



CHICAGO INFRASTRUCTURE: DEFICITS & DISPARITIES

1. INTRODUCTION

- **Project Title:** Chicago Infrastructure Deficits & Disparities
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- **Date:** October 22, 2024

2. EXECUTIVE SUMMARY

Infrastructure issues, such as unrepaired potholes, malfunctioning streetlights, and neglected or littered vacant lots, often reflect deeper problems of neglect and underinvestment in a community. These visible signs of disrepair can create environments that feel less secure and welcoming, potentially weakening community bonds and affecting economic activity. Such conditions may also signal to residents and outsiders that an area receives less attention and maintenance, which can influence crime rates. The "Broken Windows Theory" in policing suggests that visible signs of neglect, like poor infrastructure, can give the impression of disorder, leading to minor offenses that may escalate into more serious criminal activity. The concept implies that addressing minor issues or managing infrastructure concerns in a particular ward might help prevent a rise in crime.

The datasets that we examined looked at crime trends over the past five years, coupled with data on infrastructure service requests. We understand that the trends could possibly be influenced by the effects of COVID-19, as the pandemic significantly altered social behavior and patterns. During lockdowns and periods of restricted movement, certain types of crime, such as burglaries and street crimes, saw a decline due to fewer people being out and about. Conversely, other crimes, like domestic violence, may have increased as people were confined to their homes. Additionally, changes in economic conditions, such as job losses and business closures, could have impacted crime rates, leading to variations that are atypical when compared to pre-pandemic years. Therefore, any analysis of crime during this period should take into account the unique conditions and disruptions caused by the pandemic.

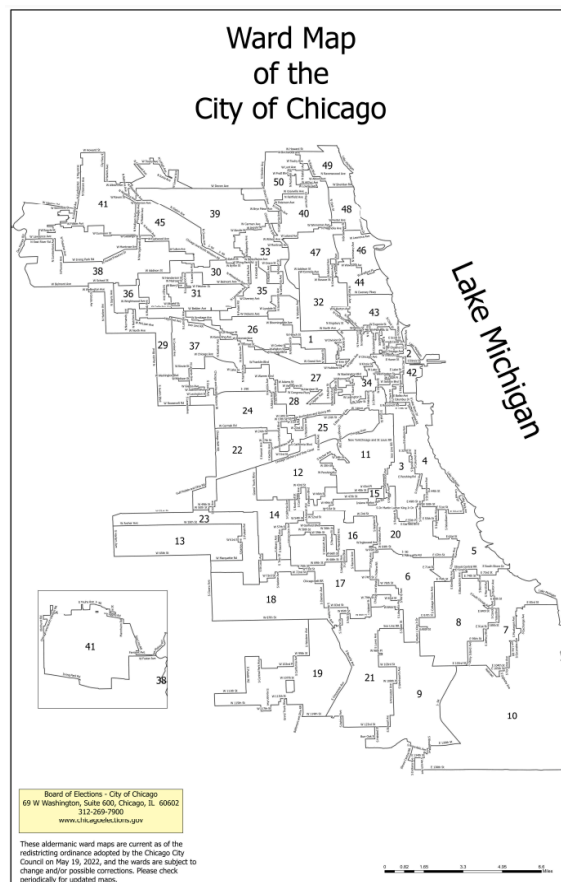
3. OVERVIEW

- **Problem Statements:**
 - Do areas with a higher concentration of infrastructure issues also report higher crime rates?

- Are there different kinds of infrastructure deficits that appear more closely linked to specific types of crime (e.g., vandalism, theft, violent crime)?
- **Project Overview:**

In this study, we decided it would be more effective to analyze the individual wards that make up Chicago rather than the community areas. Reports related to crime (911 calls) and non-crime issues (311 calls) are typically categorized by police precincts, community areas, and wards. In Chicago, wards and community areas are two distinct types of administrative and geographic divisions, each with its own purpose. Wards are political boundaries primarily used for local governance and elections. Each ward receives a specific budget that can be directed towards community and social initiatives. Chicago is divided into 50 wards, each represented by an alderperson, and these wards can vary significantly in size and demographics. On the other hand, community areas are long-standing, stable divisions established in the 1920s by sociologists from the University of Chicago [reference to wiki below]. There are 77 community areas across the city, and unlike wards, their boundaries have mostly remained unchanged since their creation. Ultimately, we chose to analyze data by ward to also assess the funding allocated to these areas and determine if there are disparities between different wards.

Figure 1. Ward Map of Chicago - 50 WARDS



- **Hypothesis:** Crime in specific wards in Chicago is not directly correlated or determined by infrastructure disparities.
- **Audience:** Our broad audience consists of community activists, alderpersons, concerned community members, potential homebuyers, and real estate industry actors.
- **Objectives - What Problem Does the Research Seek to Solve?**
 - Seek to bring awareness to the reported infrastructure issues within the city and their correlation with reported crimes. This type of analysis can inform more targeted and effective spending priorities for bringing down crime rates while investing in neighborhood infrastructure.
 - Analyze patterns of crime and infrastructure deficits over the last five years in Chicago.
 - Identify any correlations between unfulfilled infrastructure requests (e.g., potholes, trash in vacant lots) and reported crime rates.
 - 311 - Pothole Repair Requests
 - 311 - Graffiti Removal Requests
 - 311 - Vacant/Abandoned Building Complaints

4. Background

We were aware that the questions we are asking in this study narrow down a much larger overarching question attempting to discern what specifically impacts the increase in crime rates. One could also consider how socio-economic factors such as income levels, employment rates, housing stability, and educational attainment also play a critical role in influencing crime rates. Previous research has shown that neighborhoods with higher rates of unemployment and lower income levels tend to experience more crime. However, understanding the dynamics within Chicago specifically could yield insights into how these socio-economic factors interact with infrastructure deficits. This study may not necessarily solve any individual community problems, but could generate some insights that could impact alderman funding decisions.

5. Methodology

- **Analytical Techniques:**
 - Histograms
 - Visualize how the datasets are distributed (mean, median)
 - Pie Chart
 - Illustrates the distribution of different crime categories
 - Bar Graphs
 - Scatter Plots
 - Scatter Plots with Regression Lines
 - Spearman List Rank Correlation
 - Geomapping with the use of APIs
- **Data Collection:**
 - Crime reports from the Chicago Police Department: [Chicago Crime Dataset](#)

- Infrastructure complaint data: [Chicago 311](#)
- Ward breakdown: [Chicago WardWise](#)
- City of Chicago Data Portal
- **Data Preparation:**
 - Data Inconsistency: Since ward boundaries can change over time, this could complicate historical data analysis, we assessed only the past 5 years.
 - Data Size/Volume: We initially wanted to look at two sets of data for comparison, but the files were too large. The Chicago Crime dataset from 2001-present had over 8.18 million rows; the dataset from 2014-present (past 10 years) had 2.74 million rows; the 5-year dataset from 2019-present had a much more manageable 1.39 million rows.
 - Since the 311 data collected was not updated online before 2018, we assessed only January 1, 2019 through the present. This cutoff date was also chosen to align with the Crime dataset used.
 - Data Preprocess: handling missing values (null), data inconsistencies, other tasks.
- **Data Cleaning:** Described in detail in the next section, and in the Jupyter notebook.

5. Clean-up and Preliminary Data Analysis - Part 1

Figure 2. Data Cleanup Workflow



The project began by converting CSV files containing data on Graffiti Removal Requests, Vacant Building & Vacant Lot Service Requests, Pothole Complaints, City Government Spending, and Crime into separate dataframes. Each dataset included a breakdown by ward, which was selected as the common index for comparison. After examining column headers, irrelevant columns were removed. A threshold of 5% was set for acceptable null value attrition, meaning that rows containing null values were discarded with out sentinel value replacement if less than 5% of the column's rows were affected. Since relevant columns met this criterion, all null rows were removed (Figure 3)

Figure 3. Data Clean-up: Row and Column Attrition

Row and Column Reduction During Data Cleaning										
	Graffiti		Potholes		Vacants		Spend		Crime	
	rows	cols	rows	cols	rows	cols	rows	cols	rows	cols
Start	529,804	39	383,614	39	66,349	39	135,574	7	1,280,764	22
End	526,712	19	367,343	19	64,529	19	135,547	7	1,356,365	12

Date values were separated into year, month, and day columns, and data types across columns were checked and standardized, such as converting ward numbers to integers. Rows from years before 2019 were excluded to align with the study's time frame. Mixed data types were homogenized where necessary.

New dataframes were created by grouping and summing service requests, spending, or crime reports by ward, which were then sorted based on the aggregated values. Crime statistics were further categorized into two groups: CAP (Crimes Against Persons, including Assault, Battery, Robbery, Criminal Sexual Assault, Kidnapping, and Homicide) and Non-CAP (all other crimes).

Histograms of the three data sets, with mean and median values displayed, were prepared to visually assess the normality of the data distribution. Both Graffiti Removal and Vacant Building & Lot Requests are right-skewed, as indicated by the shape of the distribution and by the fact that in both cases the mean value lies to the right of median value. This distribution shows that some wards experience large numbers of reported graffiti and vacancy incidents, compared to other wards. Conversely, the Pothole Service Requests are normally distributed, the mean and median values co-occurring. Potholes plausibly occur randomly throughout the city, which would be consistent with pothole data being normally distributed. histogram of crime reports is right-skewed, while spending is left skewed.

Figure 4. Histograms of Graffiti Removal, Vacant Building & Lot and Pothole Repair Requests, by Ward

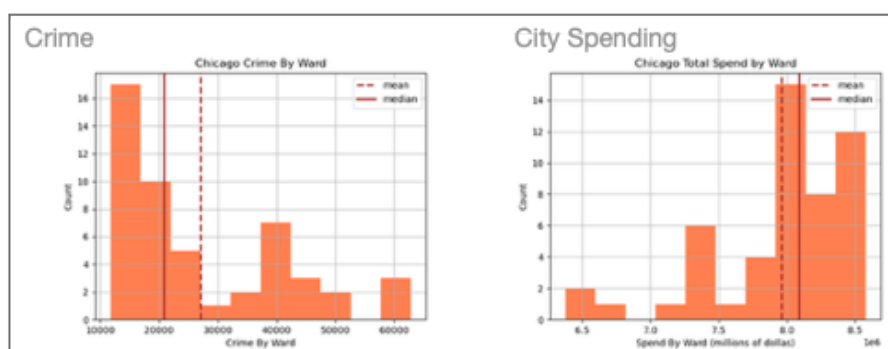


Graffiti removal and vacant building & lot service requests show considerable variation across wards. Graffiti requests range from as few as 719 in Ward 14 to 35,629 in Ward 18, representing nearly a 40X difference. Similarly, vacancy-related requests range from 127 in Ward 48 to 5,643 in Ward 33, almost a 50X difference.

The range for pothole requests and crime reports is narrower but still substantial. Pothole requests vary from 3,761 in Ward 43 to 12,332 in Ward 41, a difference of just over 3X. Crime reports range from 11,708 in Ward 37 to 62,857 in Ward 28, reflecting about a 5X variation.

Spending data presents an outlier, with values ranging from \$6,373,877 in Ward 47 to \$8,580,870, showing only a 1.2X difference. Accurately assessing spending proved challenging, and the relatively narrow range observed across wards in our data led us to postpone further analysis of this aspect for future studies.

Figure 5. Histograms of Crime and Spending by Ward



Bar charts were created to display the data, plotting wards against the number of service requests, spending, or crime incidents. Graffiti and vacant building & lot requests differ widely across wards, with a relatively small number of wards reporting high numbers of service requests. We selected the top ten wards as focused subsets (outlined in blue, figure 6). Pothole

service requests also have a wide range, but trends linearly, thus *not* displaying the prominent peaks seen in the wards most active for graffiti and vacancy requests.

Figure 6. Graffiti, Vacant Building & Lots, and Pothole Repair Requests, sorted by Ward



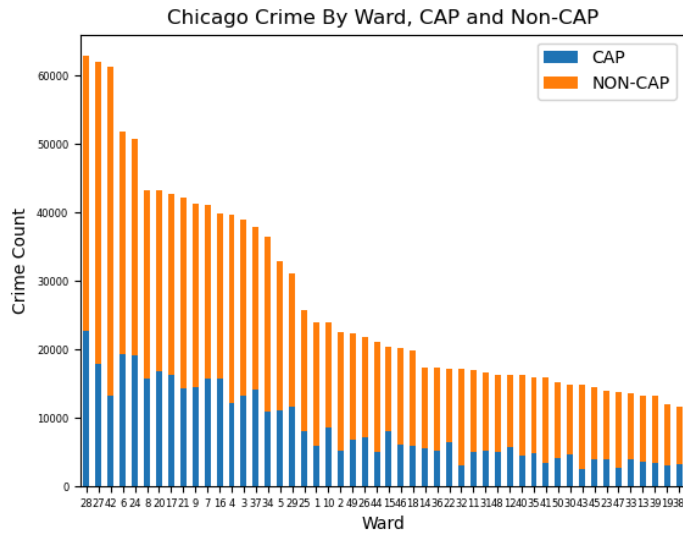
As noted in the histogram section, spend data is fairly evenly spread across wards (Figure 7)

Figure 7. Spending, sorted by Ward



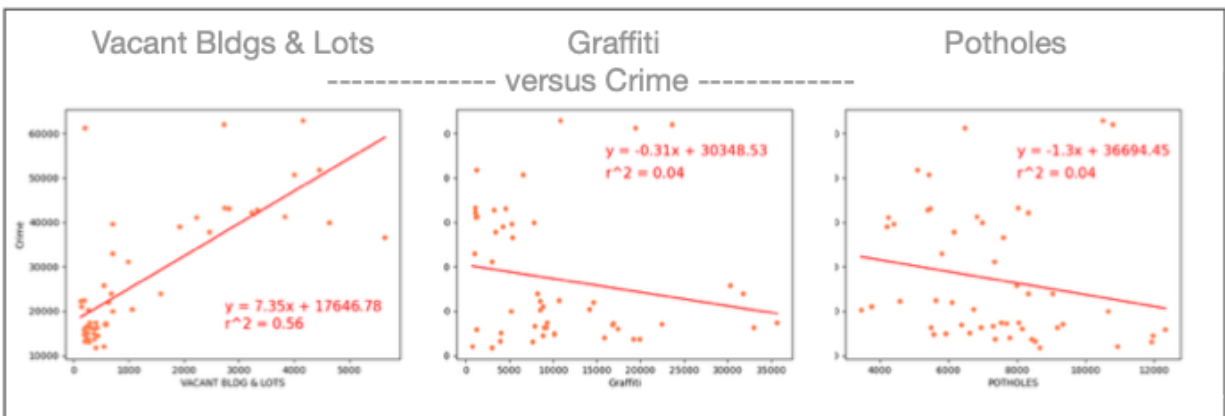
The shape of the sorted ward-by-ward bar chart for crime reports looks similar to the graffiti and vacancy bar charts; a relatively large number of crime reports occur in a sub-set of wards (Figure 8). The top wards (28,27,42,6, and 24) have more than 40,000 crime reports each; the next thirteen wards fall into a band between 30 - 40,000 reports. Both CAP and non-CAP crimes increase with total crime reports, but CAP reports increase more slowly; the major influence on crime reports in high crime wards is non-CAP crime.

Figure 8. CAP and non-CAP Crime Reports, sorted by Ward



Scatter Plots of vacant building & lot, graffiti and pothole service requests, versus crime reports, were created, linear regression performed on each, and the respective r-squared values calculated (figure 9).

Figure 9. Scatter Plots with linear regression



Vacancy has a fairly strong, positive correlation to crime (r-squared 0.56). Graffiti and pothole requests have essentially no correlation to crime (r-squared of 0.04 for each). The regression results can be interpreted as meaning that vacancy requests explain 56% of the variability in crime rates across wards, while graffiti and potholes requests have essentially no explanatory power.

Spearman Rank Correlation was conducted on the sorted ward lists to measure the degree of similarity in the order of items ranked by specific criteria. This non-parametric statistic is used to compare ranked data when numerical values determining rank are not available. For instance,

if two lists of the same ten countries were created—one ranked by average adult male height and the other by annual caloric intake as a proxy for nutrition —Spearman Rank could assess the correlation between them. An identical order on both lists would yield a score of 1.0, indicating a strong positive correlation, while a score of -1.0 would suggest a strong negative correlation. A score of 0.0 would imply no correlation. The Spearman Rank Correlation (SRC) can range between -1.0 and 1.0 and can be calculated on a dataframe using the ‘.corr’ method:

```
result = list_to_compre_df.corr(method='spearman')
```

Spearman Rank is useful when precise values are unavailable, thus precluding stronger statistical methods. Because this study benefits from access to quantitative data, it is possible to compare the performance of Spearman Rank against linear regression.

Figures 10 & 11. Spearman Rank Correlation Calculation

	graffiti	pothole	vacant	spend	crime	cap	noncap
graffiti	1	0.060648	-0.224010	0.012533	-0.010228	-0.44418	-0.033085
pothole		1	0.026363	-0.131044	0.038271	-0.029724	0.116351
vacant			1	0.205762	-0.336279	0.320624	0.221609
spend				1	-0.105018	0.270396	0.263001
crime					1	---	---
					crime: CAP	1	---
					crime: NON-CAP		1

Spearman List Rank Correlation
All Wards (sorted)
(1.0 = perfect positive, -1.0 = perfect negative)

	graffiti	pothole	vacant	spend	crime	cap	noncap
graffiti	1	-0.442424	0.18182	0.272727	-0.56363	--0.41818	-0.745455
pothole		1	0.20000	-0.490909	0.769697	-0.175758	-0.418182
vacant			1	0.260606	-0.054545	0.418182	-0.163636
spend				1	-0.103030	0.369697	-0.030303
crime					1	---	---
					crime: CAP	1	---
					crime: NON-CAP		1

Spearman List Rank Correlation
Top Ten Wards (sorted)
(1.0 = perfect positive, -1.0 = perfect negative)

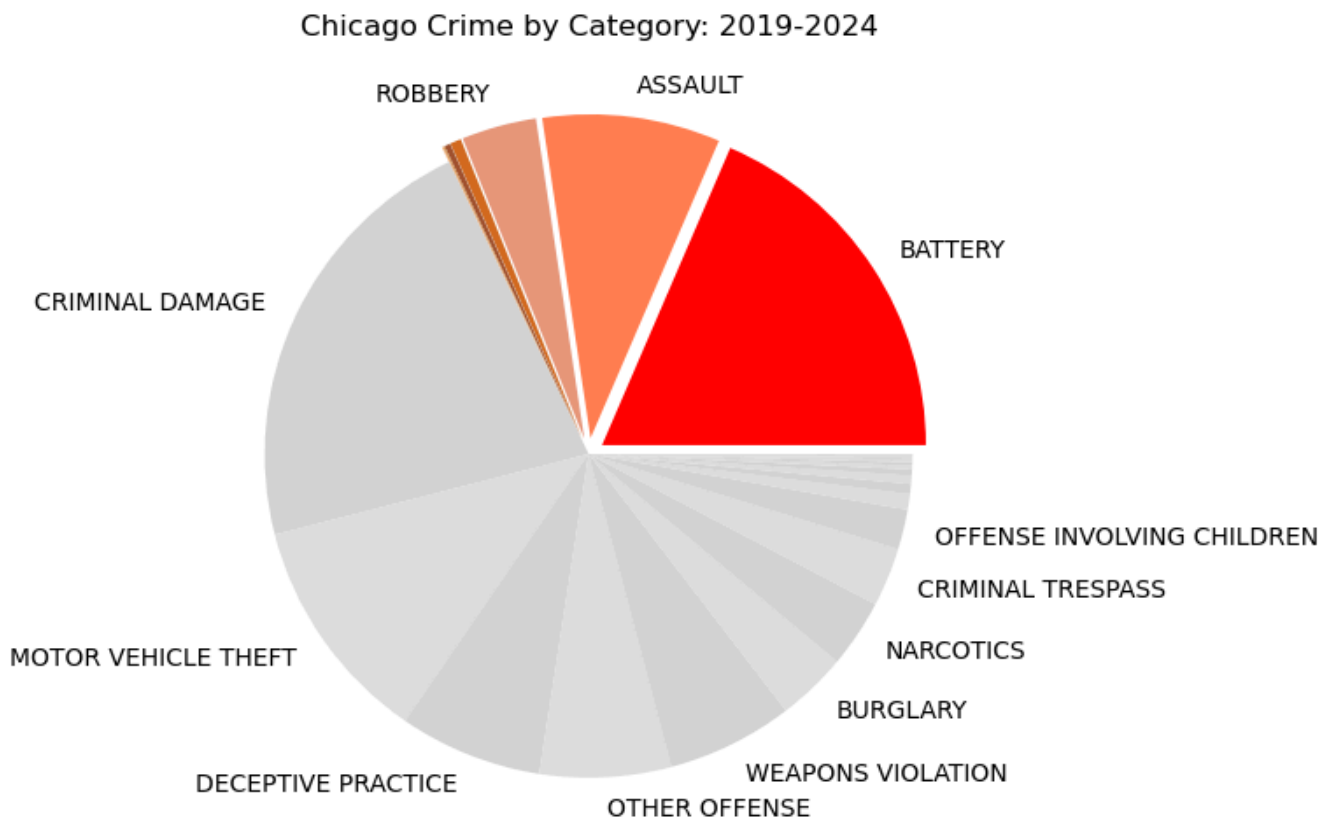
Limitations of Spearman = Small change in values can change the list rank, and affect the SRC.

The linear regression analysis indicates a clear link between vacancy and crime, while the Spearman Rank Correlation (SRC) shows no significant correlation. However, when crime is divided into CAP (Crimes Against Persons) and non-CAP categories, a correlation between vacancy and crime becomes evident, even though total crime is a combination of both. These results suggest that SRC may not fully capture the relationship, and caution should be exercised when using it to interpret these types of data.

A **pie chart** proportionally displays the categories of crimes tracked by the Chicago Police Department. Crime reports are assigned to one of thirty-four so-called 'primary types'. Different types of crime might affect disinvestment unequally. In particular, crimes against persons (CAP crimes: assault, battery, robbery, homicide, criminal sexual assault, and kidnapping), impose a greater burden of psychological trauma, and thus, they might have disproportionate impact. CAP and Non-CAP crime data were segregated and CAPS visualized with color for emphasis with labels for infrequent CAPs and non-CAPS omitted for legibility (Figure 12). CAP crimes represent roughly one third of total crime. The counts for each CAP are:

- battery: 252, 277
- assault: 120,324
- robbery: 50,656
- criminal sexual assault: 7,435
- homicide: 3,922
- kidnapping: 700

Figure 12.



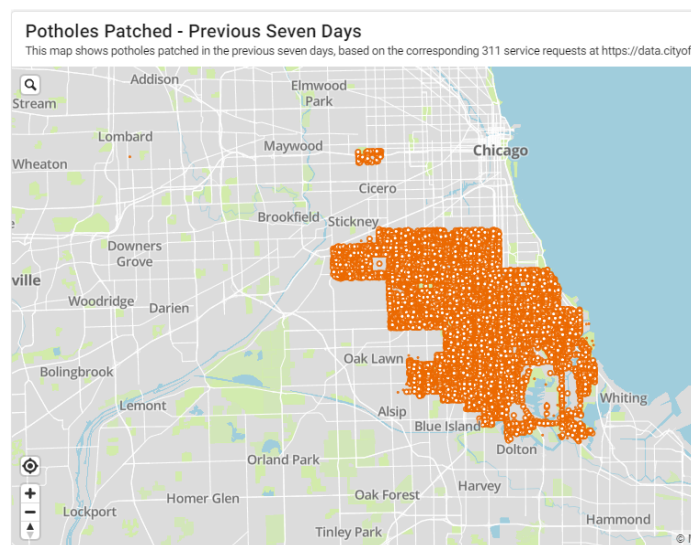
6. Data Analysis & Results - PART 2

- **How are pothole repair requests relevant to the crime types present in the area?
Examining the quality of the city streets and how it relates to crime by ward.**

Potholes appear mostly on arterial streets (which carry the most vehicles), and under bridges and viaducts, areas where water often collects. After receiving 311 notifications of needed pothole repairs, the Chicago Department of Transportation (CDOT) uses a computerized mapping and tracking system to identify pothole locations and schedule crews most efficiently. Using that map, managers determine routings for each crew that will allow them to fill the most potholes possible. Night and weekend crews repair high-traffic areas when traffic is lightest, which maximizes efficiency and minimizes traffic impacts.

CDOT's priority is arterial streets—larger streets that carry tens of thousands of vehicles daily will take priority over a residential street that carries far fewer vehicles. However, all potholes are important and every pothole reported to 311 will be fixed. The amount of time it takes to be fixed varies, but repairs are reported to be generally completed within 3-6 days from the first report of a pothole to 311. Weather influences how long a repair takes--especially when frigid temps and precipitation prevent crews from performing their tasks. The location of the pothole also influences the time required to repair--arterial streets are completed before residential streets. During peak winter months, duration times usually rise.

Figure 13.

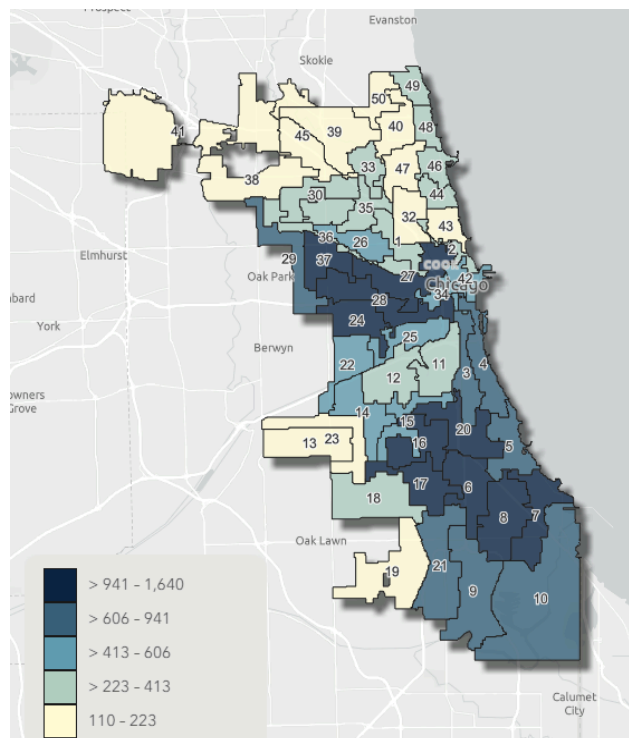


The 311 call portal documents the time complaints were placed and the actual date and time the potholes were repaired. Although some reports are valid, there are many complaints that services were never rendered.

Residential street resurfacing is funded by local tax dollars, while most arterial street resurfacing and reconstruction is funded by state and federal sources. Lower tax paying residences may have a prolonged wait in getting their potholes filled due to financial and resource deficits.

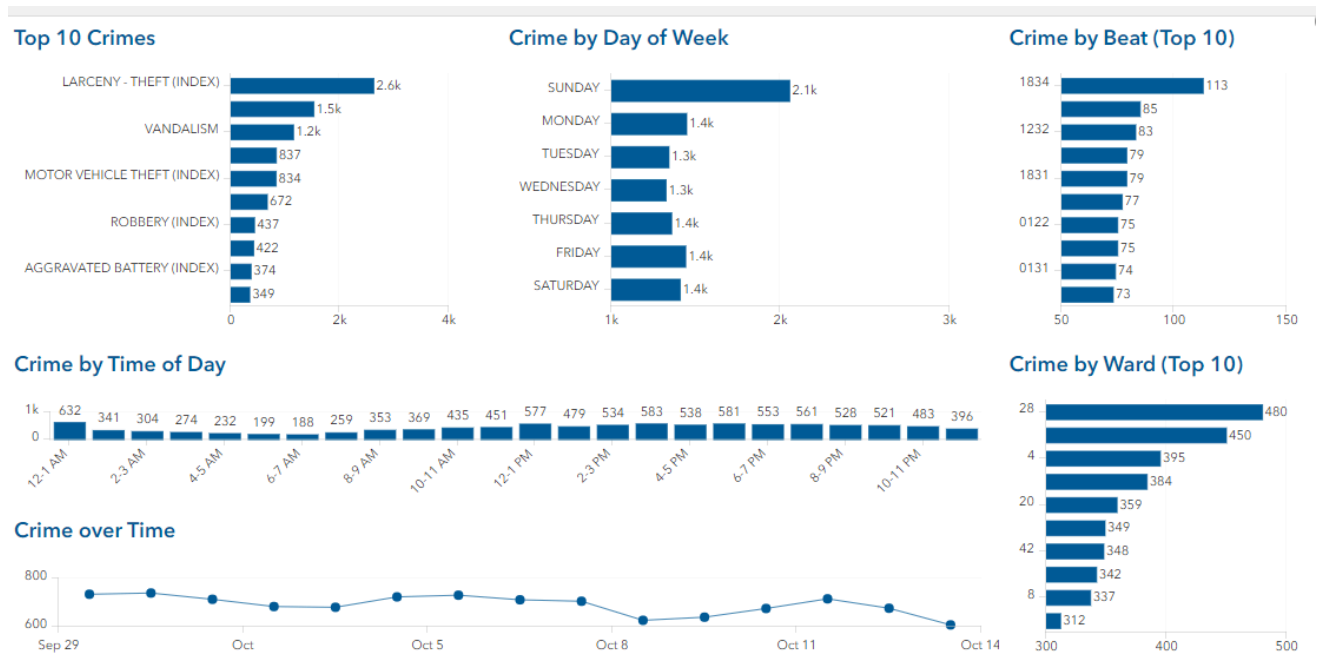
- **Crime**
 - Crime in Chicago correlates with neighborhoods. A number of factors contribute to this, including poverty, unemployment, and lack of access to education.
- **Socioeconomic factors**
 - Poverty and unemployment are strongly correlated with crime rates in Chicago. Neighborhoods with high poverty rates, like Englewood and Washington Park, are more likely to experience violent crime.
- **Neighborhood disparities**
 - Even within the same race, income inequality can impact homicide rates.
- **Location**
 - Some neighborhoods are more likely to experience violence than others. For example, in 2021, police districts 5, 6, 11, 12, and 15 accounted for 42% of Chicago's homicides, and some of the neighborhoods in these districts include Auburn Gresham, Austin, Chatham, East Garfield Park, and Humboldt Park.
- **Social disorganization theory**
 - This sociological theory suggests that crime is largely the result of unfavorable conditions within a community.

Figure 14.



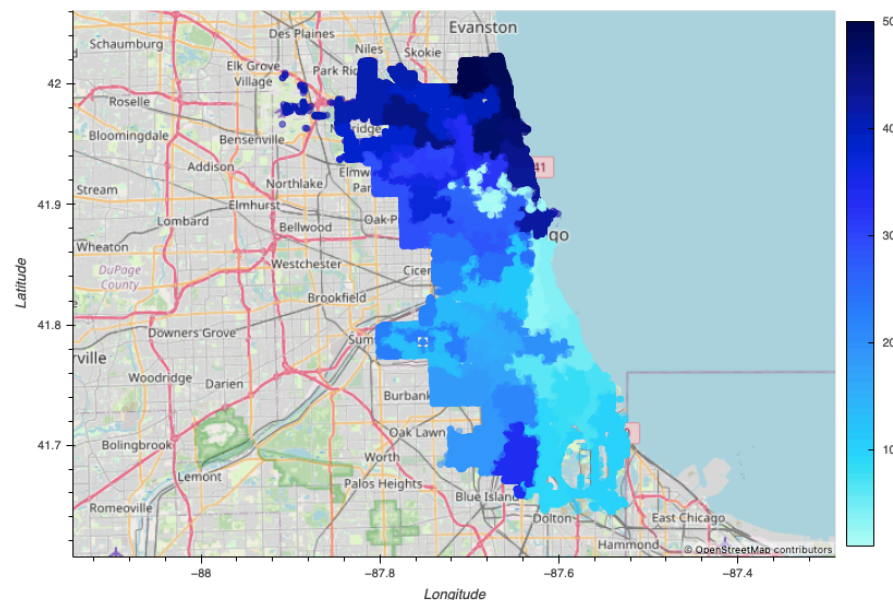
CRIME REPORTED BY WARD

Figure 15.



Mapping and Visualization: Use geospatial tools to map out pothole fill requests by ward.

Figure 16. Potholes Location in Chicago Per Ward



- **Discussion:**
 - Interpretation of Results: There isn't much evidence that potholes directly relate to crime in Chicago: the r^2 value is 0.04.

8. Data Analysis & Results - PART 3

- How are graffiti removal requests relevant to the crime types present in the area?

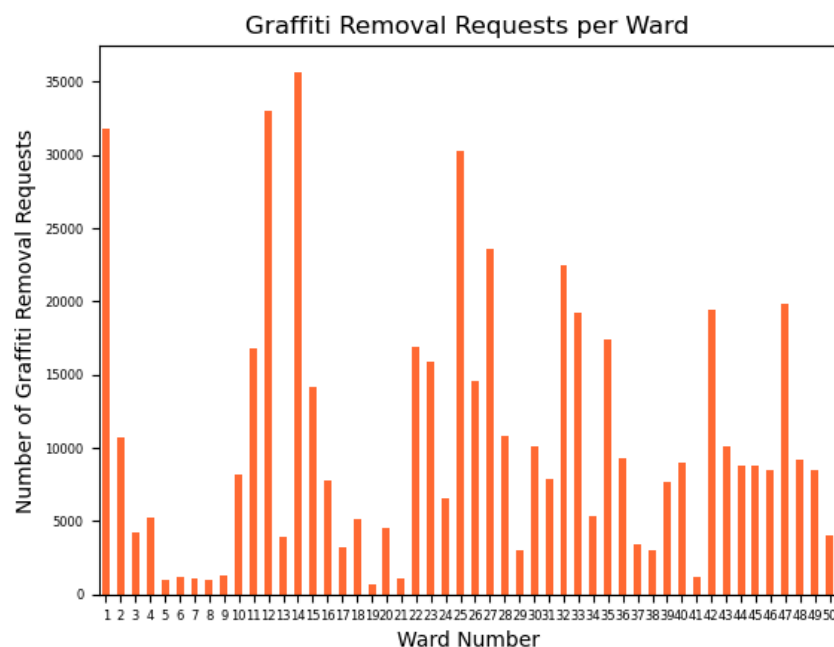
Examining the presence of graffiti and how it relates to crime by ward.

- **Indicator of Neighborhood Health:** Frequent graffiti can signal a lack of resources or community investment. For example, if graffiti removal requests are consistently high in a specific ward, it might indicate that the local government or community does not have sufficient resources to maintain public spaces. This neglect can foster conditions that contribute to higher crime rates, such as loitering, vandalism, or drug-related activities.
- **Gang-Related Graffiti:** In some cases, graffiti may be used by gangs to mark territory or communicate messages. An increase in gang-related graffiti could indicate areas where gang activity is more prevalent, which may correlate with higher rates of violent crime, such as assaults, shootings, or homicides.
- **Distinguishing Between Art and Vandalism:** Not all graffiti is illegal or a sign of disorder. Some wards might have thriving street art scenes that are part of the local culture. Differentiating between illegal graffiti and sanctioned street art can be challenging but is important to avoid misinterpreting data.

Determining if graffiti is found to be closely linked crime rates, can inform where to allocate resources within each ward. By examining how graffiti removal requests correlate with crime across Chicago wards, we can uncover deeper insights into how physical signs of disorder are related to broader social and criminal issues.

Statistical Findings:

Figure 17. Graffiti Removal Requests per Ward



Figures 18 and 19. Top 10 Wards by Graffiti Removal Requests & Top 10 Wards by Crimes Reported

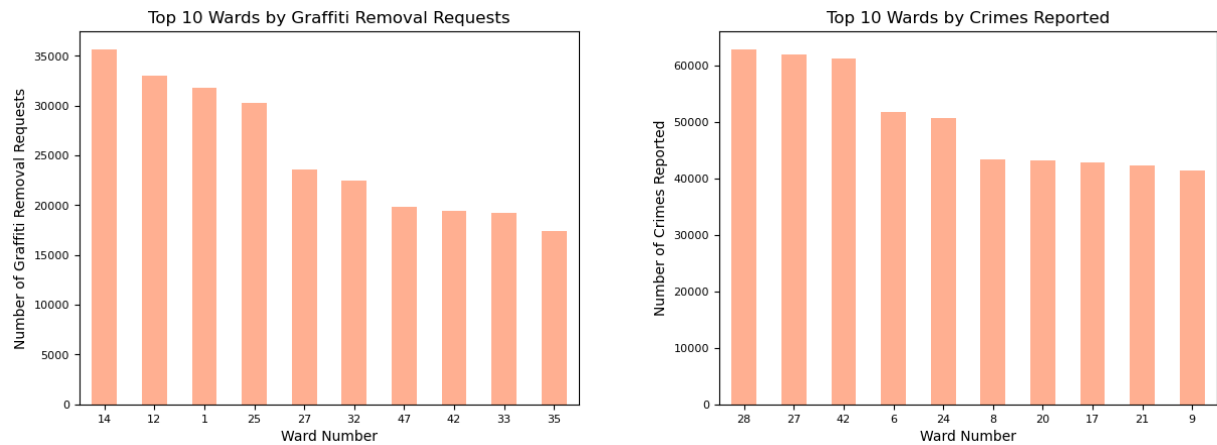
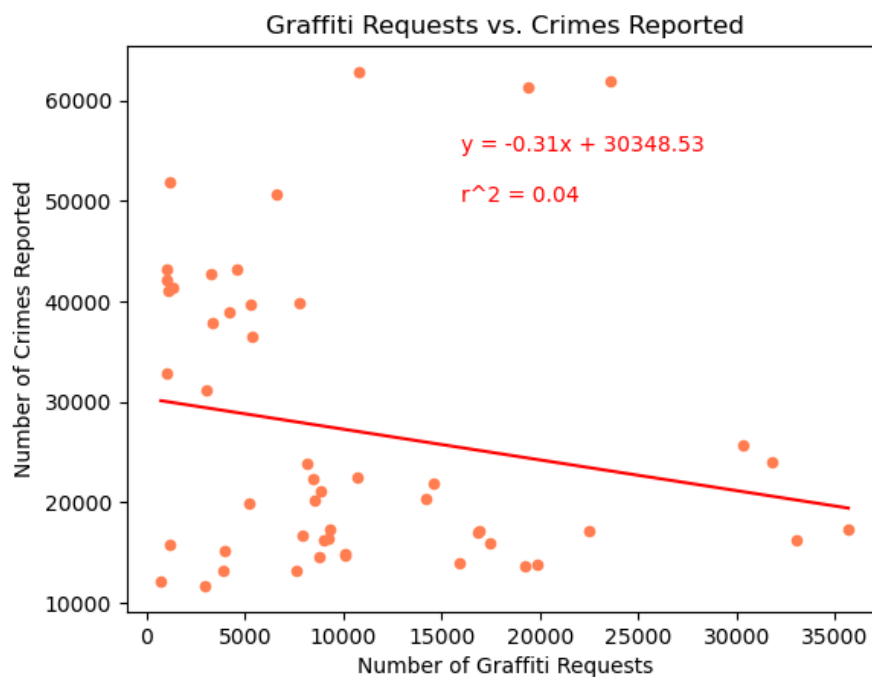


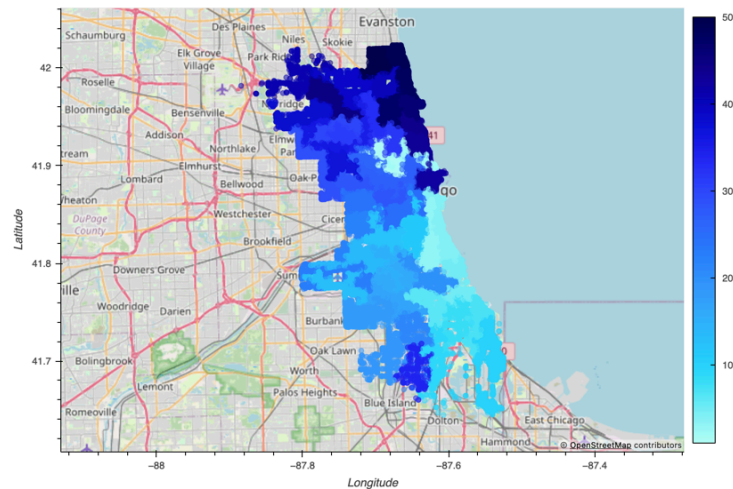
Figure 20. Correlation between Graffiti Requests vs. Crimes Reported



The correlation between graffiti removal requests and the crime rate is 0.04.

- **Mapping and Visualization:** Use geospatial tools to map out graffiti removal requests by ward. The shade of the color corresponds to the ward number (50 wards in Chicago, hence, 50 shades of blue are displayed on the map)

Figure 21. Map of Graffiti Removal Request per ward



- **Results Discussion:**

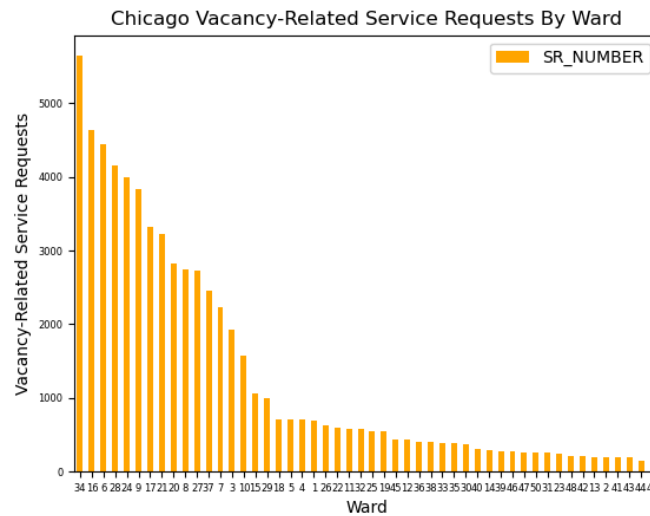
- There was not a direct correlation between the wards with the highest reported graffiti removal requests and the wards with the highest crime rates. I analyzed the top ten wards in both categories and there were only two wards that both were elevated (ward numbers 27 and 42). Therefore, there was only a 20% correlation in the top ten wards.
- Overall, there was a negative correlation between crime and graffiti within the last five years.
 - Number of crimes reported range: 11,708 to 62,857
 - Number of graffiti removal requests: 719 to 35,679
 - Correlation coefficient = 0.04

7. Data Analysis & Results - PART 3

- **How are Vacant/Abandoned Building Complaints or Clean Vacant Lot Requests relevant to the crimes present in the area? Examining the complaints and requests and how it relates to crime by ward.**
 - Vacant/Abandoned Building Complaints are complaints regarding the presence of vacant/abandoned buildings, as well as suspected activity occurring at such sites. These 311 service requests are routed to the City of Chicago's Department of Buildings. Vacant or abandoned buildings can be a sign of population drain and general municipal disinvestment—this supports the “broken windows” theory. Activity in or around vacant buildings can go largely unnoticed in areas with lower populations, and can pose issues in areas with higher population density, as these sites are ideal for gang activity or other disruptive behavior.
 - Clean Vacant Lot Requests: Trash on vacant lots can be an indicator of city disinvestment (no regular upkeep). This type of 311 service request goes to the City of Chicago's Department of Streets & Sanitation.

- **Results Discussion:**
 - Number of vacant buildings/lots complaints: 127 to 5,643
 - Number of crimes reported range: 11,708 to 62,857
 - Correlation coefficient = 0.56
- **Statistical Findings:**

Figure 22. Vacant/Abandoned Building Complaints per Ward



Figures 23 & 24. Top 10 Wards by Vacant/Abandoned Building Complaints & Top 10 Wards by Crimes Reported

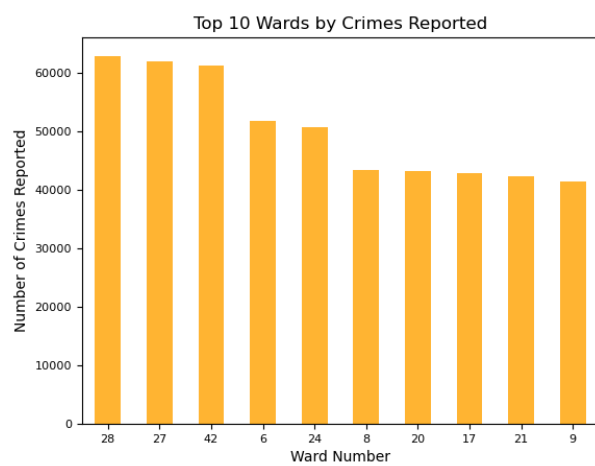
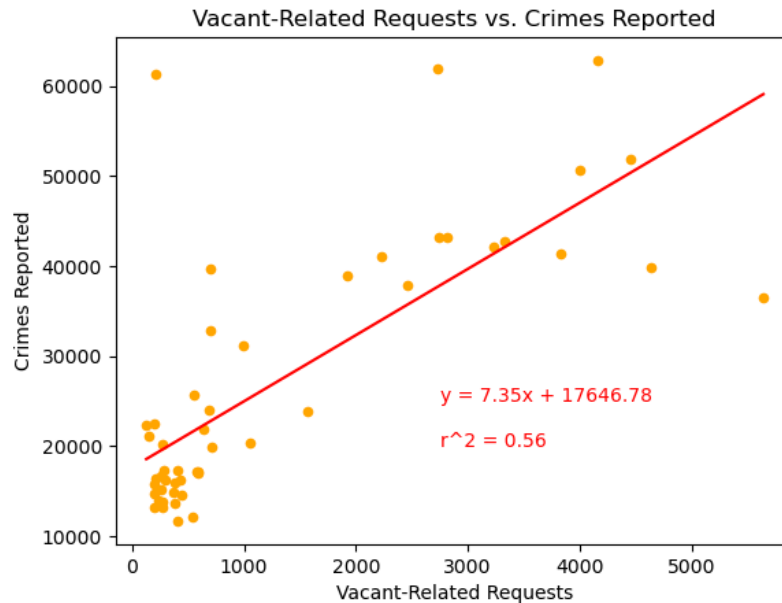
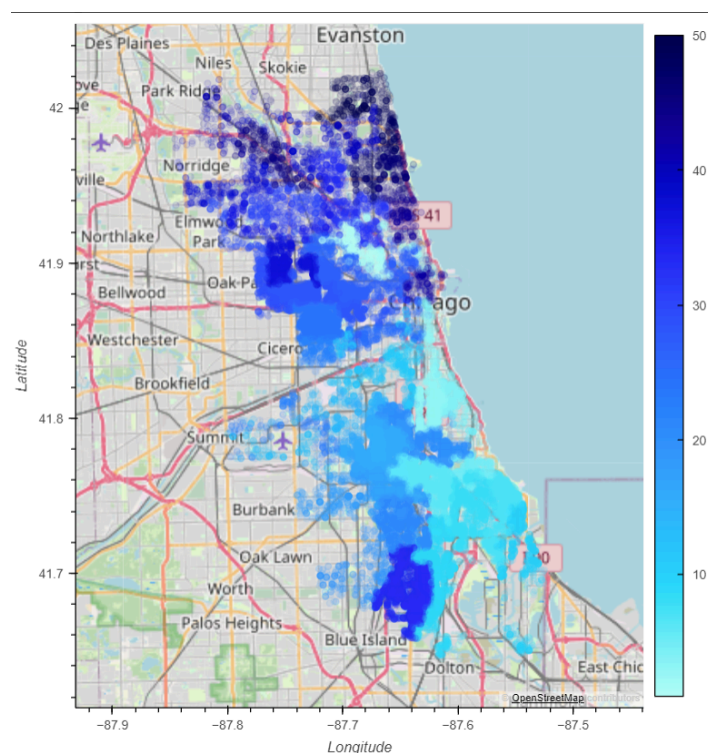


Figure 25. Correlation between Vacant/Abandoned Building Requests vs. Crimes Reported



- Mapping & Visualization:** Vacant Building/Lot Complaints in each ward. The shade of the color corresponds to the ward number (50 wards in Chicago, hence, 50 shades of blue are displayed on the map) and the transparency of the color corresponds with the number of complaints. More densely-colored areas signify a greater number of complaints. From the below visualization, one can see that the west, south, and southeast neighborhoods of Chicago have the most solid coloration, indicating that these are the areas with the highest number of vacancy-related 311 service requests.

Figure 26. Vacant Building/Lot Complaints per ward



- **Results Discussion:**

Figure 27.

Top 10 Vacancy & Crime Report Wards Comparison										
Vacancy Wards	34	16	6	28	24	9	17	21	20	8
Crime Wards	28	27	42	6	24	8	20	17	21	9

- Interpretation of Results: there is a relatively stronger correlation between vacant building/lot requests and crime reports, as shown by the r^2 value being 0.56, and is further corroborated by comparing the top 10 wards with crime reports with the top 10 wards with vacant building/lot complaints. As shown in the figure above, eight of the top 10 wards with vacant building/lot complaints are wards in the top 10 for number of crime reports.
- Alternative Narratives or Confounding Variables: both crime reports and 311 service requests rely on an “awareness” factor; crimes, for example, must either be discovered or otherwise made known (e.g., tip line, 911 call, complaint) to the Chicago Police Department in order to be entered into the crime database. Similarly, 311 service calls’ creation are biased toward “concerned citizens” who could have an above-average knowledge of local crime data or additional motivation to improve their surrounding infrastructure through the 311 system.

10. Conclusion

- **Summary of Findings:** Recap the main findings and their implications. Highlight the most significant results that either support or refute your hypothesis. Ensure you clearly explain the data visualizations and their implications.
 - **Crime Distribution:** Across all 50 wards in Chicago, the ratio of Crimes Against Persons (CAP) to Non-CAP is approximately 2:3. Approximately two-fifths, or 40% of crimes in each ward involve offenses against individuals, regardless of ward location or other potential socioeconomic factors. This suggests a fairly uniform distribution of violent versus non-violent crimes throughout the city.
 - **Graffiti and Pothole Complaints:** The analysis showed no significant correlation ($r^2 = 0.04$) between the number of graffiti or pothole complaints in Chicago wards and the number of crimes reported in those wards. This suggests that these particular infrastructure issues do not have a strong direct link to overall crime rates. However, this could be influenced by unexamined variables, such as gang activity or median household income, which might play a more significant role in shaping crime patterns.
 - **Vacant Building and Lot Service Requests:** A relatively stronger correlation ($r^2 = 0.56$) was found between the number of vacant building and vacant lot service

requests in Chicago wards and the number of crimes reported in those wards. This indicates that areas with higher numbers of neglected or abandoned properties tend to experience more crime. Several uninvestigated factors, including gang activity and possible biases (e.g., residents' awareness of 311 services), could be influencing this relationship. Residents who are more knowledgeable about city services might be more inclined to report issues, potentially skewing the data.

Overall, the findings suggest that certain indicators of disinvestment, specifically the presence of vacant buildings and lots, may have a stronger association with crime than other factors like graffiti or pothole complaints. **Our hypothesis that infrastructure deficits would not directly correlate with crime was mildly supported, the relationship between neglected properties and higher crime rates points to potential areas for further investigation.** Addressing vacant and abandoned properties could be a more effective strategy for reducing crime than focusing solely on other forms of infrastructure repair. Future research could benefit from considering additional variables, such as socioeconomic conditions and gang presence, to gain a more comprehensive understanding of crime patterns in Chicago.

- **Limitations & Challenges:**

- Difficulty managing larger datasets and uploading information to GitHub
- Utilizing GitHub throughout the project analysis was challenging
 - This could be mitigated if we determine file naming syntax and organization as a group up front for uniformity throughout
- An outlier was observed during the geomapping of the crime dataset that would not have been observed otherwise - this was an error that would not have been noticed otherwise and skewed the data for that image

- **Future Research Directions:**

- Since wards are tied to political representation, data on crime, infrastructure requests, and socio-economic conditions, examining the individual crime types per ward and the financial distribution breakdown could help understand how political actions and decisions impact local issues.
- Take a closer look at connections between crime, 311 service requests, and income data or other indicators of household-based economic health, possibly using the Census API.
- Look into any existing Chicago initiatives focused on graffiti removal or neighborhood beautification. For example, the "Graffiti Blasters" program, which aims to remove graffiti quickly, could be examined to see if it correlates with any changes in crime statistics by ward.
- Analyzing graffiti removal requests in conjunction with reports of gang-related incidents can help identify wards where gang presence is a significant factor. Similarly, analyzing vacant building complaints could help identify wards where such sites are hotspots for gang activity.
- Investigating the possible correlation between pothole & vacancy requests and the real estate industry (median home price, etc) to make steps toward

recommendations on where city money might be spent to best advantage potential home sellers and buyers.

- In this analysis, we looked at data from the past 5 years. Given more time and/or stronger computing power and memory, we would be able to analyze data from a longer period of time, such as the past 10 years or even the past 15 years for a fuller picture. With a larger dataset of crimes and 311 service requests (including cleaning up & standardizing legacy data from pre-2018 311 service requests), we would potentially be able to draw more trend-based conclusions before and after COVID-19, as well as analyze a fuller picture of Chicago's crime and spending environments.
- Investigate the differences and significance between CAP (crimes against persons) vs non-CAP (crimes not against persons) crime classifications as they relate to 311 service requests.

11. References

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