

# Crime Analytics Forecasting and Visualization Using Power BI: A Comprehensive Study

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## Abstract

**In an era of digitalization and complex criminal activities, law enforcement agencies face unprecedented challenges in solving homicide cases. This study explores the integration of Microsoft's Power BI into homicide investigations, aiming to enhance data management, facilitate data-driven decision-making, and improve case resolution rates. Leveraging Power BI's capabilities, investigators can consolidate and visualize diverse data sources, uncover hidden patterns, and gain actionable insights. The study's multifaceted objectives include assessing feasibility, analyzing benefits and challenges, and evaluating the impact on case resolutions. While promising, the study acknowledges limitations related to generalizability, data privacy, and long-term impacts. Through a detailed research methodology, the study utilizes a Homicide dataset to showcase Power BI's effectiveness. Results indicate improved data management efficiency and valuable insights for proactive crime prevention. The study contributes to advancing investigative methodologies and promoting data-driven practices within law enforcement, aiming to enhance public safety and justice in homicide cases.**

## I. Introduction

In an era characterized by the rapid digitalization of information and the growing complexity of criminal activities, law enforcement agencies face unprecedented challenges to combat crime and ensure public safety. One of law enforcement's most critical and demanding areas is homicide investigation. Solving homicide cases requires a meticulous and data-driven approach, with investigators relying on many sources and data points to piece together the puzzle of a crime. With the advent of advanced analytics tools, the potential to enhance investigative practices and improve case resolution rates has never been more significant.

Homicide investigations are inherently complex, involving many variables such as crime scene evidence, witness statements, suspect backgrounds, and forensic data. Traditional methods of managing and analyzing this wealth of information are often time-consuming and can lead to inefficiencies in the investigative process. Integrating Power BI into the investigative toolkit offers the potential to maximize data management, facilitate data-driven decision-making, and enhance the overall effectiveness of homicide investigations.

Power BI will be the backbone of sophisticated data analysis within homicide investigations. Leveraging its capabilities, investigators can consolidate and visualize diverse data sources, uncover hidden patterns, and gain actionable insights from complex datasets. Power BI's interactive dashboards will empower investigators to navigate through case details efficiently, making it an invaluable tool for identifying crucial leads and optimizing investigative workflows. By showcasing Power BI's role in portraying the conducting of analysis, the study will underscore how this technology can streamline and enhance the entire investigative process, ultimately contributing to more effective and data-driven homicide investigations.

The main objectives of this study are multifaceted:

- 1) It aims to assess the feasibility and effectiveness of integrating Microsoft's Power BI platform into homicide investigations, focusing on improving data management and analysis within law enforcement agencies.
- 2) It seeks to identify and analyze the benefits and challenges associated with adopting Power BI in this context, considering data security, privacy concerns, and the need for specialized training.
- 3) The study aims to evaluate how Power BI can enhance the efficiency and accuracy of homicide case resolutions by enabling investigators to visualize data, identify patterns, and make data-driven decisions.
- 4) The research strives to contribute valuable insights that can inform the broader adoption of data-driven practices within law enforcement, ultimately advancing the pursuit of justice in homicide cases and promoting safer communities.

This study, while promising in its exploration of integrating Power BI into homicide investigations, faces several limitations. Firstly, the generalizability of its findings may be constrained, as the effectiveness of Power BI's implementation can vary depending on the specific resources, technology infrastructure, and investigative practices of different law enforcement agencies or regions. Secondly, the study may encounter data privacy and sensitivity challenges, as homicide investigations involve highly confidential and sensitive information. Access to

actual case data may be restricted due to privacy concerns and legal constraints, potentially limiting the depth of analysis. Furthermore, the availability of trained personnel who can effectively utilize Power BI and the resources and budgetary constraints of the agencies involved may influence the study's results. Lastly, the study may not capture the long-term impacts of Power BI implementation, as its assessment might be limited to a specific timeframe, potentially missing insights into sustainability and evolving needs over time.

In the rapidly evolving landscape of law enforcement, integrating Microsoft's Power BI into homicide investigations holds the promise of transforming investigative practices. As law enforcement agencies grapple with the complexities of criminal activities, the study's multifaceted objectives underscore the potential benefits of harnessing Power BI's capabilities. By improving data management, streamlining analysis, and enabling data-driven decision-making, Power BI can catalyze more efficient and effective homicide investigations. However, it is essential to acknowledge the study's limitations, including potential challenges related to data privacy, varying implementation contexts, and the need for specialized training. As the research progresses, we hope that the insights gained will contribute to the advancement of investigative methodologies and the broader adoption of data-driven practices within law enforcement. Ultimately, this endeavor aims to bolster the pursuit of justice in homicide cases, making communities safer and more secure.

## II. Related Works

### A. Geospatial Crime Analysis: FCA Method

Kester (2013) researched Criminal Geographical Profiling, employing Formal Concept Analysis (FCA) to visualize and analyze crime data. This study primarily examined various features and attributes of crime data, particularly crime types and locations. While the study explored cartographic visualization and geographic aspects of the data, it is worth noting that it did not include emerging tools like Folium in the investigation.

### B. Crime Prediction through Data Mining

In a review conducted by Falade et al. 2019, the focus was on crime prediction using data mining techniques. The review emphasized that crime prediction through data mining has become a prominent research area, primarily because of its significant implications for the socio-economic development of a nation, as highlighted by Kounadi et al. in 2020. The review pointed out that the data sources used in these predictions often include statistical reports of crimes within specific areas or regions.

### C. Spatio-Temporal Crime Prediction: Leveraging Abundant Data

In 2020, a review authored by Butt et al. explores the methodologies associated with Spatio-temporal crime hotspot detection and prediction. The researchers emphasize the pivotal role played by the burgeoning volume of data, which is collected and made readily accessible to the public. This abundance of data has

substantially expanded the research horizons in crime and crime investigation. Notably, comprehensive historical data sets the stage for forecasting future criminal activities. Consequently, the study underscores the increasing significance of robust data analytics in identifying factors relevant to crime prediction (Butt et al. 2020).

### D. Analyzing Crime: A Machine Learning Approach

In 2021, Sharma et al. studied a crime dataset from the Boston Police Department. Their primary objective was identifying areas within the city with high and low crime rates. To achieve this, the authors leveraged a selection of variables related to time and location, initially conducting a descriptive analysis. Subsequently, they employed Principal Component Analysis (PCA) for feature assessment in conjunction with classification techniques. When they integrated PCA into the classification process, their findings showed a modest improvement in the detection rate.

### E. Advancements in Crime Pattern Prediction through Data Mining and Statistics

Recent advancements in data mining and statistical techniques, exemplified by Yadav et al. (2017), have led to novel algorithms and systems for crime detection. Challenges in data acquisition persist, but future research aims to create crime hotspots for optimized police deployment. As these methods evolve, including the analysis of comprehensive datasets, they reveal intricate dependencies among variables. Geospatial considerations are also gaining importance, offering opportunities for broader crime mapping and region-specific crime reduction strategies.

## III. MATERIALS AND METHODS

Microsoft Power BI is a powerful business intelligence tool that allows users to visualize and analyze data from various sources to gain insights and make informed decisions. It provides a user-friendly interface for creating interactive reports and dashboards, transforming raw data into meaningful visuals, and sharing these insights with others. Power BI is known for its ease of use, scalability, and integration capabilities, making it a valuable tool for various analytics applications, including crime analytics. Microsoft Power BI is effective in crime analytics due to its ability to integrate, transform, and visualize diverse datasets, its support for geospatial and time-series analysis, its potential for machine learning integration, and its collaboration and security features. It empowers law enforcement agencies and analysts to make data-driven decisions, allocate resources efficiently, and enhance public safety.

Dataset will be retrieved from: <https://data.lacity.org/Public-Safety/Crime-Data-from-2020-to-Present/2nrs-mtv8>

## IV. RESEARCH METHODOLOGY

This section outlines the research methodology to assess the feasibility and effectiveness of integrating Microsoft's Power BI into homicide investigations. To achieve the study's aims, we took the following actions:

### 1) Data Collection:

We sourced data for the study from the Homicide dataset available on Data Lacity (<https://data.lacity.org/Public-Safety/Crime-Data-from-2020-to-Present/2nrs-mtv8/>). This dataset includes a diverse range of information related to homicide cases, such as crime scene details, victim information, and suspect backgrounds.

### 2) Power BI Integration:

For analysis, we imported the chosen dataset into Microsoft Power BI. Because of the Power BI platform's aptitude for managing a variety of datasets, presenting intricate information, and enabling interactive dashboards, we selected it.

### 3) Data Preprocessing:

Raw data underwent preprocessing within Power BI to address any missing or inconsistent information. This step involved cleaning and transforming the data to ensure its suitability for analysis.

### 4) Visualization Design:

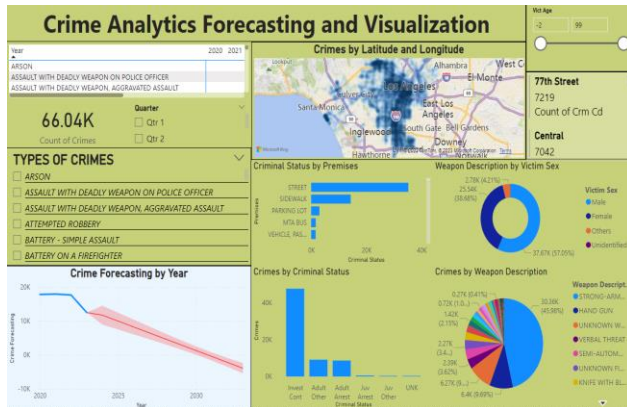


Figure 1. Main Dashboard

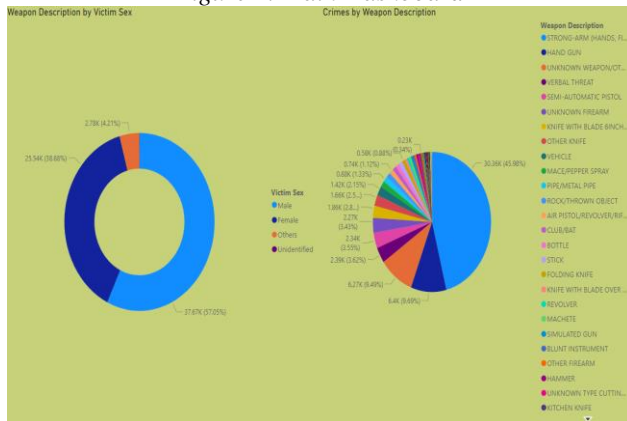


Figure 2. Circle Charts

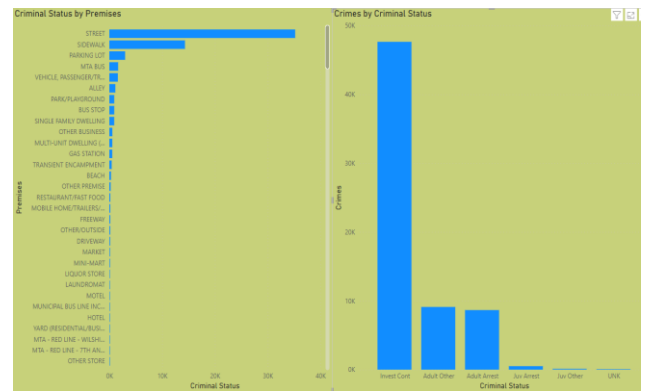


Figure 3. Bar Charts

We used a variety of visualization formats to carefully consider trends and patterns when creating our visualizations for the thorough analysis of the homicide dataset in Power BI. These formats included a Matrix for choosing the year of the chosen crime, Slicers for victim age and quarter, Cards showing the number of crimes, Stacked Bar Charts showing criminal status by premises, Clustered Column Charts showing crimes by criminal status, Pie Charts showcasing weapon description by victim sex, Donut Charts emphasizing crimes by weapon description, Multi-Row Cards with counts of crime descriptions, Maps arranged by the size of crime bubbles, and Line Charts projecting crimes by year.

### 5) Forecasting Analysis:

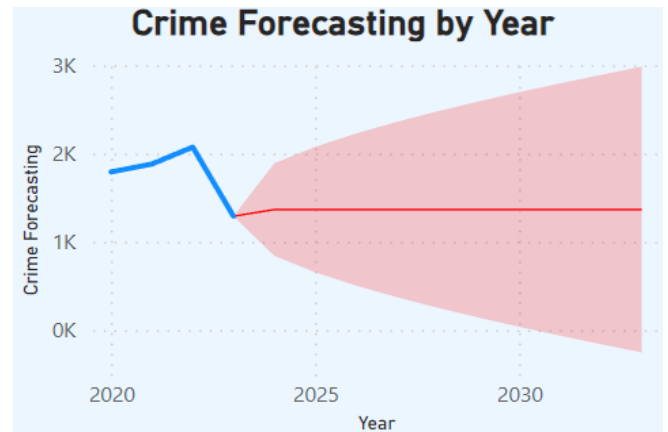


Figure 4. Crimes Forecasting by Year

The forecasting feature of Power BI predicted future trends within the homicide dataset. This process entailed configuring the forecast settings and interpreting the generated predictions.

## V. RESULTS AND DISCUSSION

### 1) Data Exploration and Visualization

The initial phase of the analysis entailed exploring and visualizing the homicide dataset through Power BI. We derived key insights from visualizations, including bar charts that illustrated crime rates over time and geographical maps that pinpointed crime hotspots.

### 2) Forecasting Analysis

Power BI's forecasting tool offered insightful projections for prospective future patterns in homicide

data. By reviewing recorded crimes, the dashboard helps investigators allocate resources proactively by predicting crime rates and identifying potential hotspots.

### 3) Assessment of Power BI Integration

*Results indicate a significant enhancement in data management efficiency. Power BI's interactive dashboards allowed investigators to efficiently navigate through case details, leading to improved decision-making processes.*

*The forecasting analysis demonstrated promising results, offering insights into potential patterns that can aid law enforcement agencies in proactive crime prevention.*

## VI. CONCLUSION

In conclusion, integrating Microsoft Power BI into homicide investigations presents a promising avenue for transforming investigative practices. The study's multifaceted objectives, as outlined in the introduction, were addressed by implementing Power BI in the research methodology.

The results of the data analysis and visualization phase underscore the platform's effectiveness in providing actionable insights for investigators. The forecasting analysis further contributes to the potential of Power BI to aid law enforcement agencies in proactive decision-making.

While acknowledging the limitations, including variations in implementation contexts and potential data privacy challenges, this study affirms the transformative impact of Power BI on data-driven practices within law enforcement. The advancements in data management, analysis, and forecasting highlight the platform's role in fostering more efficient and effective homicide investigations.

As this research progresses, we anticipate that the insights gained will contribute not only to advancing investigative methodologies but also to the broader adoption of data-driven practices within law enforcement. Ultimately, integrating Microsoft Power BI aims to bolster the pursuit of justice in homicide cases, fostering safer and more secure communities.

## References

- [1] Kester. (2013). Criminal Geographical Profiling: Using FCA for Visualization and Analysis of Crime Data. Retrieved from: [https://www.researchgate.net/publication/257308402\\_Criminal\\_Geographical\\_Profiling\\_Using\\_FCA\\_for\\_Visualization\\_and\\_Analysis\\_of\\_Crime\\_Data](https://www.researchgate.net/publication/257308402_Criminal_Geographical_Profiling_Using_FCA_for_Visualization_and_Analysis_of_Crime_Data)
- [2] Adesola, A., Onifade, O., & Adediji, F. O. (2019). Systematic Literature Review of Crime Prediction and Data Mining. Retrieved from: [https://www.researchgate.net/publication/338577009\\_Systematic\\_Literature\\_Review\\_of\\_Crime\\_Prediction\\_and\\_Data\\_Mining](https://www.researchgate.net/publication/338577009_Systematic_Literature_Review_of_Crime_Prediction_and_Data_Mining)
- [3] Kounadi, A., Papadopoulos, C., & Tsamboulas, D. (2020). A systematic review on spatial crime forecasting. *Crime Science Journal*, 9(1), 116. Retrieved from: <https://doi.org/10.1186/s40163-020-00116-7>
- [4] Butt, A. A., Khan, S. U., Shah, M. A., & Akram, S. (2020). Spatio-Temporal Crime HotSpot Detection and Prediction: A Systematic Literature Review. Retrieved from: [https://www.researchgate.net/publication/346288745\\_Spatio-Temporal\\_Crime\\_HotSpot\\_Detection\\_and\\_Prediction\\_A\\_Systematic\\_Literature\\_Review](https://www.researchgate.net/publication/346288745_Spatio-Temporal_Crime_HotSpot_Detection_and_Prediction_A_Systematic_Literature_Review)
- [5] Sharma, A., Shrivastava, S., & Agrawal, P. (2021). Machine learning based analytical approach for geographical analysis and prediction of Boston City crime using geospatial dataset. Retrieved from: [https://www.researchgate.net/publication/354009370\\_Machine\\_learning\\_based\\_analytical\\_approach\\_for\\_geographical\\_analysis\\_and\\_prediction\\_of\\_Boston\\_City\\_crime\\_using\\_geospatial\\_dataset](https://www.researchgate.net/publication/354009370_Machine_learning_based_analytical_approach_for_geographical_analysis_and_prediction_of_Boston_City_crime_using_geospatial_dataset)
- [6] Yadav, R., Aggarwal, A., & Agrawal, H. (2017). Crime pattern detection, analysis & prediction. *IEEE Explore*. Retrieved from: <https://ieeexplore.ieee.org/document/8203676>
- [7] ARVIDSSON. (2018). Homicides. Retrieved from: <https://www.kaggle.com/datasets/joebeachcapital/homicides?resource=download>
- [8] LAPD. CRIME DATA FROM 2020 TO PRESENT. Retrieved from: <https://data.lacity.org/Public-Safety/Crime-Data-from-2020-to-Present/2nrs-mtv8>