High-Incident Traffic Zones in Knoxville's Urban Core

Traffic safety in densely populated urban areas, particularly those with significant pedestrian and bicycle traffic, is a pressing concern. Knoxville's University of Tennessee (UT) campus, Fort Sanders neighborhood, and downtown Knoxville represent such areas with high vehicular, pedestrian, and cyclist interactions. These zones have been the site of numerous traffic crashes, including fatal and serious injuries, over recent years.

This study investigates high-incident traffic zones within these three subregions using advanced geospatial clustering methods. By leveraging the DBSCAN (Density-Based Spatial Clustering of Applications with Noise) algorithm [1], this analysis aims to pinpoint traffic crash hotspots and inform safety interventions. This research offers actionable insights for urban planners and policymakers to enhance road safety and mitigate crash risks in these vital Knoxville zones.

1 Data Collection and Preparation

The study focused on three key areas: the UT campus, Fort Sanders neighborhood, and downtown Knoxville. These areas were selected based on their high pedestrian and vehicular traffic, diverse land use, and the prevalence of crash incidents. The data for this analysis was sourced from the Knoxville Transportation Planning Organization's (TPO) Traffic Crash Map, covering the years 2019 to 2024 [2]. This dataset included fatal and serious-injury crashes as well as incidents involving pedestrians and cyclists. Need to mention that this study integrates OpenStreetMap [3] as the base map to provide spatial context and visualize traffic clusters relative to Knoxville's urban infrastructure.

2 Methodology

Using QGIS, the geographic coordinates of each incident were visualized and spatially processed. The DBSCAN algorithm, integrated with QGIS plugins, was applied to identify clusters. DBSCAN groups points based on their proximity and density, making it ideal for identifying spatial patterns in urban environments.

DBSCAN, or Density-Based Spatial Clustering of Applications with Noise, is a robust and versatile clustering algorithm that identifies groups of spatially close points based on density rather than relying on predefined shapes or distributions. This feature makes it particularly suitable for analyzing geospatial data, such as traffic incidents, which often exhibit irregular spatial patterns influenced by urban infrastructure and human behavior. In this study, DBSCAN was utilized within QGIS to identify high-density clusters of traffic incidents in Knoxville's urban core, providing valuable insights for urban planning and safety interventions. Unlike other clustering methods such as k-means, DBSCAN does not require the user to specify the number of clusters in advance. This flexibility is crucial when analyzing traffic incidents, as the number and locations of clusters are unknown beforehand. The algorithm was configured with a minimum of three points required to form a cluster and a maximum allowable distance of 25 meters between points within the same cluster. This configuration enabled the detection of high-density areas while filtering out isolated incidents.

QGIS was further used to overlay the identified clusters onto base maps of Knoxville, incorporating infrastructure features such as roads, intersections, and pedestrian zones. The software's advanced visualization capabilities enabled a clear representation of crash clusters and their centroids, facilitating deeper insights into spatial trends.

3 Results

The analysis revealed several high-density clusters across the study area. In the UT campus zone, clusters were concentrated near Neyland Drive, Volunteer Boulevard, and Cumberland Avenue. These areas are significant traffic corridors, often experiencing high usage from pedestrians, bicycles, and vehicles. The spatial clustering highlights recurring patterns that suggest opportunities for targeted safety improvements.

In Fort Sanders, clusters were primarily located along narrow residential streets and intersections, such as those near 17th Street and Clinch Avenue. This neighborhood's compact layout and proximity to the university contribute to its traffic activity. The findings indicate the need for measures to better manage the interaction between residential traffic and through traffic in this zone.

Downtown Knoxville exhibited clustering along main arterial roads such as Gay Street and Henley Street. These areas see a convergence of mixed-use activities, with high traffic volume attributed to commercial, transit, and pedestrian activities. Identified clusters near transit hubs and Market Square suggest infrastructure improvements could enhance safety in these high-activity zones.

Spatial analysis also showed that noise points, or isolated incidents, were dispersed across peripheral areas of the study region. These points were less frequent in zones with dense traffic, emphasizing the correlation between traffic volume and cluster density.

References

[1] Khan, K., Rehman, S. U., Aziz, K., Fong, S., & Sarasvady, S. (2014). DBSCAN: Past, present and future. In *The fifth international conference on the applications of digital information and web technologies (ICADIWT 2014)* (pp. 232-238). IEEE.

[2] Knoxville-Knox County Planning. (n.d.). Open Data. Retrieved from https://knoxplanning.org/data/open-data

[3] Haklay, M., & Weber, P. (2008). Openstreetmap: User-generated street maps. *IEEE Pervasive computing*, 7(4), 12-18.

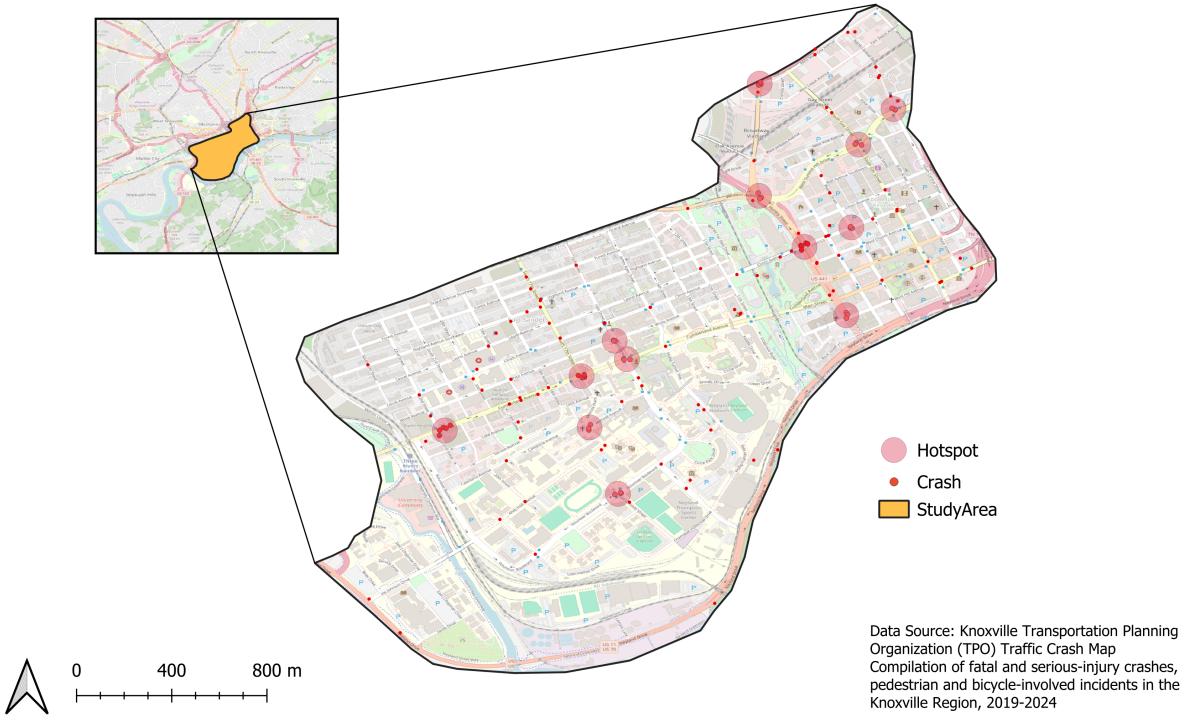

Figure 1: A spatial analysis identifying crash hotspots in the UT campus, Fort Sanders, and downtown Knoxville using DBSCAN clustering. The map highlights crash locations (red dots), cluster centroids (pink circles), and the study area's boundaries (yellow polygon)