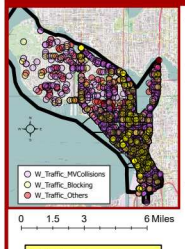
Spatial Analysis of Traffic Incidents and Urban Dynamics in Seattle's West Precinct

Poster Created by Ruqhaiya F. Syeda

Data Sources:
- Seattle Police Department (SPD) 2018 Calls for Service Data.
- City of Seattle Special Events Permits (2019). Office of Economic Development.
- City of Seattle Transit Classifications of Streets. Hansen Asset Management System, 2018.
- Google Maps. Satellite imagery and street-level views.

Introduction

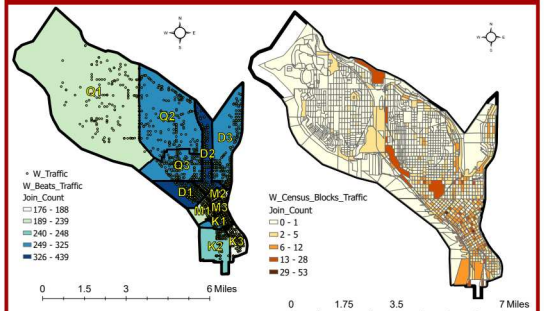


Incidents cluster near key intersections and downtown corridors, reflecting traffic flow challenges in these high-activity zones.

This poster examines traffic incidents in Seattle's West Precinct using data from multiple sources to uncover spatial and temporal patterns, identify hotspots, and assess relationships with urban infrastructure. The primary dataset is from the Seattle Police Department (SPD) for 2018, documenting 3,349 traffic-related incidents, categorized into motor vehicle collisions, traffic blocking, and other violations.

To complement this, Seattle's 2018 transit route dataset was analyzed to explore how transit classifications (e.g., major, principal, minor, and local routes) influence traffic incidents. Additionally, 2019 event permit records were summarized to provide contextual information about city activities, though they were not directly integrated into the traffic analysis.

Choropleth Maps & Temporal Analysis



Map A: Traffic Incident Distribution by Police Beats
This map divides incidents by police beats, revealing significant variation in traffic incident volume across zones.

Beat D1, D2, and M2 (Downtown) has the highest density of incidents, due to its status as a commercial hub with significant vehicle and pedestrian activity.

Map B: Traffic Incident Distribution by Census Blocks
Census block aggregation provides a finer resolution of traffic incident hotspots.

Harrison St (301-315): A hotspot near the Seattle Center, likely influenced by high foot traffic and events at nearby attractions such as the Space Needle and Seattle Children's Museum.
Lawton Park (1019 W Galer St): Another dense area due to narrow streets and nearby residential zones.

- **Monthly Traffic Incidents Trend:** Traffic incidents remain relatively consistent throughout the year, peaking in July (318 incidents) and May (309 incidents). A notable drop is observed in February (201 incidents), likely due to shorter days and reduced vehicular activity. The summer peak aligns with increased traffic volume during vacation months, highlighting the need for enhanced road safety measures during this period.

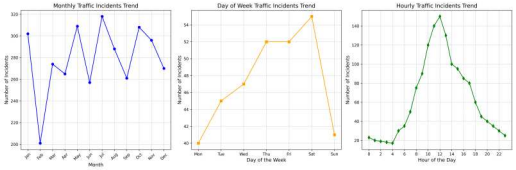
Day of Week Traffic Incidents Trend: Incidents rise steadily from Monday to Friday, peaking at 55 incidents on Saturday before dropping sharply on Sunday (41 incidents). The midweek increase corresponds with workday commutes and higher roadway usage. The spike on Saturdays may relate to leisure activities and increased night traffic, indicating an opportunity for targeted interventions.

Hourly Traffic Incidents Trend: A distinct pattern emerges with two major peaks: 8–9 AM and 5–6 PM, corresponding to morning and evening rush hours. The lowest activity occurs between 2–5 AM, reflecting minimal roadway usage. The rush-hour spikes highlight congestion periods, reinforcing the need for optimized traffic flow management during these hours.

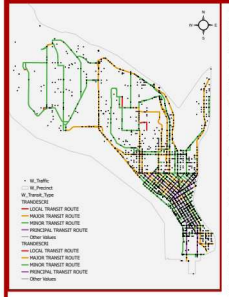
July sees the highest traffic incidents, aligning with increased summer activity.

Saturday peaks in incidents, linked to leisure and night traffic.

Rush-hour spikes show increased incidents during peak travel times.



Analysis of Transit Routes & Events

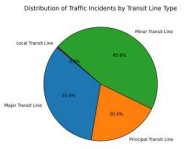


This section explores the spatial and contextual relationship between traffic incidents and urban activity in Seattle's West Precinct. It focuses on how transit routes and events influence traffic patterns, offering insights into potential traffic attractors.

Map - Spatial Distribution by Transit Lines: Shows the geographic distribution of traffic incidents along major, minor, principal, and local transit lines.
- **Minor Transit Lines:** Show a significant clustering of incidents in the northern and central parts of the precinct.
- **Major Transit Lines**: Incidents are concentrated along high-traffic corridors near downtown.

Minor transit lines, covering a broad area, account for a large proportion of incidents due to their extensive network and potential intersections with busy streets.

The pie chart quantifies traffic incidents based on their proximity to different transit lines:
Minor Transit Lines: 45.8% of all incidents, reflecting their widespread usage and accessibility.
Major Transit Lines: 33.4%, capturing incidents along high-density corridors.
Principal Transit Lines: 20.4%, likely due to intersections with other transit types.
Local Transit Lines: Only 0.3%, indicating minimal incident interaction with local streets.

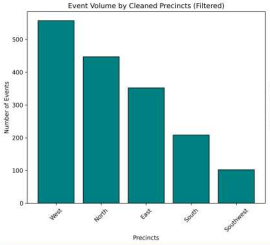


Nearly 80% of incidents occur near minor and major transit lines, highlighting the need for comprehensive traffic planning along these routes.

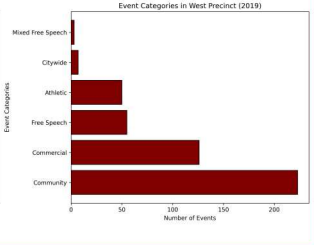
Community and commercial events dominate in the West Precinct, contributing to increased downtown traffic congestion.

The West Precinct hosted 557 permitted events in 2019, the highest among all precincts.

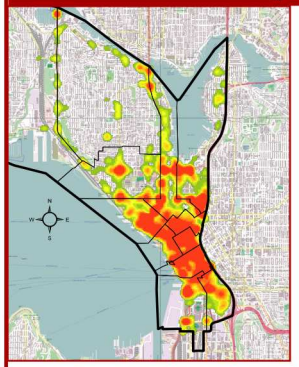
This chart shows the number of permitted events by precinct in 2019, with the West Precinct hosting the highest volume (557 events), followed by the North Precinct (402 events). The West Precinct's high event volume corresponds to its dense urban landscape, potentially contributing to traffic congestion.



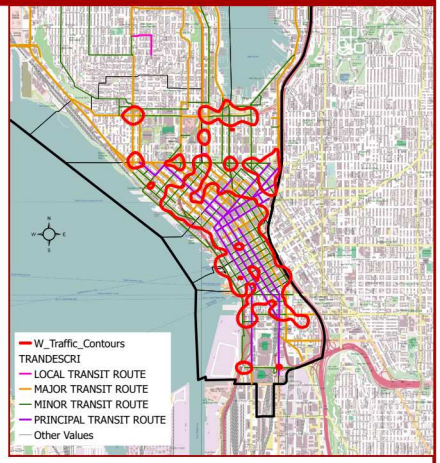
This chart breaks down events in the West Precinct by category. Community Events dominate (215 events), followed by Commercial Events (165 events) and Athletic Events (73 events). Community and commercial events in downtown areas likely exacerbate traffic volumes, particularly during weekends and peak hours.



Kernel Density Hotspots and Contours Map



Critical Hotspot Zone Identified:
The densest areas of traffic incidents exceed 2,700 incidents per square kilometer, concentrated near key transit routes and intersections.

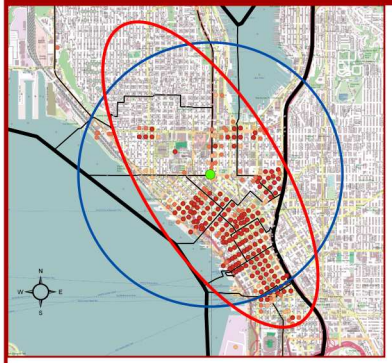


The Kernel Density Estimation (KDE) map provides a smoothed visualization of traffic incident concentrations in the West Precinct, utilizing a **250-meter** search radius. KDE was chosen for its ability to highlight spatial trends and patterns in the data, even when incident points are unevenly distributed. This technique helps identify key hotspots while minimizing the visual noise of individual data points.

Incident density values range from **0.001 to 2,736.198**, with higher densities depicted in shades of orange and red. The densest clusters, exceeding **583.683 incidents per square kilometer**, are concentrated along principal and minor transit routes, particularly around high-traffic intersections.

Lower density areas, shown in green, reflect fewer incidents, correlating with less trafficked zones. This approach not only reveals the spatial intensity of traffic incidents but also assists in prioritizing resource allocation and targeted interventions for traffic safety. The KDE analysis provides valuable insights into areas requiring immediate attention, supporting data-driven decision-making.

Statistical Analysis



This section examines the spatial patterns and clustering tendencies of traffic incidents in Seattle's West Precinct using Global Moran's I, Average Nearest Neighbor (ANN) analysis, and Getis-Ord Gi* hotspot analysis.

The **Global Moran's I** statistic confirms moderate positive spatial autocorrelation (Index: 0.20, z-score: 26.21, p-value < 0.001), indicating a tendency for traffic incidents to cluster spatially rather than being randomly distributed. The **ANN** analysis supports this, with a Nearest Neighbor Ratio of 0.20, a z-score of -88.06, and a p-value < 0.001, showing significant clustering of incidents.

The **centrographic** analysis reveals the mean center of traffic incidents at X: -13619271.76, Y: 6043650.83, with a Standard Distance of 3,035.51 units representing the average spread. The Directional Distribution ellipse, oriented northwest-southeast (Rotation: 148.93°), aligns with major transit routes, suggesting a spatial influence from infrastructure.

The Getis-Ord Gi* Hot Spot Analysis utilized the centroids of traffic incident data to pinpoint high-risk locations and identified statistically significant hotspots of traffic incidents in the precinct. Red zones highlight high-density areas with confidence levels of 90%, 95%, and 99%, while blue zones represent cold spots with lower incident densities.

The Global Moran's I analysis confirms a moderate degree of clustering in traffic incidents, with significant statistical support (z = 26.21, p < 0.001). Combined with ANN and Getis-Ord Gi* results, this highlights areas where interventions such as targeted enforcement or infrastructural improvements could mitigate traffic risks.

Average Nearest Neighbor Summary

Observed Mean Distance	19.9745 meters
Expected Mean Distance	97.6395 meters
Nearest Neighbor Ratio	0.204574
z-score	-88.061972
p-value	0.000000

Global Moran's I Summary

Moran's Index	0.200656
Expected Index	-0.000525
Variance	0.000059
z-score	26.207232
p-value	0.000000

Conclusion & Future Enhancements

This analysis examined traffic incidents in Seattle's West Precinct using advanced geospatial methods, including Kernel Density Estimation (KDE) and Getis-Ord Hotspot Analysis. Results highlighted high-density clusters near principal transit routes and intersections, with temporal trends identifying peak hours and days for incidents. These findings support targeted strategies to enhance traffic safety and resource allocation.

In the future, I plan to expand this analysis by integrating social attractors like bars, restaurants, and shopping hubs to better understand their correlation with traffic hotspots. Narrowing the focus to specific high-density areas will allow for more precise insights that can guide actionable interventions. Adding pedestrian and cyclist data will help paint a complete picture of traffic safety across different modalities. I also intend to analyze seasonal trends, such as how weather or annual events impact traffic incidents, to improve planning strategies. Lastly, developing interactive dashboards could make these findings more accessible and useful for decision-makers and stakeholders.