Interactive Urban Analysis: Mapping Vulnerabilities and Citizen Complaints in Valencia

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Index

1 Summary

This project presents an interactive application designed to analyze and visualize the relationship between urban vulnerabilities and citizen complaints in the city of Valencia. Using open data from the Valencia Open Data portal, the application integrates various datasets to provide a comprehensive view of the city's dynamics. The tool features interactive maps and temporal graphs that help city officials, urban planners, and citizens understand and address urban challenges. By offering insights into the spatial distribution and temporal trends of vulnerabilities and complaints, the application facilitates data-driven decision-making, resource allocation, and community engagement. The application was developed using Streamlit, a powerful library for creating interactive web applications in Python.

2 Introduction

Cities are complex systems where social, economic, and environmental factors interact dynamically. Managing these interactions effectively is crucial for urban development and quality of life. One significant aspect of urban management is understanding the vulnerabilities within the city and how they correlate with citizen complaints. This understanding can guide policy-making, improve resource allocation, and foster community engagement.

This project leverages open data from the Valencia Open Data portal to create an interactive application that maps urban vulnerabilities and citizen complaints. The application aims to provide a tool for city officials, urban planners, and residents to explore and analyze these data interactively. By integrating spatial and temporal analyses, the application offers a detailed and comprehensive view of the urban landscape, highlighting areas that require attention and intervention.

3 Methodology

The methodology used in this report integrates a robust analytical approach, based on detailed data and advanced software tools, to assess the implications of different equity criteria on credit scoring. Each component of the methodology used is detailed below:

3.1 Data Acquisition

The primary data sources for this project are:

- Urban Vulnerability Data: Indicators of social, economic, demographic, and infrastructural vulnerabilities for various neighborhoods and districts in Valencia.
- Citizen Complaints Data: Records of citizen complaints, including suggestions, complaints, and reports to different authorities.

These datasets were downloaded from the Valencia Open Data portal.

3.2 Description of the Data Used

3.2.1 Urban Vulnerability Data

The urban vulnerability data was sourced from the Valencia Open Data portal. This dataset contains various indicators that measure the level of vulnerability across different neighborhoods and districts in Valencia. The key attributes of this dataset include:

- **Ind_Equip**: An index measuring the availability and quality of public facilities and infrastructure.
- **Ind_Dem**: A demographic index that assesses population characteristics such as age distribution and density.
- **Ind_Econom**: An economic index that evaluates factors like income levels, employment rates, and economic activities.
- **Ind_Global**: A composite index that provides an overall measure of vulnerability by combining the other indices.
- **Vul_Equip**: A categorical variable indicating the level of vulnerability related to public facilities and infrastructure (High, Medium, Low).
- **Vul_Dem**: A categorical variable indicating the level of demographic vulnerability.
- **Vul_Econom**: A categorical variable indicating the level of economic vulnerability.
- **Vul_Global**: A categorical variable indicating the overall level of vulnerability.

This dataset provides a comprehensive view of the structural, demographic, and economic conditions in different parts of the city, making it essential for understanding the broader context of urban vulnerabilities.

3.2.2 Citizen Complaints Data

The citizen complaints data was also obtained from the Valencia Open Data portal. This dataset includes records of various types of complaints filed by residents, categorized by their nature and the authority to which they were addressed. Key attributes of this dataset include:

- **tipo_solicitud**: The type of complaint or request (e.g., Síndic, Sugerencia, Queja, Otras, Defensor).
- **barrio_localización**: The neighborhood where the complaint was filed.
- **distrito_localización**: The district where the complaint was filed.
- **fecha_entrada_ayuntamiento**: The date when the complaint was submitted to the municipal authorities.
- **geo_shape**: The geographical shape data representing the boundaries of the neighborhoods and districts.

The complaints data provides insights into the specific issues and concerns raised by residents in different areas, allowing for an analysis of how these complaints correlate with urban vulnerabilities.

3.2.3 Data Citizen Complaints Data

To create a meaningful analysis, the urban vulnerability data was integrated with the citizen complaints data. This involved:

- **Geospatial Mapping**: Converting and simplifying the geographical shapes (geo_shape) to facilitate visualization.
- **Data Aggregation**: Grouping and aggregating data by neighborhood and district to calculate the average vulnerability indices and the total number of complaints.
- **Custom Data for Visualization**: Preparing custom data attributes for interactive tooltips in the visualizations, providing detailed information about each neighborhood and district's vulnerabilities and complaints.

By combining these datasets, the application offers a holistic view of the urban landscape in Valencia, highlighting areas with high vulnerabilities and frequent complaints. This integrated approach allows for a comprehensive analysis that can inform urban planning and policy decisions.

3.3 Data Preparation

1. **Data Cleaning**: The datasets were cleaned to handle missing values and ensure consistency. The geographical shapes of neighborhoods and districts were processed using GeoPandas to ensure accurate mapping.
2. **Data Transformation**: Vulnerability indices were mapped to corresponding neighborhoods and districts. Complaints data were grouped by location and type to facilitate analysis.

3.4 Data Integration

1. **Combining Datasets**: The cleaned datasets were merged to create a comprehensive dataset that included both vulnerability indices and complaints data.
2. **Geospatial Processing**: The geographical shapes (geo_shapes) were converted and simplified using the Shapely library to optimize them for visualization.

3.5 Visualization

1. **Interactive Maps**: Using Plotly, interactive choropleth maps were created to display various vulnerability indices and the density of complaints. These maps allow users to explore specific aspects of urban vulnerability and complaints by toggling between different layers.
2. **Temporal Analysis**: A line graph was created using Matplotlib to show the evolution of different types of complaints over time. This graph helps identify trends and patterns in citizen complaints.

3.6 Application Development

The application was developed using Streamlit, a Python library for creating interactive web applications. Streamlit was chosen for its simplicity and ability to create interactive components easily. The application was then deployed online, making it accessible to users via a web link.

3.7 Features

- **Interactive Maps**: Display different vulnerability indices (economic, demographic, infrastructural) and complaint densities with detailed tooltips.
- **Temporal Analysis**: Show the evolution of various types of complaints over time.
- **User Interaction**: Users can toggle between different layers of data and explore specific details through interactive tooltips.

By following this methodology, the project successfully created an application that provides valuable insights into the urban dynamics of Valencia, aiding in effective urban management and policy-making.

4 Originality and Innovation

This application stands out due to its innovative approach of integrating multiple dimensions of urban data, combining both spatial and temporal analyses to provide a comprehensive view of urban dynamics in Valencia. The unique feature of this tool lies in its ability to link urban vulnerabilities with citizen complaints, offering valuable insights into how different forms of urban stress may correlate with areas of citizen dissatisfaction and concern. This dual-faceted analysis not only enhances the understanding of the city's issues but also provides a more detailed and actionable framework for addressing urban challenges.

5 Benefits of the Application

5.1 Data-Driven Decision Making

City officials can leverage this tool to make informed decisions by prioritizing interventions in areas identified as having high vulnerabilities and a significant number of complaints. This targeted approach ensures that urban policies are more effective and responsive to the specific needs of different neighborhoods and districts.

5.2 Public Awareness

The application serves as a valuable resource for citizens, enabling them to gain a better understanding of the challenges faced by their neighborhoods. By visualizing vulnerabilities and complaints, the tool fosters a sense of community and encourages civic engagement, empowering residents to participate more actively in urban development and decision-making processes.

5.3 Resource Allocation

Urban planners can use the insights provided by the application to allocate resources more efficiently. By identifying hotspots of vulnerabilities and complaints, planners can focus their efforts and resources on the areas that need them the most, leading to more balanced and equitable urban development.

5.4 Trend Analysis

The temporal analysis feature of the application allows for the recognition of patterns and trends in citizen complaints over time. This capability aids in proactive urban management, enabling city officials to anticipate and address emerging issues before they escalate. By understanding the temporal dynamics of complaints, the city can implement timely interventions and improve overall urban resilience.

In summary, this application provides a powerful tool for enhancing urban management and planning through data-driven insights, fostering public awareness and engagement, and facilitating efficient resource allocation. Its innovative integration of spatial and temporal analyses sets it apart, making it an invaluable asset for addressing the complex dynamics of urban environments.

6 Conclusions and Recommendations

The application demonstrates how open data can be leveraged to address urban challenges. By providing an interactive platform for analyzing urban vulnerabilities and complaints, it facilitates better governance and community involvement. The insights generated by this tool can lead to more resilient and responsive urban environments.

6.1 Incorporate More Data Sources

Integrating additional datasets, such as environmental data or transportation data, could provide a more holistic view of urban dynamics. By including factors like air quality, traffic patterns, and public transportation usage, the application can offer a more comprehensive analysis of the various elements that influence urban living conditions. This broader perspective can help identify correlations and interactions between different urban factors, leading to more informed decision-making.

6.2 Predictive Analytics

Implementing machine learning models to predict future complaints or identify emerging vulnerabilities could significantly enhance the tool's utility. Predictive analytics can help anticipate issues before they become critical, allowing for proactive management and timely interventions. By analyzing historical data and identifying patterns, these models can provide valuable forecasts that support strategic planning and improve urban resilience.

6.3 User Feedback Mechanism

Adding a feature for users to provide feedback on the application or report additional issues could improve the data's richness and accuracy. User-generated data can offer real-time insights and validate existing datasets, making the application more responsive and reflective of current urban conditions. This feedback mechanism can also increase user engagement and trust, as residents see their inputs directly contributing to urban management efforts.

6.4 Scalability

Extending the application to cover more cities could provide comparative insights and foster a broader impact. By applying the same analytical framework to different urban contexts, the tool can help identify common challenges and successful strategies across cities. This scalability can also support regional and national urban planning initiatives, promoting the exchange of best practices and enhancing the overall quality of urban living conditions.

By continuing to develop and refine this tool, we can significantly contribute to smart city initiatives and improve urban living conditions. Expanding its capabilities and reach will not only enhance its effectiveness but also ensure that it remains a valuable resource for urban planners, city officials, and residents. Through ongoing innovation and user engagement, the application can help build more resilient, responsive, and sustainable cities.

7 Appendix

The resources used for the report can be found at the following link for downloading:

- https://valencia.opendatasoft.com/explore/embed/dataset/total-castellano/table/
- https://valencia.opendatasoft.com/explore/embed/dataset/vulnerabilidad-por-barrios/table/

The script used to write the report:

- https://github.com/apraalo/EDM-Proyect