the crime distribution in Boston for each year under study. The geopandas library played a crucial role in enabling spatial analyses. Using the geopandas library, Boston's neighborhoods were defined using a GeoJSON file [5]. A spatial join operation assigned each crime to a neighborhood based on geographic coordinates. The output of this operation allowed the construction

of interactive maps using folium for each year under study. These maps, enriched with marker clusters for crime instances in each neighborhood, provided detailed visual insights into crime patterns in Boston.

Data visualization relied heavily on Matplotlib [6] and Seaborn [7]. These libraries were employed to generate bar plots, line plots, and heatmaps to reveal patterns in the data and draw comparisons over the years. Visualizations focused on aspects such as the number of crimes per year, month, and hour; the distribution of crimes by offense code group; the distribution of crimes by district, among other aspects.

An exploratory analysis was conducted on specific types of crimes hypothesized to have been impacted by the pandemic. Crimes such as "Fraud," "Residential Burglary," and "Aggravated Assault" were among these. The occurrence of these offenses was plotted for each year, with tables created for a clearer comparison. As a final check correlations were examined between numerical attributes in the data to uncover potential relationships. For instance, the correlation between offense code, year, month, hour, and geographic coordinates was assessed using a correlation matrix. The visual representation of the correlation matrix was a heatmap.

Analysis

The results of the data analysis reveal several noteworthy patterns and trends in the crime data across the years 2018, 2020, and 2022. The total number of crimes reported witnessed a significant decrease from 2018 to 2020, reducing by about 28%, and then a slight increase in 2022 (Figure 1). Specifically, the crime density in Boston also echoed this trend. In 2018, Boston experienced approximately 397 crimes per square kilometer. However, this density dropped to around 298 crimes per square kilometer in 2020 before seeing a slight rise to roughly 302 crimes per square kilometer in 2022.

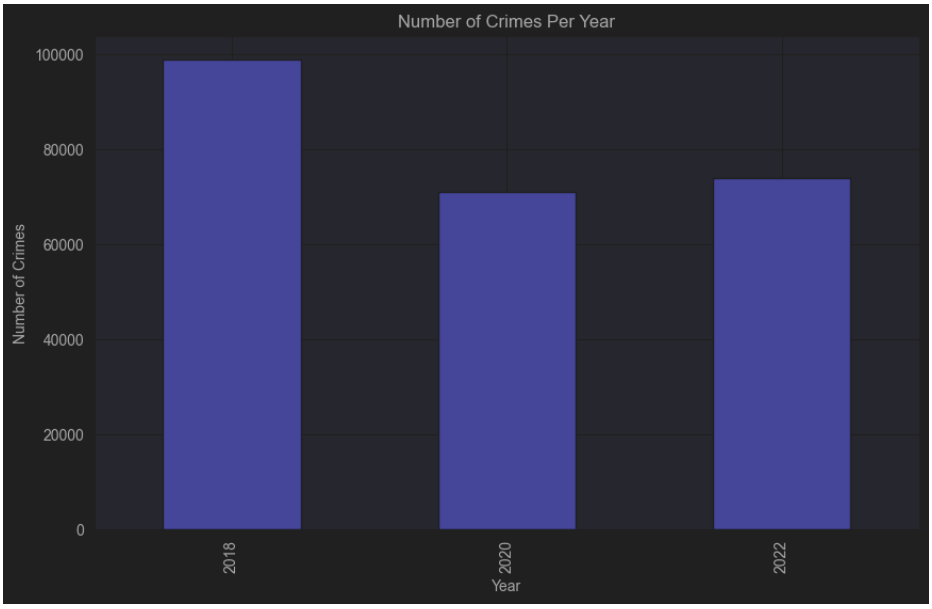

Figure 1: Number of crimes Per Year

This trend is further reflected in the crime data across Boston's neighborhoods (Table 1). In 2018, Dorchester reported the highest crime count at 22,711, followed by Roxbury with 12,136 crimes. By 2020, these figures had decreased to 16,634 for Dorchester and 9,216 for Roxbury. This downward trend generally continued into 2022, with Dorchester reporting 16,177 crimes and Roxbury, 8,194 crimes. While all neighborhoods experienced decreases in crime rates, some like Brighton saw a modest increase from 3,469 in 2018 to 3,824 in 2022. This data has been visualized with an interactive map that is enriched with marker clusters for crime instances in each neighborhood, providing detailed visual insights into crime patterns in Boston.

The month-wise distribution of crimes shows some seasonality, with higher numbers typically observed from May to October. In each year, May, June, July, and August were the months with the most crimes reported, while February tended to have the fewest. One can also see that during the year 2020, there was a decrease in the number of crimes starting from February until it reached a minimum in April. This coincided with the start of the pandemic and the quarantine measures that were announced in the state of Massachusetts.

Neighborhoods	2018	2020	2022
Allston	2351	1433	1747
Back Bay	3781	1433	1747
Bay Village	249	103	118
Beacon Hill	815	511	474
Brighton	3469	3371	3824
Charlestown	1809	1437	1401
Chinatown	839	475	512
Dorchester	22711	16634	16177
Downtown	5966	4505	4287
East Boston	3780	3127	3557
Fenway	2803	1320	1657
Harbor Islands	0	6	5
Hyde Park	4122	3432	3260
Jamaica Plain	4685	3752	3812
Leather District	153	59	74
Longwood	395	183	240
Mattapan	4357	2386	2542
Mission Hill	1650	1032	1116
North End	814	550	621
Roslindale	2705	1708	1744
Roxbury	12136	9216	8194
South Boston	4926	3669	3976
South Boston Waterfront	607	412	550

South End	3897	4663	4317
West End	1150	669	1081
West Roxbury	1918	2485	2385

Table 1: Number of crimes per Boston neighborhood

Examining the most common offense groups, "Motor Vehicle Accident Response" was the most reported crime in all three years (Figure 3). In contrast, the occurrences of "Medical Assistance" crimes dropped significantly from 8,257 in 2018 to 2,710 in 2022, possibly due to changes in reporting or a reduction in incidents requiring police assistance. It is also notable that "Drug Violation" incidents and “Investigate Person” incidents increased sharply in 2022 which might be hinting at a change in societal patterns post-lockdown.

Figure 2: Number of crimes reported each month for all three years.

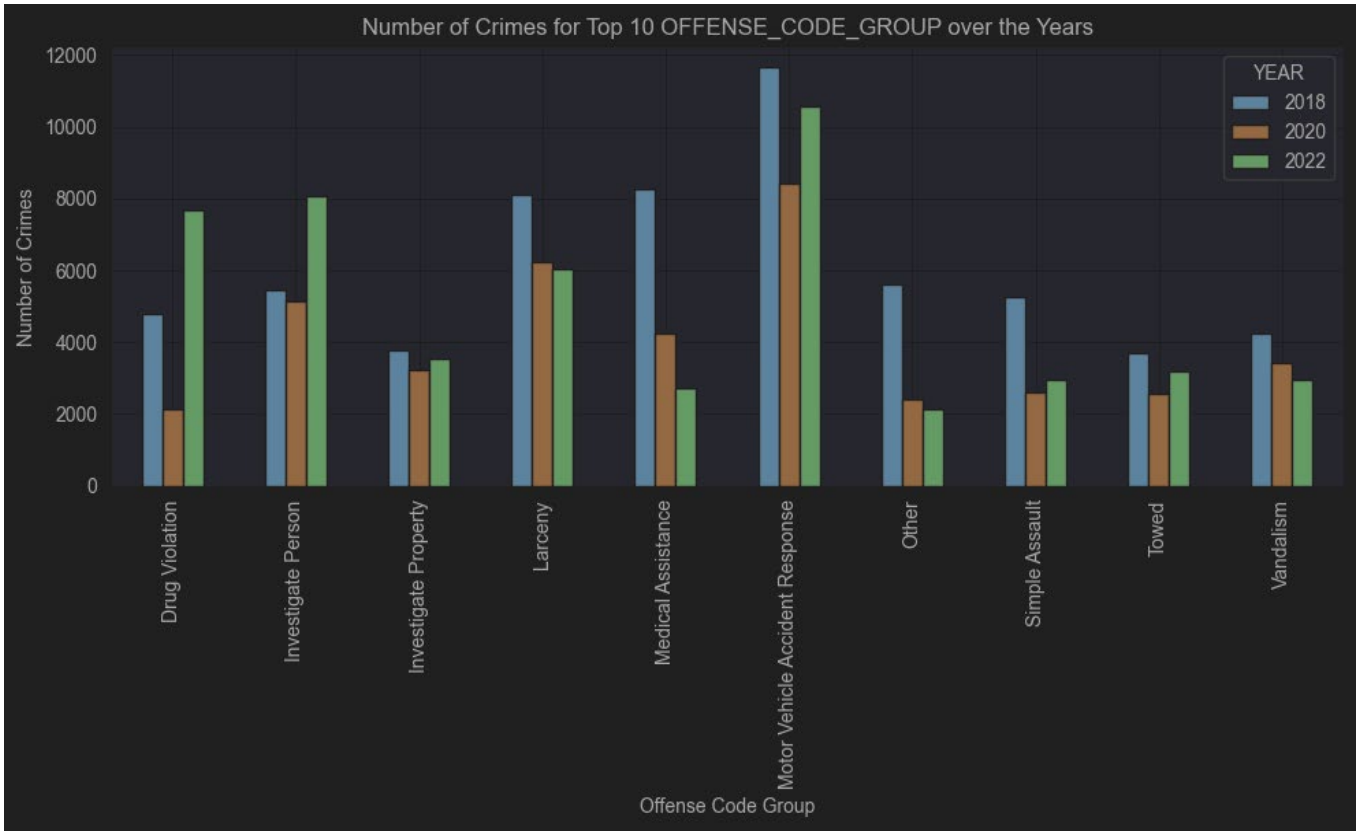

Figure 3: Number of crimes for the top 10 most common offense codes

Finally, the analysis of specific offense types yielded interesting results. The hypothesis that "Fraud" might increase due to more online transactions during the pandemic was confirmed, as the number of incidents rose from 2,077 in 2018 to 3,077 in 2020 and 3,462 in 2022 (Figure 6). The hypothesis that "Residential Burglary" might decrease with more people staying at home was also supported: these incidents fell from 3,446 in 2018 to 1,918 in 2020 and 1,657 in 2022. However, "Aggravated Assault" did not show a clear trend, rising from 4,005 in 2018 to 4,065 in 2020 but then falling to 3,910 in 2022. The hypothesis that "Assembly or Gathering Violations" might increase during the pandemic was not supported, as these incidents fell from 387 in 2018 to 136 in 2020 and 124 in 2022.

Figure 4: Crimes per hour over the years

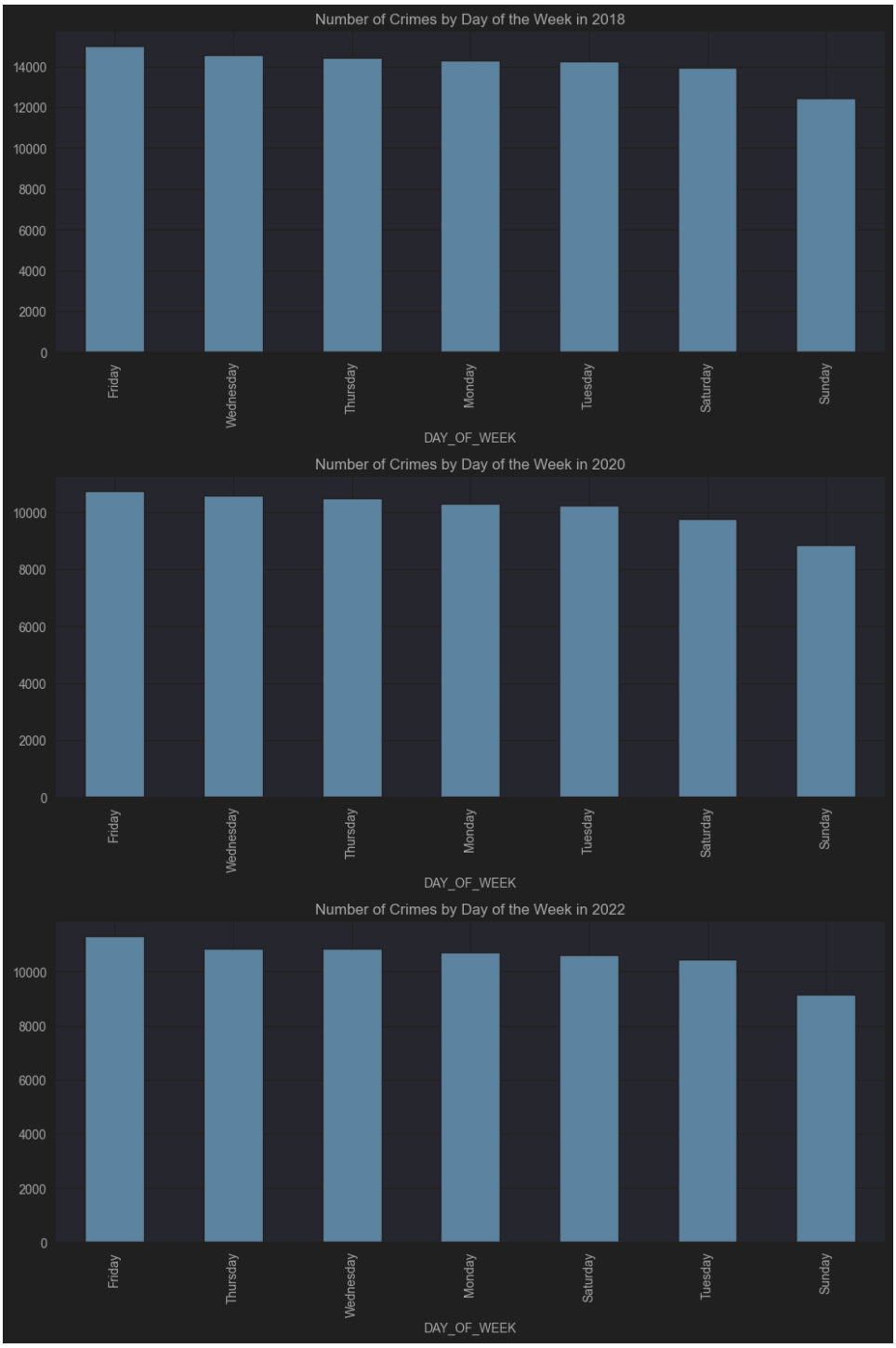

Figure 5: Number of Crimes per Day of the week

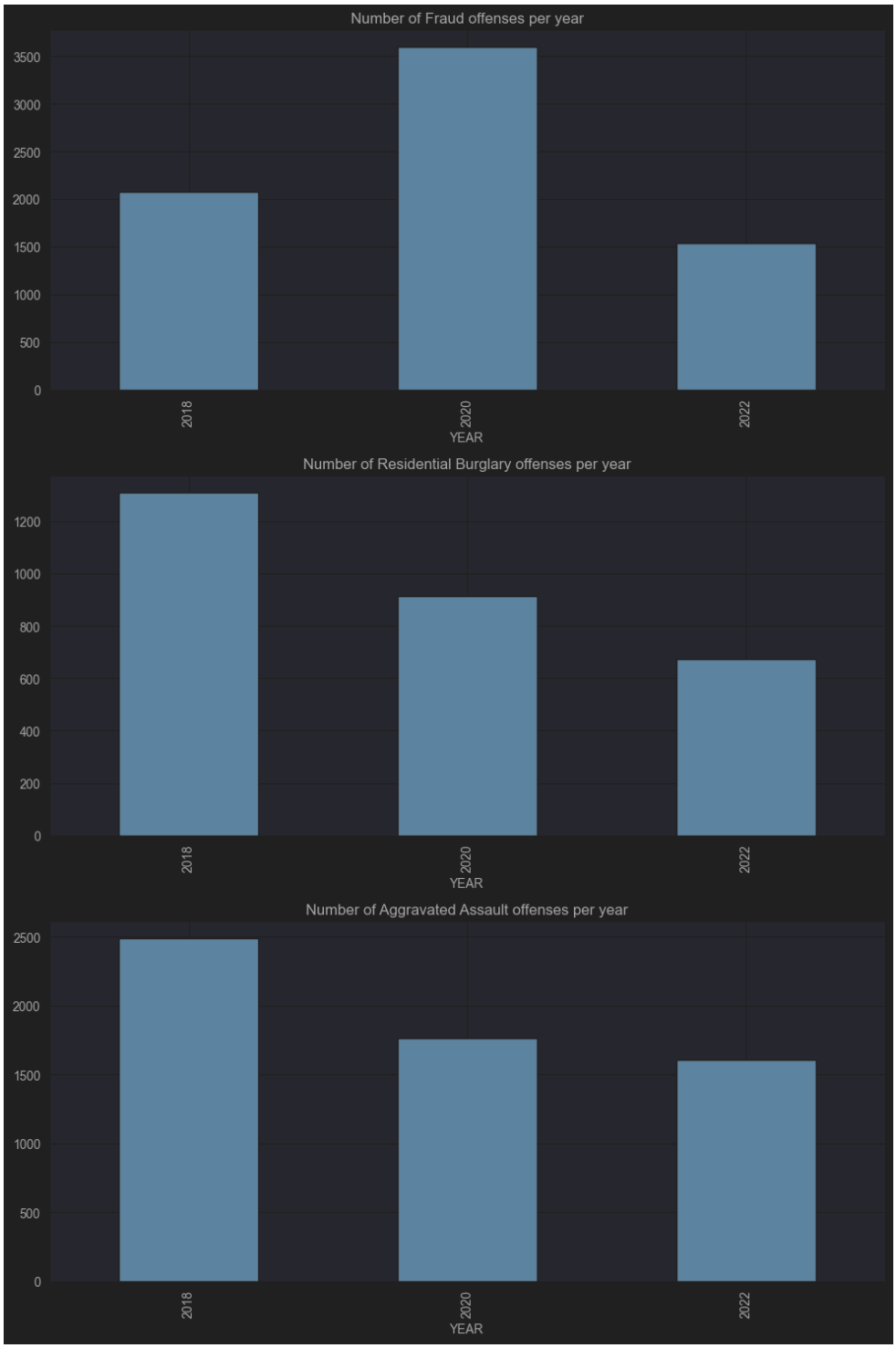

Figure 6: Hypothesis-based comparison results for offenses

The analysis indicates a general decrease in the total number of crimes reported from 2018 to 2022, with shifts in specific offense types. The observed patterns could be attributed to various societal changes during this period, including the effects of the COVID-19 pandemic. The change in crime density over

these years and its variation across neighborhoods also provide essential insights into the spatial distribution of crimes within Boston.

Conclusion

In conclusion, the Covid-19 pandemic appears to have influenced crime patterns in Boston, with a general decrease in overall crime rates, though the impact varies by type of offense. Some crime types decreased during the pandemic, possibly due to changes in public behavior in response to social distancing and stay-at-home orders. As society started to return to normal in 2022, we see a slight rebound in crime rates, though still lower than pre-pandemic levels.

This analysis provides a starting point for understanding the complex effects of the pandemic on crime. Future research should consider other variables, such as changes in policing strategies and societal changes that may have influenced these trends. Further, a detailed investigation into the specific types of crime mentioned in the initial hypothesis could provide more insights.

References

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