Conflict Point Safety Performance Functions for the Planning-Level Safety Evaluation of Alternative Intersections

Taehun Lee[1], Shannon Warchol[2], Christopher M. Cunningham[2], and Thomas Chase[2]

ITRE — NC STATE UNIVERSITY

OVERVIEW

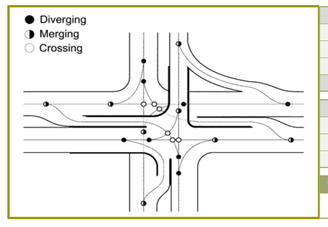
Due to the difficulty of comparing safety across multiple geometries, the state-of-the-practice planning level safety evaluation for alternative intersections is limited to the conflict points (CP) totals. To support the planners in selecting the best design for each site, this study suggests a new planning level approach for safety evaluation. As the project is on-going, this poster only includes the suggested methodology and expected contributions

OBJECTIVES

- Develop a quantitative methodology for the planning level safety evaluation of alternative intersections
- Develop the conflict point safety performance function (CP-SPF) to predict the crashes for conflict points, which can be aggregated for the intersection safety evaluation
- CP-SPF can compare the safety performance between the alternative intersections for a given traffic volume

Limitations of Existing Methodology

Virginia DOT developed VJuST which considers the different crash severity according to the CP types



Conflict Type	Count
Crossing	6
Merging	8
Diverging	8
Total	22

Step 1

Conflict Type	Weight
Crossing	2
Merging	1
Diverging	1

Step 2

Weighted Total Conflict Points
28

Step 3

Step 1 Count the Conflict Points (Crossing / Merging / Diverging) → **Step 2** Weighting System (Weight X CPs) → **Step 3** Weighted Total Conflict Points

[VJuST Safety Evaluation Process]

Limitations

- Assumed same crashes at every CP regardless of CP types
- Did not consider the different crash rates for the CP types
- Did not consider the impact of traffic volume on crashes

RESEARCH FLOW

STEP 1
Data Collection

33 sample sites in North Carolina → Collect → Crash Data, Traffic Volume Data

STEP 2
Classify Crashes into CP Types

Crash Data → Crash Info → Crossing / Merging / Diverging

STEP 3
Calculate the Conflict Point Volume

- CP volumes are determined based on the movement AADTs
- Movement AADT is calculated by
  - TM Counts (%)
  - AADT

STEP 4
Estimate CP-SPF

Datasets → Estimate → Conflict Point Safety Performance Functions

STEP 1 DATA COLLECTION

Collect Data from 33 Sample Sites in North Carolina

- 15 Conventional Intersections
- 6 Conventional with Channelized Lane
- 4 Single Point Urban Interchanges (SPUI)
- 7 Partial Restricted Crossing U-Turn (RCUT)
- 1 Diverging Diamond Interchange (DDI)

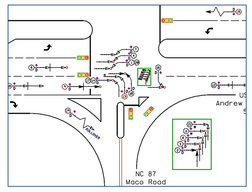
- **Crash data**
  - Crash Severity
  - Crash Type & Location
  - Vehicle Maneuver
- **Traffic Volume**
  - Turning Movement Counts
  - AADT

STEP 2 CRASH CLASSIFICATION

Determine the CP for each crash where it occurred based on

- **Crash Type**
- **Crash Location**
- **Vehicle Maneuver**

* For the CP crash prediction, exclude the non-conflict point crashes (e.g. rear-end or ran-off crashes)

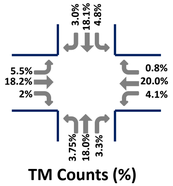


Example of Conflict Diagram

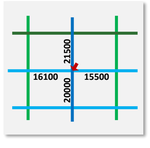
STEP 3 CALCULATE CONFLICT POINT VOLUME

Multiply the proportions (%) of TM counts to AADT to compute the movement AADT

Example Calculations



TM Counts (%)



AADT

Movement	TM (%)	ΣAADT/2	Movement AADT
SBL	0.03	36550	1097
SBT	0.181	36550	6616
SBR	0.048	36550	1754
NBL	0.0375	36550	1371
NBT	0.18	36550	6579
NBR	0.033	36550	1206

Movement AADT

CPV (Conflict Point Volumes)

- Two movement AADTs passing a conflict point are the major and minor CPVs
  - Higher volume = Major CPV
  - Lower volume = Minor CPV

Concept of CP Volume

STEP 4 ESTIMATE CP-SPF

Complete the dataset for the estimation of CP-SPF
Each row includes the conflict-level crash and volume data

Example of Dataset for Model Estimation

Site No.	CP Type	CP Code	Crash	CPV_{Major}	CPV_{Minor}
1	Diverging	D1	2	6,600	4,350
1	Diverging	D2	1	5,300	3,800
⋮					
33	Merging	M1	3	7,900	5,200

Model Structure of CP-SPF

$$N = \exp(\alpha_i + \beta_{Major} \cdot ln(\mathrm{CPV}_{Major}) + \beta_{Minor} \cdot ln(\mathrm{CPV}_{Minor}))$$

N	: predicted number of crashes for the CP;
α_i	: constant for CP type i (crossing, merging, diverging);
β_i	: coefficient for major and minor CP volumes;
CPV	: major and minor CP volumes (unit: veh/day);

INTERSECTION-LEVEL SAFETY EVALUATION

- CP-SPF predicts the number of crashes for a conflict point for a given traffic volume
- The predicted crashes can be aggregated to evaluate the intersection-level safety performance
- To consider the severity, the EPDO weights can be multiplied to the average severity for the CP types
- As the CP-SPF predicts the CP crashes as surrogate safety, the non-CP crashes (e.g. rear-end, ran-off, etc.) are excluded in the analysis

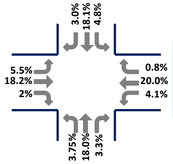
Calculation of EPDO crashes

- Equivalent Property Damage Only crashes
- EPDO weights can be multiplied to the average severity for each CP type

Crash Severity	EPDO
Killed or A	76.8
B or C	8.4
Property Only or Unknown	1.0

NC DOT – EPDO Weights

Intersection-Level Safety Evaluation



AADT & TM counts (%)

CP-SPF & Severity

CP Type	EPDO CP Crashes		
	Conventional	SPUI	RCUT
Crossing	132	136	48
Merging	48	35	65
Diverging	24	20	42
Total	204	191	155

EPDO crashes for each intersection design

* The above figure and table show the examples of inputs and output

CONTRIBUTIONS

Quantitative Methodology for Safety Evaluation

- While the existing methodology only provides the fixed outputs, the CP-SPF evaluates the safety performance that varies according to the traffic volumes

Application to Alternative/Nonexistent Designs

- The suggested methodology compares the surrogate safety between various alternative or nonexistent intersections for a given traffic volume like the CAP-X

AUTHORS

1 PhD student in Transportation Systems Engineering at North Carolina State University
2 Institute for Transportation Research and Education (ITRE) at North Carolina State University