Assignment 1: Motor Vehicle Collisions in the City of Kitchener Report

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Introduction

Motor vehicle collisions represent a significant public safety concern in urban environments, with spatial distribution patterns that can inform targeted planning and emergency response strategies. This report presents a spatial analysis of motor vehicle collision data recorded in the City of Kitchener, Ontario, between 2015 and 2022, using data provided by Waterloo Region Police Services. The purpose of this analysis is to identify spatial patterns and concentrations of collisions across the city using hexagonal tessellation in ArcGIS Pro. By examining the aggregated distribution of collisions from 2015 to 2022 and trends across three individual years (2016, 2019, and 2022), this report aims to provide actionable insights for city planners and police services regarding high-risk areas and potential contributing factors to collision clustering.

Methods

To conduct the analysis, data was sourced from the City of Kitchener Open Data portal and Waterloo Region Police Services. Datasets used include the motor vehicle collision records (2015–2022), the City of Kitchener municipal boundary, roads, and ION LRT route and stop locations.

The collision CSV was first cleaned in Microsoft Excel to ensure all records contained valid coordinate values. Rows with XCOORD and YCOORD values of zero were removed, as these would place points at a null location and skew the spatial analysis.

The cleaned data was imported into ArcGIS Pro using the "XY Table to Point" tool, with the coordinate system set to NAD 1983 UTM Zone 17N. The easting/northing fields were used rather than the latitude/longitude fields, as several records were missing valid lat/lon values. In the tool, XCOORD was assigned to the X field (easting) and YCOORD to the Y field (northing), outputting a point feature class representing all collision locations across Kitchener.

Hexagonal tessellation was generated using the "Generate Tessellation tool (Data Management)", producing a uniform hexagonal grid clipped to the Kitchener municipal boundary. A cell size of 0.65 km^2 was selected after testing multiple sizes. Smaller cells produced overly fragmented patterns while larger cells masked neighborhood-level variation. This size was further supported by a Moran's I value of 0.495, indicating moderate spatial clustering at this scale. The tessellation was subsequently clipped to the Kitchener boundary using the "Clip" tool to remove hexagons extending beyond the city limits.

Collision counts per hexagon were calculated using the "Summarize Within" tool, which counts the number of point features falling within each polygon. This was run four times, once for the full 2015–2022 dataset and once each for 2016, 2019, and 2022. These three years were selected to represent distinct temporal periods: 2016 captures the data during ION construction, 2019 captures the year of ION opening and the onset of shifting traffic patterns, and 2022 represents the post-pandemic recovery period when traffic volumes began returning to normal.

Spatial autocorrelation was assessed using the "Spatial Autocorrelation (Moran's I)" tool on the 2015–2022 combined layer, with *Point_Count* as the input field. Moran's I measures the degree to which similar values cluster spatially, where values closer to 1 indicate clustering, values closer to -1 indicate dispersion, and values near 0 indicate randomness.

Finally, all four datasets were symbolized as both choropleth and graduated symbol maps. Choropleth maps shade each hexagon by collision count using a sequential yellow-to-red color ramp, while graduated symbol maps scale circles proportionally to collision count. Both use Natural Breaks (Jenks) classification with five classes, which groups values by natural gaps in the data distribution. Ancillary layers including road centrelines and ION route and stop locations were added to all maps to provide spatial context for interpreting collision patterns.

A complete workflow diagram summarizing the processing chain is provided in Appendix A.

Results

Analysis of the combined 2015–2022 dataset reveals that motor vehicle collisions in Kitchener are not uniformly distributed across the city. The highest concentration of collisions occurs along the King Street corridor, particularly near Downtown Kitchener around Kitchener City Hall. This area is characterized by high pedestrian activity, dense mixed-use development, and serves as a major hub for the ION LRT. This pattern of clustering is consistent across all four time periods examined.

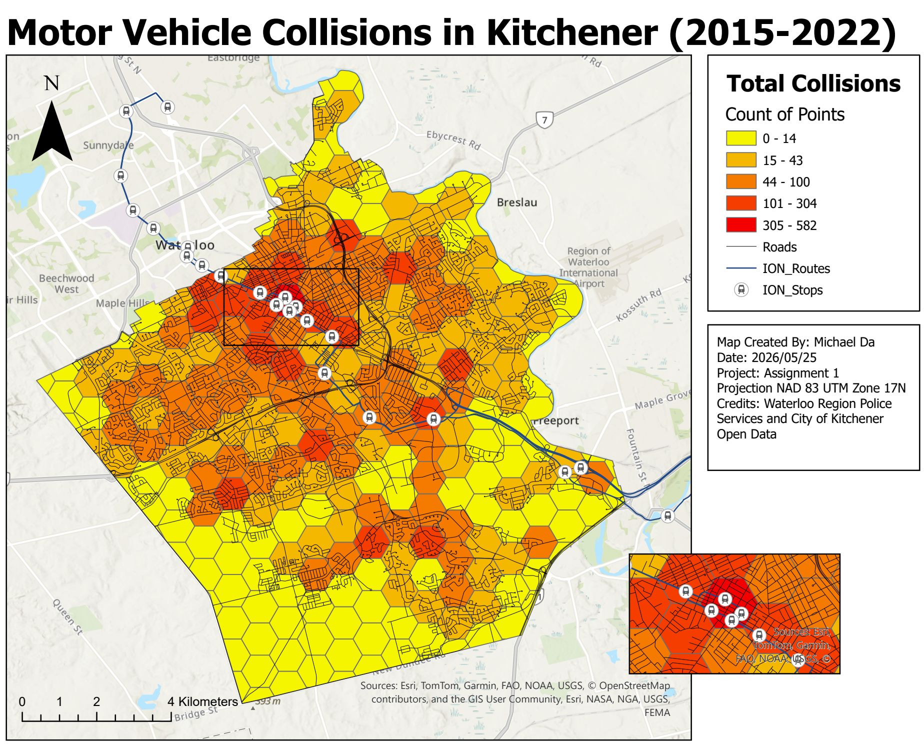


Figure 1: *Choropleth map of total motor vehicle collisions in the City of Kitchener (2015–2022)*

ION corridor alignment

To further investigate the spatial drivers of collision clustering, ION LRT route and stop locations were overlaid onto all maps. A clear alignment was observed between high-collision hexagons and the ION corridor, with hotspots consistently concentrated near LRT stops. This suggests that areas of high pedestrian-vehicle interaction associated with transit infrastructure may be a contributing factor in increasing collision risk in Kitchener.

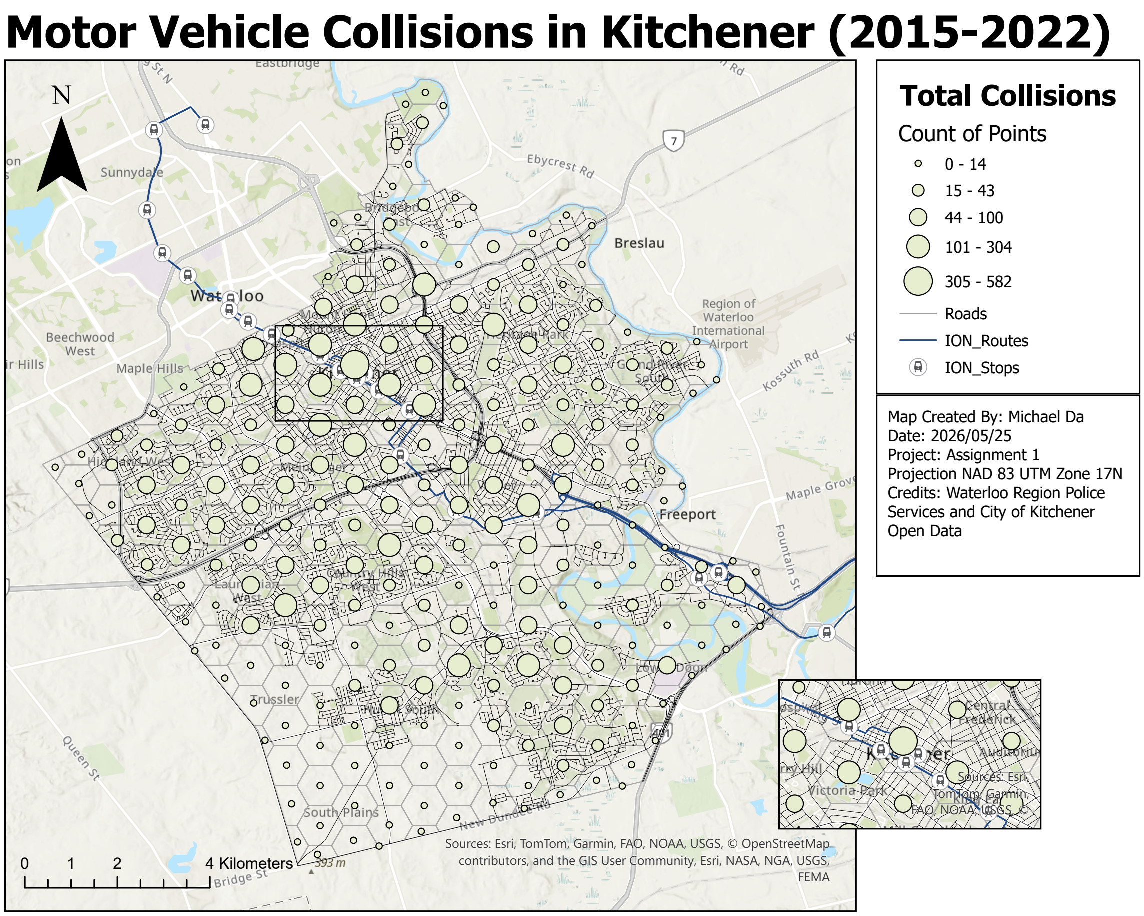


Figure 2: *Graduated symbol map of total motor vehicle collisions in the City of Kitchener (2015–2022)*

Year-by-year comparison

Examining individual years reveals notable temporal shifts in collision patterns. In 2016, prior to the ION opening, collisions were already concentrated along the King Street corridor and Downtown Kitchener area, suggesting this was already a high-risk zone before LRT infrastructure was introduced.

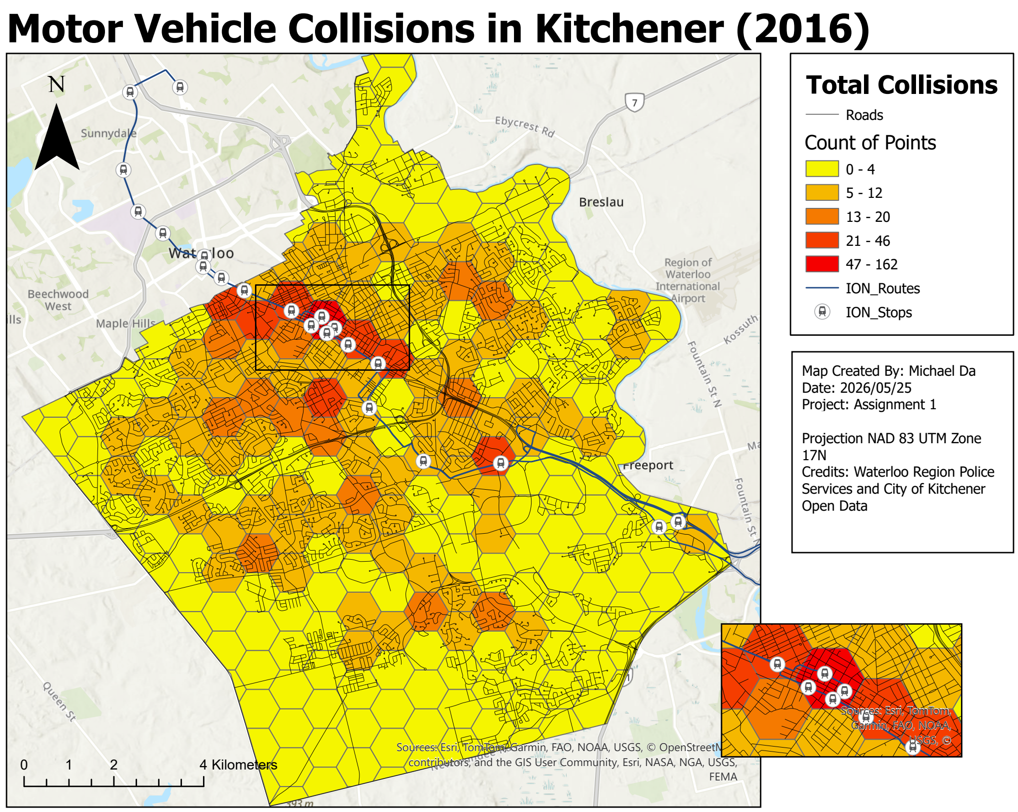


Figure 3: *Choropleth map of motor vehicle collisions in the City of Kitchener (2016)*

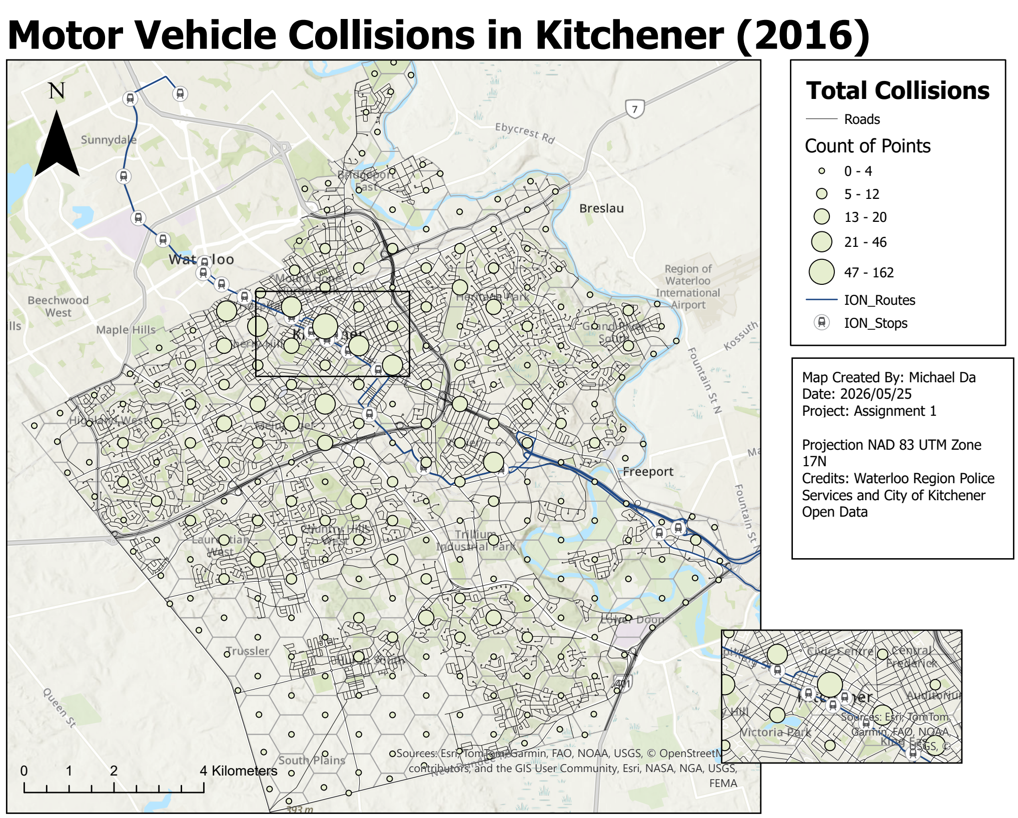


Figure 4: *Graduated symbol map of motor vehicle collisions in the City of Kitchener (2016)*

By 2019, the year the ION LRT officially opened, a marked increase in collision hotspot intensity is observed, with more hexagons reaching higher count thresholds across the corridor. This is likely attributable to the disruption caused by new LRT infrastructure, requiring drivers to adapt to updated road configurations, new signalized crossings, and altered traffic flow along King Street.

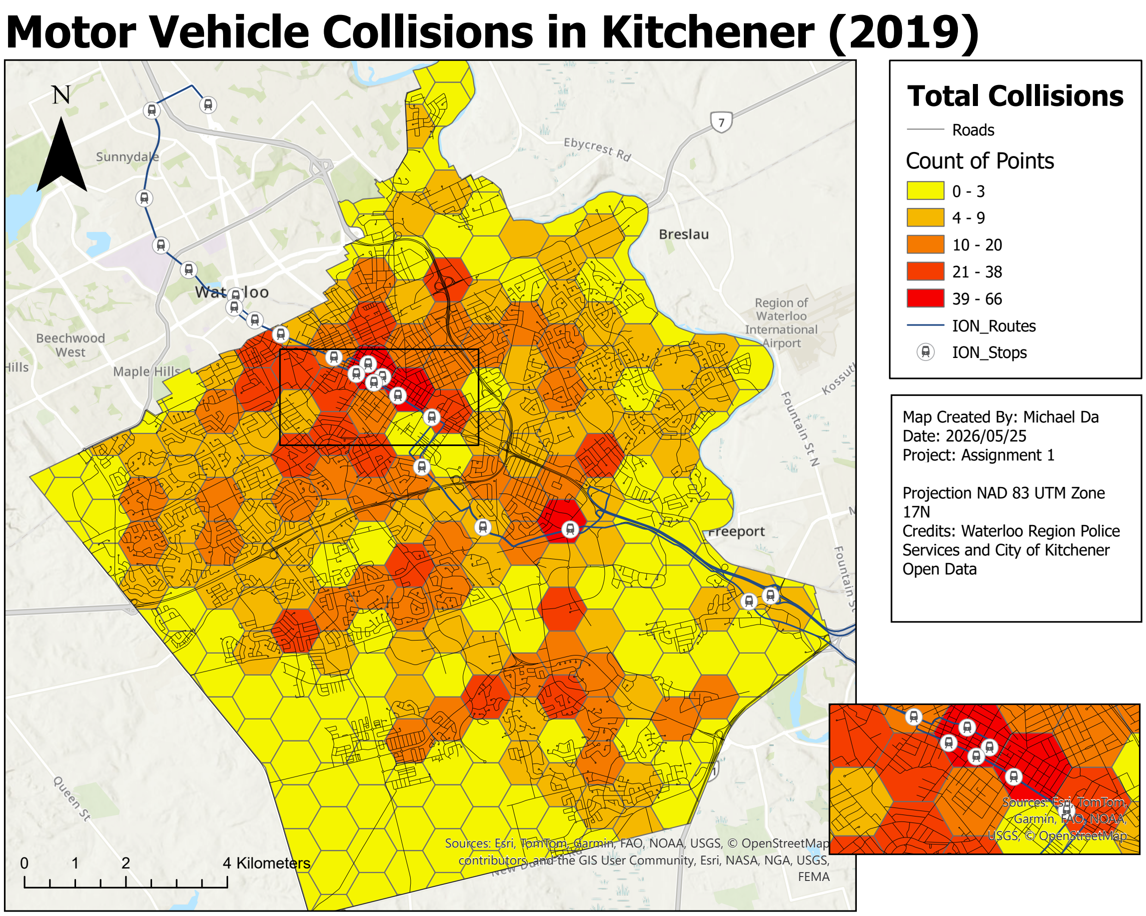


Figure 5: *Choropleth map of motor vehicle collisions in the City of Kitchener (2019)*

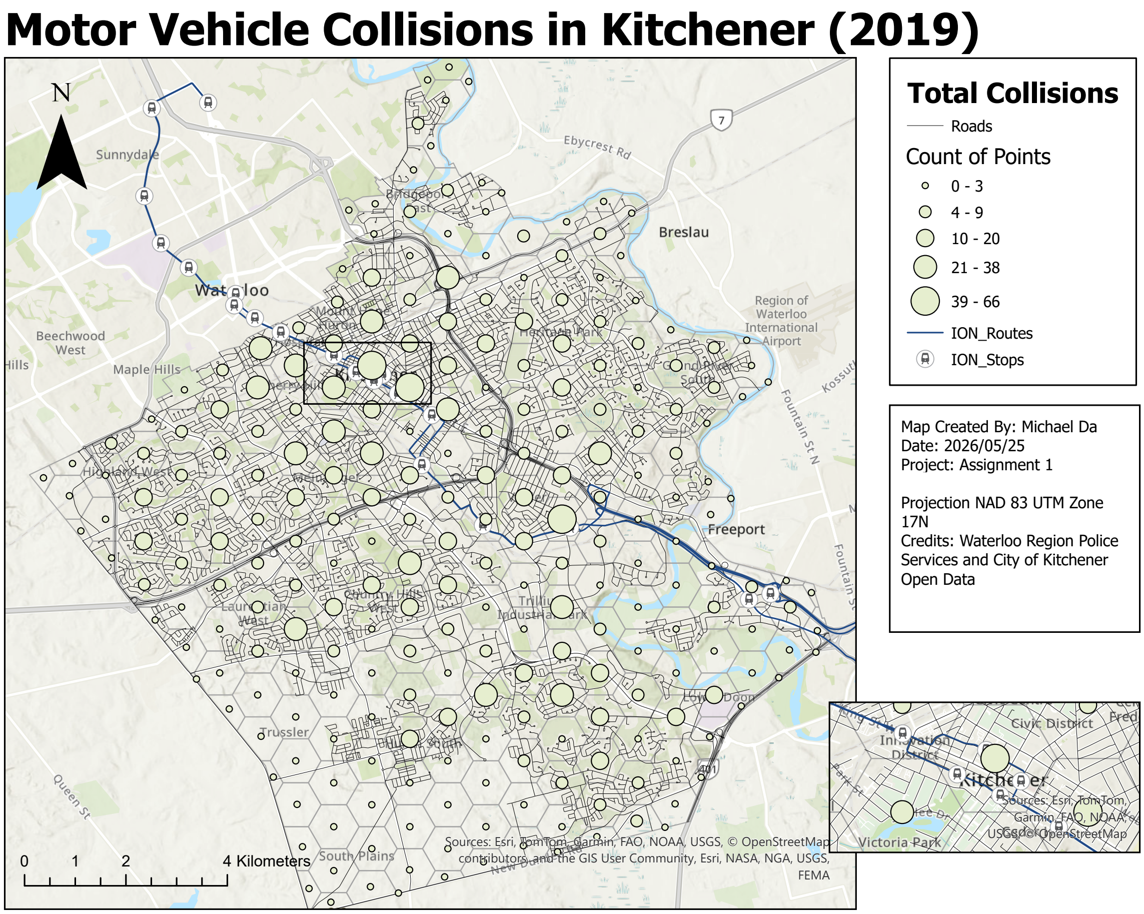


Figure 6: *Graduated symbol map of motor vehicle collisions in the City of Kitchener (2019)*

In 2022, collision intensity along the corridor remains high but shows a modest reduction compared to 2019. This may reflect two compounding factors: drivers becoming more accustomed to navigating the ION infrastructure over time, and the gradual recovery of traffic volumes following the COVID-19 pandemic, during which reduced vehicle activity temporarily suppressed collision counts in 2020 and 2021.

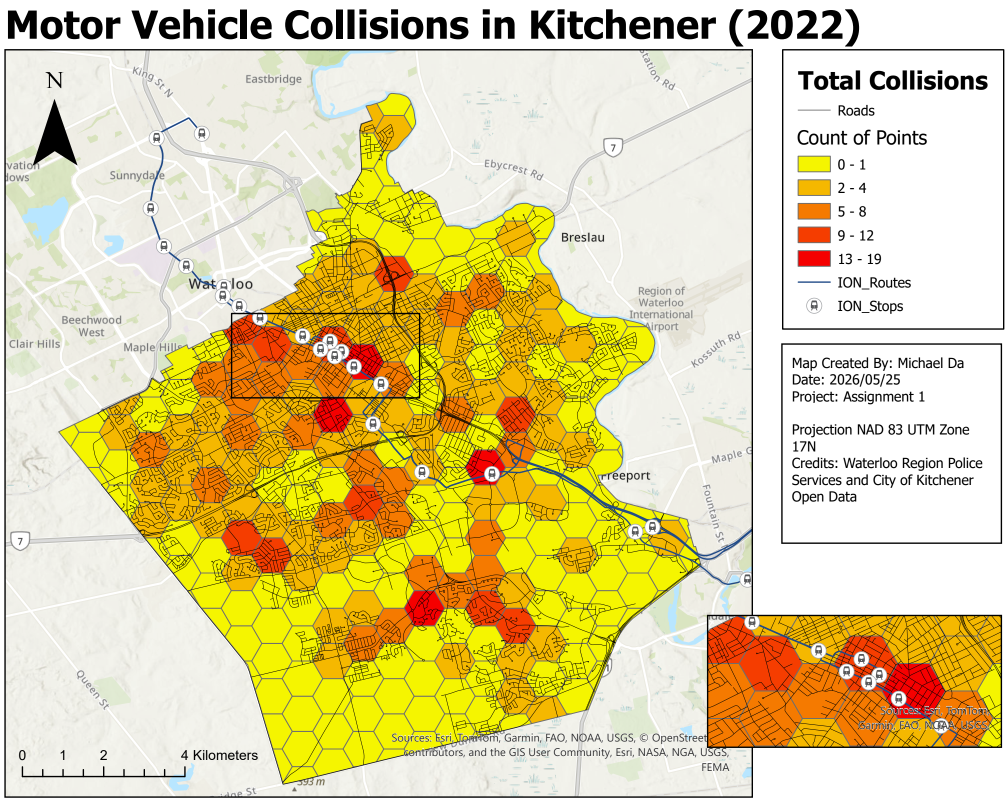


Figure 7: *Choropleth map of motor vehicle collisions in the City of Kitchener (2022)*

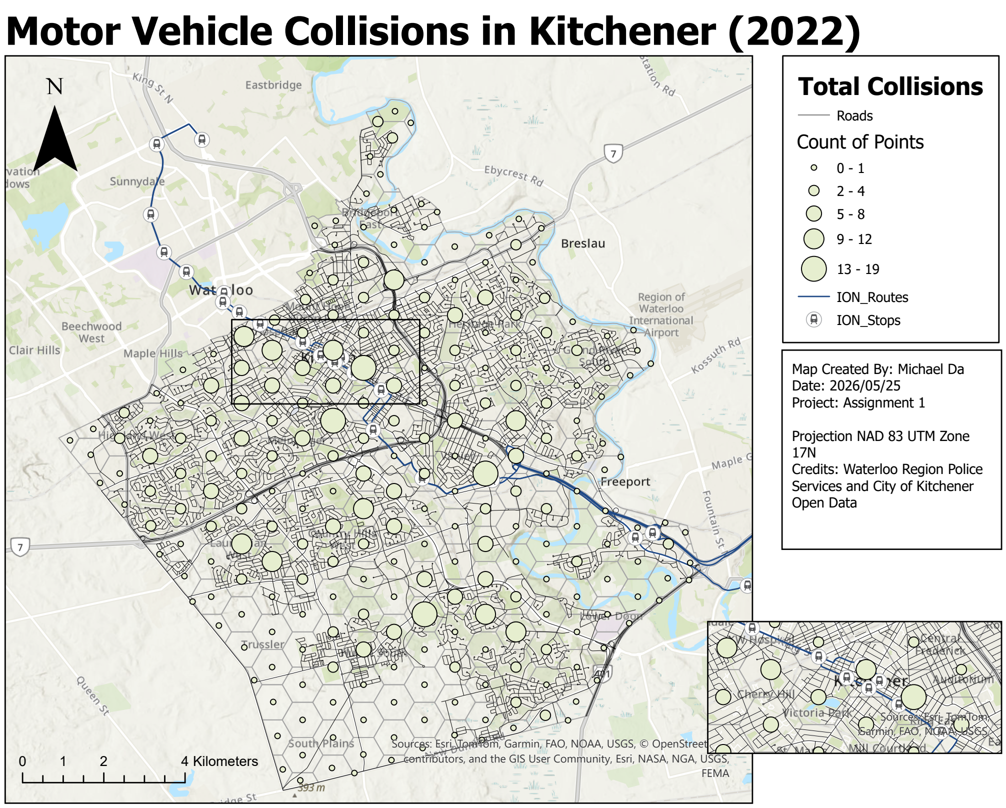


Figure 8: *Graduated symbol map of motor vehicle collisions in the City of Kitchener (2022)*

Spatial autocorrelation

The Spatial Autocorrelation (Moran's I) analysis returned a value of I = 0.495 with a z-score of 19.13 and p-value < 0.001, confirming that the observed clustering is statistically significant and not the result of random chance. This indicates that high-collision areas tend to be spatially adjacent to other high-collision areas, reinforcing the geographic concentration of risk along the King Street and ION corridor identified visually in the maps (see Appendix B).

Conclusion

The key findings of this analysis reveal that motor vehicle collisions in Kitchener are heavily concentrated along the King Street corridor, particularly near Downtown Kitchener where the ION LRT route operates, and that this clustering is statistically significant rather than randomly distributed. Understanding the spatial component of collision data is critical for both city planners and Waterloo Region Police Services, as knowing precisely where collisions cluster allows resources such as traffic enforcement, road safety improvements, and signage to be deployed strategically rather than uniformly across the city. Furthermore, the alignment of hotspots with the ION corridor highlights the importance of monitoring how transit infrastructure influences collision risk over time. Looking ahead, future analysis could incorporate additional datasets such as pedestrian volume counts, posted speed limits, intersection geometry, and land use classifications to develop a more comprehensive understanding of the factors contributing to collision clustering in Kitchener.

References

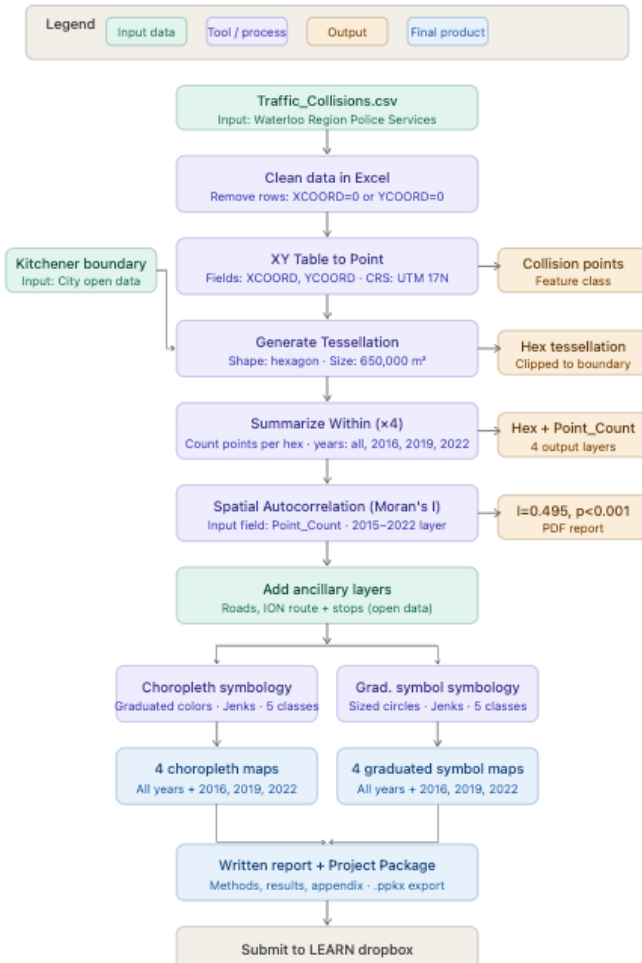
City of Kitchener. (2024). Open Data Catalogue. Retrieved from https://open-kitchenergis.opendata.arcgis.com/pages/open-data-listing

Waterloo Region Police Services. (2022). Traffic Collisions Dataset. Retrieved from https://open-kitchenergis.opendata.arcgis.com/datasets/KitchenerGIS::traffic-collisions/about

Esri. (2026). ArcGIS Pro (Version 3.7) [Computer software]. https://www.esri.com

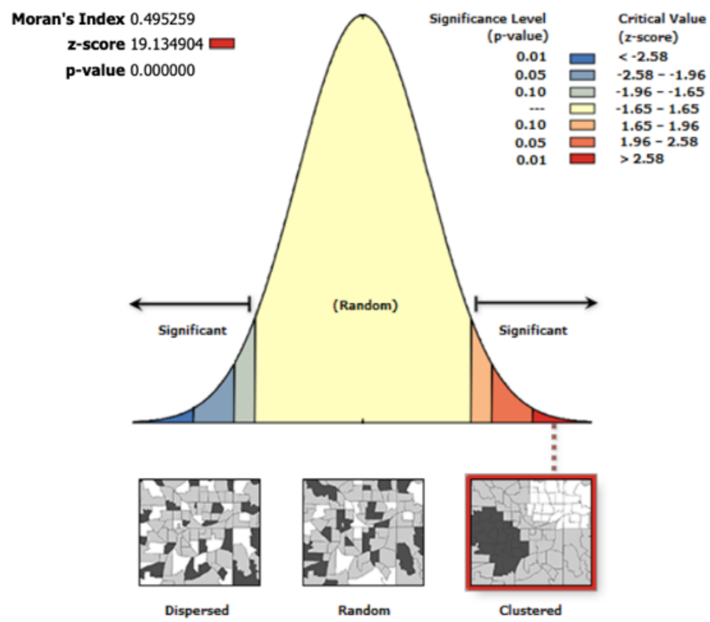
Appendix

Appendix A: Workflow Diagram



Appendix B: Moran's I output report (PDF screenshot)

Spatial Autocorrelation Report



Given the z-score of 19.134904, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Global Moran's I Summary

Moran's Index	0.495259
Expected Index	-0.002169
Variance	0.000676
z-score	19.134904
p-value	0.000000

Dataset Information

Input Feature Class:	Tessellation_2015_2022
Input Field:	POINT_COUNT
Conceptualization:	INVERSE_DISTANCE
Distance Method:	EUCLIDEAN
Row Standardization:	True
Distance Threshold:	866.4326 meters
Weights Matrix File:	None
Selection Set:	False