

2026-27 HIVE Summer Internship Project

What causes the crashes? Congestion or Compliance?

Primary Academic Supervisor

Dr. S Zaung Nau

Project Background

Road traffic safety remains a critical concern for transport authorities, urban planners, and the public. Understanding the underlying mechanisms that trigger road incidents is vital for designing effective safety interventions and optimizing network management. Historically, road safety research has debated whether traffic crashes are predominantly caused by environmental operational conditions—such as traffic volume and congestion—or individual driver behaviors, particularly speed non-compliance.

Congestion vs. Compliance

Traffic Congestion: Heavy traffic density restricts vehicle maneuverability and creates stop-and-go patterns. While lower average speeds during congestion generally reduce crash severity, frequent speed variation and tight headway increase the likelihood of low-impact rear-end collisions.

Speed Compliance: Speeding directly increases stopping distance and reduces reaction margins. Non-compliance with posted speed limits elevates both crash frequency and severity, especially under free-flow conditions where drivers operate with minimal physical constraint.

Determining which factor dominates, or how they interact dynamically prior to an incident, requires granular spatial and temporal empirical data.

Research Approach & Data

This project investigates the relative impact of congestion levels versus speed compliance on incident rates. By integrating 2022 Western Australia crash records with spatial traffic count data from Main Roads Western Australia (M-Links Road Network), the study examines pre-crash vehicle states across the state's road corridors. Link-level metrics—such as traffic volumes, average operational speeds, and free-flow speed thresholds—allow us to quantify real-time congestion and evaluate compliance levels

immediately surrounding crash sites. Ultimately, this research provides data-driven insights to help road agencies tailor targeted safety policies, enforcement strategies, and infrastructure upgrades.

Project Description, Expected Outputs, Possible Stretch Goals

1. Integrated Spatial-Temporal Crash Dataset

- A merged GIS dataset linking 2022 Western Australia crash locations directly to the Main Roads M-Links Road Network segments.
- Calculated pre-crash operational parameters for each crash segment, including localized volume-to-capacity (V/C) ratios (as a proxy for congestion level) and free-flow speed deviations.

2. Statistical Breakdown of Crash Causes (Congestion vs. Compliance)

- Quantitative findings showing the proportion of crashes attributable to high traffic congestion versus speed non-compliance.
- Regression and correlation models establishing the mathematical relationship between pre-crash vehicle speed/volume conditions and crash occurrence.

3. Crash Type and Severity Profiles

- Analysis showing how congestion levels and non-compliance influence specific crash typologies (e.g., rear-end vs. angle collisions).
- Comparison of severity outcomes (property damage vs. serious injury or fatality) under congested conditions versus high-speed non-compliant conditions.

4. Hotspot Identification and Interactive Spatial Maps

- High-resolution GIS heatmaps identifying road corridors in Western Australia where crashes are primarily driven by congestion bottlenecks versus sections where non-compliance poses the dominant risk.
- Segmentation maps categorizing M-Links segments into risk profiles (e.g., High Congestion / Low Compliance, Low Congestion / High Compliance).

5. Data-Driven Policy & Targeted Intervention Recommendations

- Practical recommendations for Main Roads Western Australia and the Road Safety Commission to target interventions effectively:

Congestion-driven locations: Variable speed signs, ramp metering, or bottleneck infrastructure upgrades.

- Compliance-driven locations: Automated speed enforcement, targeted police presence, or speed calming measures.

Links to background reading and any relevant recent work in the field

- Hughes, J.E., Kaffine, D. and Kaffine, L., 2023. Decline in traffic congestion increased crash severity in the wake of COVID-19. *Transportation research record*, 2677(4), pp.892-903.
- Phan, D.C. and Truong, L.T., 2024. Traffic congestion and safety: Mixed effects on total and fatal crashes. *Sustainability*, 16(20), p.8911.
- Sánchez González, S., Bedoya-Maya, F. and Calatayud, A., 2021. Understanding the effect of traffic congestion on accidents using big data. *Sustainability*, 13(13), p.7500.

What type of visualisation will the student develop or produce?

Geospatial maps to visualise the following:

1. Statistical Breakdown of Crash Causes (Congestion vs. Compliance)
 - Quantitative findings showing the proportion of crashes attributable to high traffic congestion versus speed non-compliance.
 - Regression and correlation models establishing the mathematical relationship between pre-crash vehicle speed/volume conditions and crash occurrence.
2. Crash Type and Severity Profiles

How will the visualisation contribute to your research outcomes?

- A Risk-Factor Dominance Framework
- Empirical quantification showing whether traffic density (congestion) or speed limit non-compliance is the primary driver of crash frequency across specific road corridor types.
- Speed Threshold & Safety Trade-off Analysis
- Determination of exact volume-to-capacity (V/C) thresholds where traffic transitions from "free-flow speed risk" (high compliance risk,

high crash severity) to "congested density risk" (low compliance risk, high rear-end crash frequency).

If the project is successful, where would you consider publishing the results?

- Journal of safety research, Transport policy, Journal of road safety
- Australasian Road Safety Conference (ARSC)
- World Congress on Transport Research (WCTR)

Draft Project Timeline:

Week 1

Nov 16 - Full day HIVE induction

Nov 17 - Area and Project Induction with Primary supervisor

Develop project plan with HIVE and academic team

Literature and relevant project review

Project Familiarisation

Week 2

Data Acquisition, Cleaning & Schema Alignment

Week 3

Spatial Integration & Pre-Crash Link Snapping

Week 4

Congestion Metric Computation, Speed Compliance Metric Computation

Week 5

Statistical & Causal Factor Analysis

Week 6

GIS Spatial Hotspot & Risk Profiling

Week 7

GIS Spatial Hotspot & Risk Profiling

Week 8

Map Cartography, Layer Finalization & Data Export

Week 9

Focus on report writing and presentation (including demo) preparation

Week 10

Focus on report writing and presentation (including demo) preparation

5th Feb Final Showcase Day and final report due

Student Experience and Supervision:

How often will you meet with the student over the 10-week period?

4-5 times in first week, once a week in week 2 and 3 (online), 2-3 times a week for the rest

Your work desk location and the location of student desk

402 level 5

Student Attributes:

Please indicate any preference for student's academic discipline or field of study

Any discipline with good technical skills on data structure, analytics and statistical modelling, GIS or any geospatial analysis skill is preferable

What competencies are required to start this project

Advanced - Data structures, analytics, statistical modelling

Advanced - GIS spatial mapping (ArcGIS, QGIS)

Do you have any other student attributes you think are important to the project?

Willing to learn and explore, professionalism