Memorandum

Crash Risk Factors Memo

This memorandum provides a comprehensive analysis aimed at identifying segment risk factors associated with the following crash types: Intersection, Lane Departure, Speed, Bicycle, Pedestrian, and Motorcycle within the Capital Area Metropolitan Planning Organization (CAMPO) area. Intersection risk factors are also further investigated based on total crashes and bicycle/pedestrian crashes only. The objective is to enhance road safety through the identification and analysis of specific characteristics where fatal (K), suspected serious injury (A), and suspected minor injury (B) crashes are most likely to occur. Combined with the reactive safety approach, utilizing the High Injury Network (HIN) and High Injury Intersections (HII), this proactive approach serves to inform effective transportation policies and infrastructure improvements, guiding the allocation of resources to mitigate these types of crashes.

Data

The project team obtained crash, roadway, intersection, transit, multimodal facilities, and traffic data from the North Carolina Department of Transportation (NCDOT). These data included several characteristics such as location, presence of crosswalks, roadway facility type, average speeds, crash type, and crash severity. The team pulled all crash data for the years 2016 to 2023 and Bicycle and Pedestrian crashes for 2014 to 2023. For roadways, the team obtained the data produced in the third quarter of 2024. The project team pulled intersections, transit, multimodal facilities and traffic data in 2024. In addition to these data, NCDOT also provided the Transportation Disadvantage Index (TDI) that includes community characteristics related to social vulnerability.

Beyond NCDOT, the project team obtained K-12 school and university campuses from the Department of Homeland Security's Homeland Infrastructure Foundation-Level Data (HIFLD) database. The project team obtained population and employment data from the U.S. Census Bureau's American Community Survey (ACS) and Longitudinal Employer-Household Dynamics (LEHD) datasets. The Center for Disease Control's (CDC's) Social Vulnerability Index (SVI) was also available at the Census Tract-Level and provided an additional metric of social vulnerability. The project team obtained speed data from RITIS if licensed or from the data vendor INRIX.

Methodology

The scope of work involved analyzing locations where severe crashes are most prevalent across the CAMPO region. The methodological framework is built on three key components:

1. Identifying focus crash types.
2. Identifying focus facility types for these crash types.
3. Identifying risk factors associated with crashes on these facilities.

This memo emphasizes the third component, applying logistic regression models to determine risk factors for each crash type. The project team separated the risk analysis according to crash and facility type (e.g., route segments and intersections). This approach acknowledges the distinct characteristics and contributing factors of both route segments and intersections, thereby enhancing the precision and effectiveness of the analysis.

Overall Risk Analysis Framework

The risk analysis consists of three components, 1) likelihood, 2) exposure, and 3) severity. Each of these components reflect a dimension of a safe system:

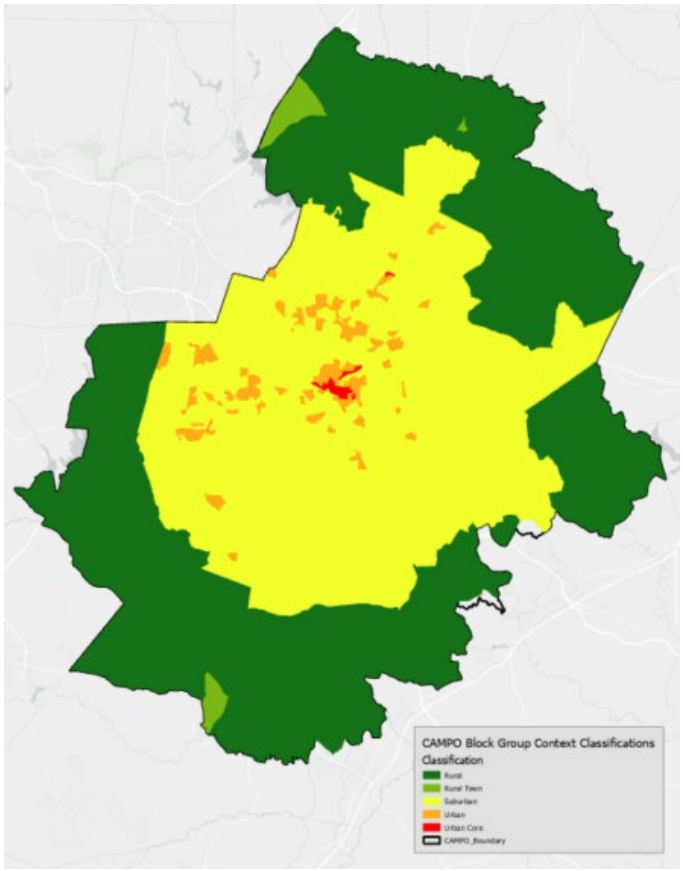
1. **Likelihood:** This represents the presence of a conflict or the potential for a collision to occur.
2. **Exposure:** This represents the presence of (all) road users and the volume of traffic that might travel through an existing conflict.
3. **Severity:** This represents the potential for a collision that does occur to end in a more severe outcome.

Each component informs tools created for the Blueprint for Safety to be applied at priority locations in the CAMPO region.

Context Classification

NCHRP Research Report 1022: *Context Classification Application: A Guide* [1]informed appropriate context classifications that helped determine the character of a given community. The five classifications include: Rural Town, Rural, Suburban, Urban, and Urban Core, and the project team categorized each block group according to classification. The criteria used to determine context classification include: urban flags, municipal flags, intersection density, and building area density.

- If the urban flag was 0, and the municipality flag is 1, it was classified as a Rural Town.
- If it was not urban and the municipality flag is 0, it was classified as Rural.
- For Suburban, Urban, and Urban Core, if the urban flag is 1 and the building area density is greater than 4,500,000 square feet per mile, it was Urban Core; if the intersection density was greater than 110 intersections per square mile than it was Urban, the remaining segments were classified as Suburban (Figure 1).



[1] https://nap.nationalacademies.org/catalog/26819/context-classification-application-a-guide

Figure 1: Capital Area MPO Context Classifications

Likelihood

Using the focus crash types identified in the previous analysis as well as the focus facility types, risk factors were identified for these segment crashes over the CAMPO region using logistic regression. These risk factors include (Table 1):

Table 1: Risk factors for segments based on focus crash types

Factor	Lane Departure	Speed	Bike	Pedestrian	Motorcycle
AADT	+	+	+	+	+
Number of Lanes	-	-	+	+	+
Presence of Transit Stop	--	--	Yes	Yes	--
School or University Proximity	Yes	Yes	Yes	Yes	--
Zero Vehicle Households	--	--	+	+	--
Context Classification	Urban Core or Urban	Urban Core, or Rural	Urban Core or Urban	Urban Core	Urban Core, Urban, or Suburban
Population and Employment Density	+	+	+	+	+
SVI Overall Score	+	Yes	--	+	+
Route Class	US Route NC Route Secondary Route	US Route NC Route Secondary Route	--	US Route	US Route NC Route Secondary Route

Once these factors were identified, the project team created "probabilities" (i.e., a likelihood of a crash) for each roadway segment in the CAMPO region based on these factors. For example, if a roadway had higher AADT, fewer lanes (e.g., 2 lanes), had a high SVI, was a Secondary Route, and in Franklin County, this segment would have a higher probability of a K, A, or B lane departure crash occurring.

Using the focus crash types identified in the previous analysis as well as the focus facility types, risk factors were identified for these intersection crashes over the CAMPO region using logistic regression. These risk factors include:

Table 2: Risk factors for intersections based on focus crash types

Factor	Intersection – All Crashes	Intersection- Bike/Ped Crashes
Intersection AADT	+	+
Number of Legs	4+	4+
Signalized	Yes	Yes
Interchange Ramp Terminal	--	--
Intersection Angle <70 Degrees	Yes	--
Transit Stop Proximity	Yes	Yes
School, College or University Proximity	No	Yes
Zero Vehicle Households	--	+
Population and Employment Density	+	+
Context Classification	Rural or Rural Town	Urban Core or Urban
SVI Overall Score	--	+

Once these factors were identified, the pro team created probabilities for each CAMPO intersection based on these factors. For example, if an intersection had higher AADT, four or more legs, was signalized, had an intersection angle <70 degrees, close to a transit stop, in a rural town, in an area with a high SVI score, and located in Wake County, there is a higher probability of a K, A, or B crash happening at that intersection (Table 2).

Exposure

VHB developed an exposure map to offer a multimodal understanding of road usage patterns and potential risks (Figure 21). The exposure map is instrumental in answering the crucial question of whether there is an expectation of an increase in the number of road users or a greater diversity in types of road users. This includes both traffic volumes (i.e., AADT) and context classification for non-motorized users. The exposure map helps identify high risk areas that may require additional safety measures due to 1) higher traffic volume, 2) higher likelihood of non-motorized travel demand, and 3) the confluence and mixing of road users across modes.

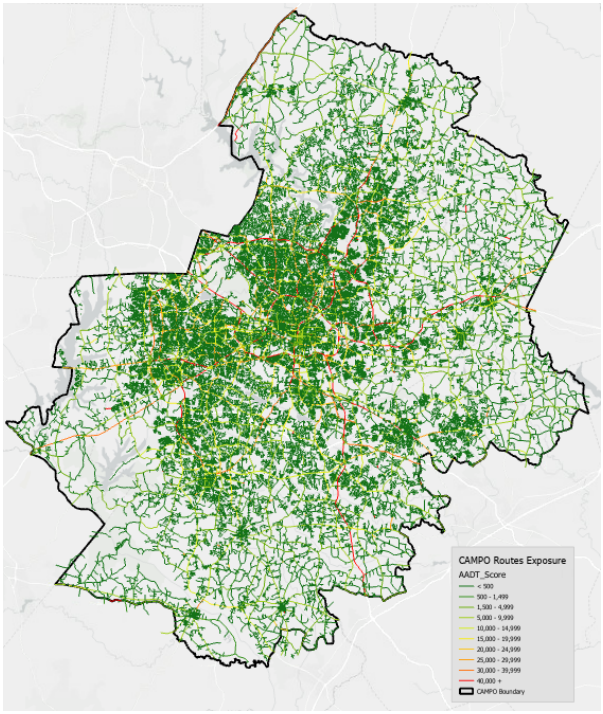


Figure 1: Capital Area Metropolitan Planning Organization Traffic Volumes

Severity

To complete the risk assessment, a severity layer based on the 85th percentile of speed during workdays for a 24-hour period was created (Figure 32). The severity helps inform CAMPO and regional jurisdiction staff understand where kinetic energy on the road is highest, and collisions that occur at these locations will tend to be more severe.

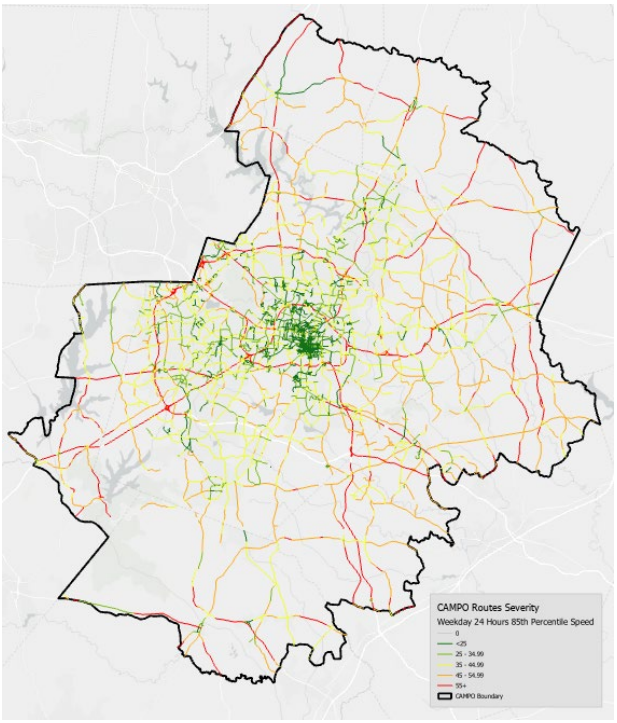


Figure 2: Capital Area Metropolitan Planning Organization Severity

Conclusion

This memo provides a detailed analysis of roadway and intersection risk factors that contribute to severe crashes across the CAMPO region. Using findings from previous analyses and logistic regression models, segment risk factors were found for Intersection, Lane Departure, Speed, Bike, Pedestrian, and Motorcycle crashes. The exposure and severity maps complement this analysis by contributing the 1) number and type of road users that might travel on higher risk roads and the 2) speed or kinetic energy at which these collisions might occur. Where the conflict is present (likelihood), a high number of road users are present (exposure), and speeds are high (severity), there is a higher likelihood of a fatality or serious injury to occur. The combined approach allows for strategic allocation of resources ensuring proactive measures are in place to mitigate crash risks and improve overall road safety in the region.