Application: 7043

UW-Madison

Page: Applicant Information

Team Name

UW-Madison

Category

Student Category

Key Contact First Name

Erynn

Key Contact Last Name

Schroeder

Key Contact Address

3955 Orleans Ln N
Plymouth Minnesota 55441 US

Key Contact Email

eschroeder6@wisc.edu

Key Contact Phone Number

+1 651-756-0245

Company or University Name

University of Wisconsin - Madison

How many are on your team?

4

Provide the names of additional team members

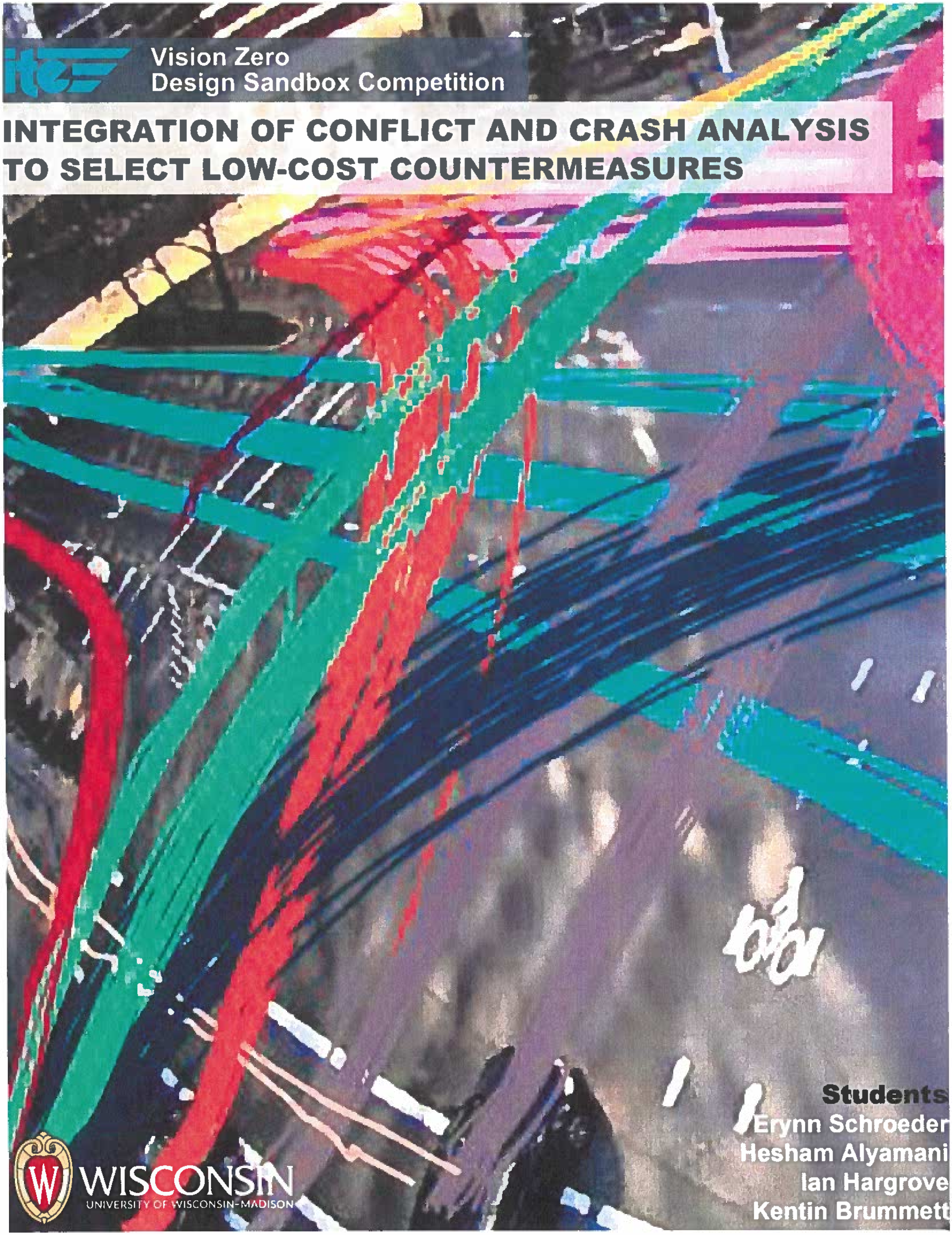
Hesham Alyamani, Kentin Brummett, Ian Hargrove

Presentation upload

Download File

Vision Zero
Design Sandbox Competition

INTEGRATION OF CONFLICT AND CRASH ANALYSIS TO SELECT LOW-COST COUNTERMEASURES



Students
Erynn Schroeder
Hesham Alyamani
Ian Hargrove
Kentin Brummett

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

INTRODUCTION

In response to the ITE Vision Zero Design Competition, a team of graduate students (UW-Madison) developed a methodology to demonstrate how conflict data collected through innovative technologies can be used to gain new insights into safety and selection of low-cost countermeasures at intersections. The main objective of the research was to develop analitical procedures, transferable and adaptable to any community, by integrating traditional and alternative data, using conventional methods for safety analysis, and providing statistical software code for modeling. The proposed methodology not only focuses on a process to select low-cost countermeasures but also to evaluate the effectiveness of countermeasures after implementation using **Extreme Value Theory** (EVT).

Selection of Low-Cost Countermeasures

Figure 1 illustrates the methodology to select low-cost countermeasures. The approach integrates traditional and alternative data. Traditional data consist of intersection geometry, traffic, and crash data. Alternative data consist of conflict data using the Post Encroachment Time (PET) as safety surrogate.

In the data analysis, selected data elements from conventional and alternative data are considered. The focus is on **critical conflicts** (PET < 2 s), number of lanes, presence of sidewalks, signal control type, traffic volumes by movement, and bike/ped volumes. The objective is to identify associated movements leading to the most frequent critical conflicts. Data analysis facilitates the process to identify **safety targets** and evaluate potential safety improvements by type of collision, crash severity, location, and users involved.

Following traditional safety analysis, Crash Modification Factors (CMFs) can be applied to safety targets and **potential crash reduction** can be quantified. CMFs and **cost of implementation** for several proven low-cost countermeasures in the literature were considered. From a combination of safety targets, potential crash reduction, **crash cost**, and cost of treatment; the benefit-cost ratio can be obtained. Since we are dealing with low-cost countermeasures, most B/C ratios will be high. Thus, not only does the B/C ratio need to be considered but also the treatment must specifically target safety needs associated with movements and location of critical conflicts to select countermeasures with the highest potential for reducing risk and crashes.

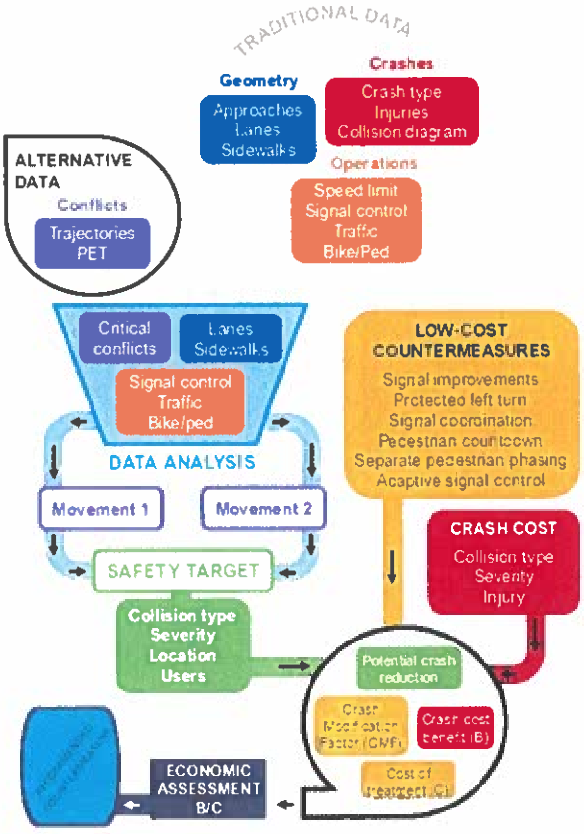


FIGURE 1 Countermeasure selection methodology

Countermeasure Effectiveness Evaluation

Conflict data available can be used to model risk and estimate extreme events using EVT. The methodology consists of using before and after data, EVT modeling, and quantify the change in risk with the treatment to determine the effectiveness of the intervention. Thus, after the implementation of the treatment, additional conflict data would be required. Although the approach is similar to conventional safety effectiveness evaluations, conflict data can be collected right after the implementation (days or weeks) in comparison to historical crash data that would require several years to obtain reliable estimates. Conflict data and EVT provide a proactive approach to manage risk and evaluate the effect of treatments after implementation.

LITERATURE REVIEW

The research team conducted a literature review of implementations of the TRANSOFT Solutions video-based road safety analysis in other jurisdictions, conflict analysis theory, low-cost intersection countermeasures, and crash costs.

TRANSOFT Solutions Video-Based Road Safety

There have been several experiences and applications using the video-based road safety analysis product from TRANSOFT Solutions in the City of Toronto, Midtown Atlanta, Oakland County, and the City of Prince George.

The implementation in the City of Toronto focused on curb radius reduction and pedestrian safety. Conflicts were evaluated before and after the curb radius reduction, and results validated the hypothesis that the curb radius treatment reduced conflict rates and speed of turning vehicles, resulting in improved safety for pedestrians (1). Similarly, in Midtown Atlanta, conflicts were evaluated before and after the implementation the all-walk phase for pedestrians at a signalized intersection. The results of the study showed that the all-walk phase reduced pedestrian conflict rates by 75% (2). In the case of Oakland County, a cross-sectional safety study of four roundabouts was conducted. The findings of the study indicated that speeding and high frequency of unexpected movements at the roundabouts were the main factors resulting in conflicts and possibly collisions (3). At an intersection in the City of Prince George, several treatments were implemented: change of permissive left turn phasing to protected phasing, increase of pedestrian crossing time, and the addition of pedestrian counters. Before and after implementation, vehicle speed, road user type, and road user arrival patterns were evaluated. The aggregated benefit of all implemented treatments was evaluated with the results confirming that treatments were very effective at minimizing conflict risk at this intersection (4).

Conflict Analysis Theory

Crash-based safety analysis is somewhat limited due to the infrequent and random nature of crashes. Months of data collection are insufficient and up to three years of crash data collection is required, which makes it difficult for transportation engineers to analyze safety performance for facilities with poor or little to no crash data. Methods without a dependency on historical crash data are needed (5).

Post encroachment time (PET) serves as a safety surrogate, and it is defined as the time between the first vehicle leaving the conflict zone and the second vehicle entering the conflict zone. A crash corresponds to a PET value of zero. A smaller PET value corresponds to a higher likelihood of a crash. Figure 2 illustrates the PET represented by $t_2 - t_1$ (5).

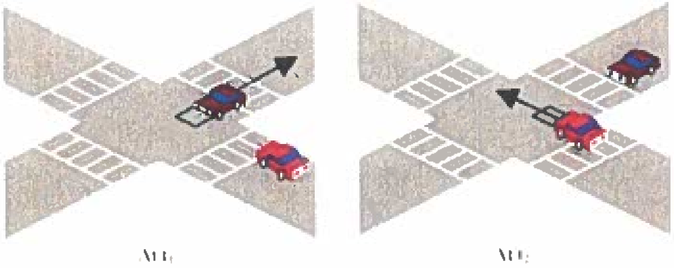


FIGURE 2 Post Encroachment Time (PET) Illustration (5)

For roadway interactions, higher frequency events typically have a lower associated risk. "Accidents" or crashes tend to occur less frequently but are of the highest risk. Figure 3 shows the relationship between risk and frequency of traffic events. Risk and frequency relationship can be modeled to associate conflicts with crashes. The EVT can be used to model crash frequency and risk. EVT models the extremes of a distribution and is useful when modeling datasets that are stochastic and particularly large or small. Datasets representing infrequent behaviors with insufficient historical observational data can be modeled. The modeling process is based on finite-level approximations and extrapolated with the assumption that it is adequately smooth (6, 7).

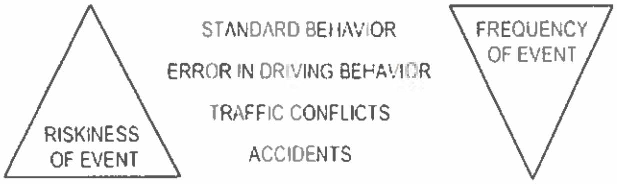


FIGURE 3 Post Encroachment Time (PET) Illustration (6)

Low-Cost Intersection Countermeasures

The goal of this research project is to select countermeasures to reduce risk, crashes, and severity by implementing low-cost treatments—$50,000 or less. Recommended and proven intersections treatments were selected from national guidance (8, 9) which focus on: improvements to traffic control devices including signs, signal timing, pavement markings, coordination of signal timing, and pedestrian treatments. Table 1 provides a list of proven low-cost countermeasures with corresponding CMFs, safety target, and approximate implementation cost. The CMF is a representation of the effect of treatments on specific crashes (safety targets). For instance, the safety effect of implementing separate pedestrian phasing has a CMF of 0.66, which means that a reduction of 34% in pedestrian crashes is expected after implementation.

TABLE 1 List of Low-Cost Countermeasures (8, 9).

No.	Countermeasure	CMF	Safety Target	Cost Range
1	Basic set of signals and sign improvements	0.70	All crashes	$5,000-$30,000
2	Permissive to protected only left turn phase	0.55	Left turn crashes	$5,000-$10,000
3	"Signal Ahead" warning signs	0.78	All crashes	$1,000
4	Supplemental signal face per approach	0.72	All crashes	$5,000-$15,000
5	Advance detection control systems	0.60	Injury crashes	$15,000
6	Signal coordination	0.68	All crashes	$5,000-$50,000
7	Pedestrian countdown signals	0.75	Pedestrian crashes	$5,000-$15,000
8	Separate pedestrian phasing	0.66	Pedestrian crashes	$5,000-$15,000
9	Crosswalk and pedestrian warning signs	0.85	Pedestrian crashes	$1,000-$3,000
10	Adaptive signal control	0.95	All crashes	$30,000-$50,000

Crash Costs

Since police reports often do not accurately describe injuries because of perception of injury, reporting thresholds, and different severity definitions among states, Council et al. (10) used the National Highway Traffic Safety Administration (NHTSA) national datasets, which included both police reported KABCO and medical descriptions of injury in the Occupant Injury Coding system (OIC), to develop crash costs. Council et al. (10) defined "cost estimate" as both human capital cost and comprehensive cost. Crash cost estimation requires information on the number of people involved in each crash, severity of injuries each person suffered in the crash, costs associated with the injuries, and costs related to vehicle damage and travel delay (10, 11). Table 2 provides crash costs by crash type in 2020 dollars, updated using the Consumer Price Index (CPI) and the Median Usual Weekly Earnings (MUWE) economic indicators (11).

TABLE 2 Crash Cost by Crash Type (10, 11).

Crash Type	Economic Crash Cost	Other Cost	Comprehensive Crash Cost
Rear-end	$24,410	$16,622	$41,031
Angle	$35,518	$38,230	$73,748
Sideswipe/change lanes	$25,725	$27,259	$52,985
Pedestrian/bike	$106,409	$143,112	$249,521
Fixed object	$57,882	$91,585	$149,467
Other/undefined	$35,664	$51,028	$86,693

METHODOLOGY

Intersection Data Screening

Data provided as part the competition material were reviewed. Geometry, signals, traffic, crash data, conflict data, and sample videos were reviewed to assess the features of each of the six intersections provided. Specifically, the average PET, amount of conflict data, peak hour factor (PHF), total entering volume (TEV), heavy traffic percentage, bicycle volumes, pedestrian volumes, and traffic volume were reviewed at each intersection. Also, available crash data by year and conflicts by road user type, movement, and severity were carefully reviewed. Data screening of all intersections was conducted to select three intersections for the study. The research team concluded that intersections with significant number of crashes per year, sufficient conflict data for EVT modeling, and representative traffic volumes were the parameters that were of interest when selecting intersections for analysis.

Selection of Intersections for Analysis

With the objective to confidently assess safety and recommend countermeasures to address safety issues, number and consistency of crashes, conflicts, and traffic data were considered for selection. Thus, in Table 3, the following three intersections were selected for analysis.

TABLE 3 Description of Selected Intersections.

Description	Bellevue Way & NE 8th St	112th Ave NE & NE 8th St	124th Ave NE & NE 8th St
Number of legs	4	5	4
Left turn signal phasing[1]	PO	PO	PP and P
Central business district	yes	yes	no
Peak traffic volume (vph)[2]	3,548	5,524	2,825
Pedestrian volume (pph)[3]	746	82	14
PHF[4]	0.96	0.96	0.95
Safety related event observations	29,507	21,303	31,616
Critical conflicts (PET < 2 s)[5]	104	248	1810
Number of crashes (5 yr)[6]	49	70	32

Notes: [1] PO = protected only, PP = protected permissive, P = permissive [2] vph = vehicles per hour [3] pph = pedestrians per hour [4] PHF = peak hour factor [5] PET = post encroachment time, s = seconds [6] yr = years

Data Analysis

Data analysis consisted of evaluating critical conflicts by severity. Figure 4 shows the thresholds of PET values that were used. Through exploratory data analysis, pivot tables were generated to count conflicts by PET threshold and identify pairs of movements that showed the largest number of critical conflicts. Figure 5 shows an image of the pivot table and how pairs of movements were identified with counts of critical conflicts at the 112th Ave NE & NE 8th St intersection. Once these pairs of movements were identified, geometric, signal control, and traffic volumes were reviewed to gather additional information for the specific movements and determine safety issues. Similarly, for EVT modeling, distribution of conflicts was analyzed for each pair of movements and all aggregated data. Conflicts distributions were visualized through pivot charts to assess the end tails of the distributions. PET threshold of five seconds was selected to classify exceedances and developed regression models with the EVT approach. Figure 6 provides the example of distribution of overall conflicts after data cleaning at the 112th Ave NE & NE 8th St intersection (CC = critical conflicts, MC = minor conflicts, PC = potential conflicts, and I = interactions).

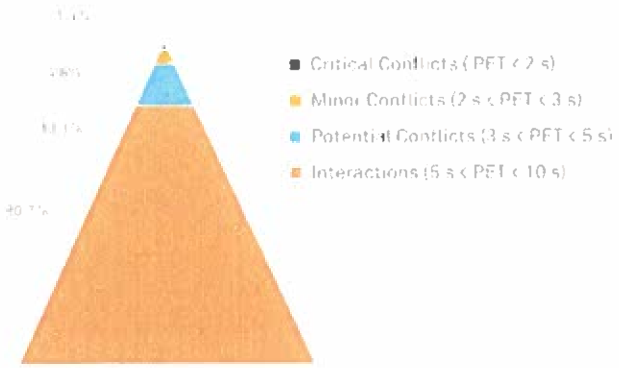
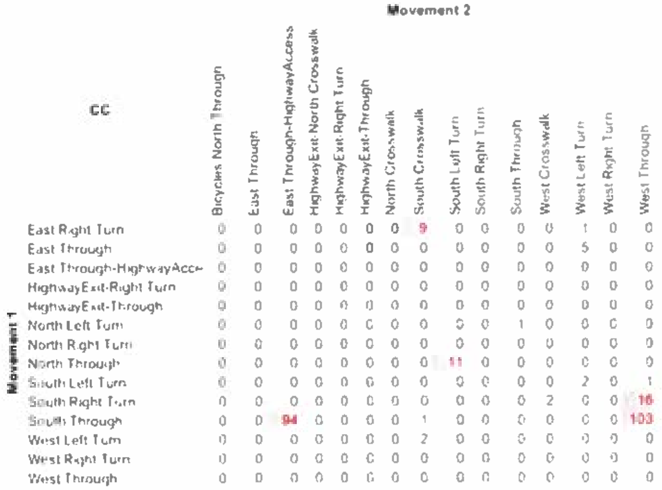


FIGURE 4 Frequency of interactions with different post encroachment times (PET) (12)



Movement 2

Movement 1

CC	Bicycles North Through	East Through	East Through-HighwayAccess	HighwayExit-North Crosswalk	HighwayExit-Right Turn	HighwayExit-Through	North Crosswalk	South Crosswalk	South Left Turn	South Right Turn	South Through	West Crosswalk	West Left Turn	West Right Turn	West Through
East Right Turn	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0
East Through	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
East Through-HighwayAcce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HighwayExit-Right Turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HighwayExit-Through	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Left Turn	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
North Right Turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Through	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
South Left Turn	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
South Right Turn	0	0	0	0	0	0	0	0	0	0	0	2	0	0	16
South Through	0	0	94	0	0	0	0	1	0	0	0	0	0	0	103
West Left Turn	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
West Right Turn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Through	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FIGURE 5 Critical conflicts pivot table for the 112th Ave NE & NE 8th St intersection

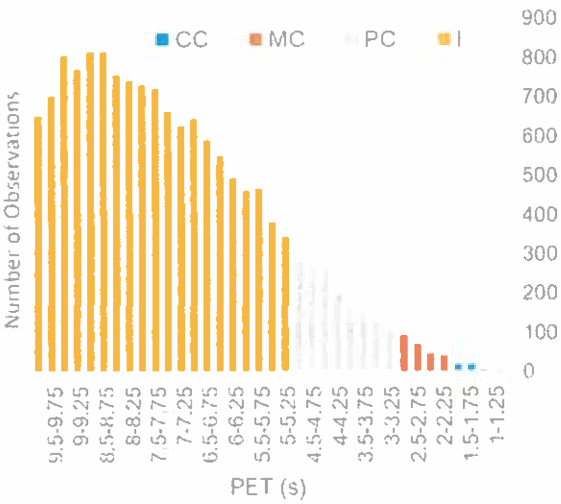


FIGURE 6 Distribution of conflicts at the 112th Ave NE & 8th St intersection

Treatment Selection

The process to select a low-cost countermeasure consisted in evaluating the safety needs identified at each intersection through conflict analysis and the effect of countermeasures in terms of the magnitude of crash reduction. Thus, historical crash data was used as reference to estimate how many of those crashes would be reduced if a treatment were to be implemented. Once the estimated benefit in terms of crashes was identified for a specific safety target (crash type or severity), the cost of those crashes was quantified and weighted against the cost of the treatment to obtain a benefit-cost (B/C) ratio. It is expected to have high B/C ratios since treatments considered have low cost of implementation. Thus, not only does the treatment need to be cost effective but it also must specifically target safety issues identified at the intersection through conflict analysis.

EVT Modeling

Exceedance distributions were considered with the extreme value theory which deals with asymptotic distribution of extreme order statistics. The Generalized Pareto (GP) distribution was chosen with a PET univariate approach. The GP distribution applies to tails of distributions with values that exceed a specific threshold (Figure 7). The GP distribution with a shape parameter of zero essentially applies to tails that follow an exponential distribution. Positive shape parameters apply to tails that decrease as a polynomial or as heavy tails such as Student t distribution. Negative shape parameters apply to light finite tails such as a beta distribution. The GP distribution is defined as (7):

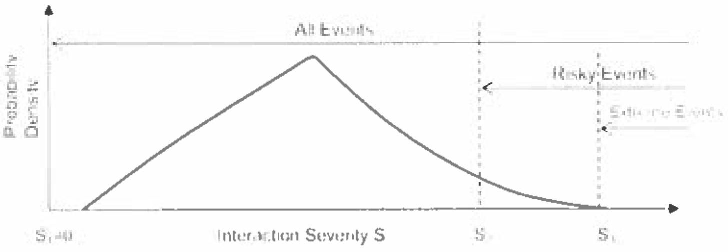


FIGURE 7 Illustration of EVT modeling (7)

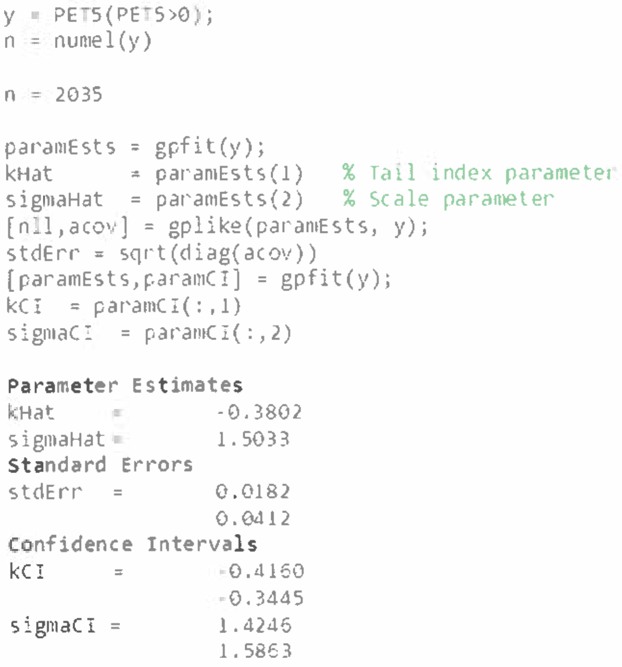
$$P(S > D_2|x_3) = 1 - F(D_2|x_3) \tag{1}$$

$$f(S|x_3) = \begin{cases} \frac{1}{\sigma} \times \left(1 + k \times \frac{S-\theta}{\sigma}\right)^{-1-\left(\frac{1}{k}\right)} & for\ (k > 0\ and\ \theta < S)\ or\ \left(k < 0\ and\ \theta < S < -\frac{\sigma}{k}\right) \\ \frac{1}{\sigma} \times e^{-S-\frac{\theta}{\sigma}} & for\ k = 0\ and\ \theta < S \end{cases} \tag{2}$$

Where

S = transformed risk event severity,
D_2 = threshold collision proximity,
x_3 = exogenous conditions under which the GP distribution is homogeneous,
F = cumulative GP distribution,
f = GP probability density function,
k = shape parameter,
σ = scale parameter.

The event severity S to fit the probability distribution is determined based on data element measures and specified thresholds. For instance, if an observation exceeded a threshold of PET < 5 s, it was considered as a conflict event and used for modeling. For this research, statistical software MATLAB and the GP with the EVT approach was used for modeling these exceedances. Modeling results provided the shape and scale parameters which can be used in equations 1 and 2 to compute the conditional probabilities of risky and extreme events (Figure 7) with the cumulative distribution and density functions. The results of the process provide the estimated risk and number of extreme events. A limitation of the method lies in estimating another threshold for obtaining extreme events which in this case would be crashes. Although (by definition) a corresponding exceedance of a PET = 0 s would provide such threshold, automated video processed estimates carry some degree of error to which the GP model is very sensitive. Fortunately, GP models can be adjusted with historical crash data to produce reliable estimates by obtaining a calibrated threshold for extreme events (crashes). The calibration process can easily be performed using the solver tool in Excel™ by matching the objective function (EVT estimated crashes), observed crashes, and specifying the extreme event threshold as the changing variable. Thus, calibrated GP models in this study when compared to yearly historical crash estimates provided accurate estimates very similar to observed data. Figure 8 provides an example of the MATLAB code and results of a EVT model. The research team is familiar with MATLAB, but other free statistical software such as R may be used as well.



```
y = PET5(PET5>0);
n = numel(y)

n = 2035

paramEsts = gpfit(y);
kHat       = paramEsts(1)    % Tail index parameter
sigmaHat   = paramEsts(2)    % Scale parameter
[nll,acov] = gplike(paramEsts, y);
stdErr = sqrt(diag(acov))
[paramEsts,paramCI] = gpfit(y);
kCI   = paramCI(:,1)
sigmaCI   = paramCI(:,2)

Parameter Estimates
kHat      =          -0.3802
sigmaHat =           1.5033
Standard Errors
stdErr    =          0.0182
                     0.0412
Confidence Intervals
kCI       =          -0.4160
                     -0.3445
sigmaCI =            1.4246
                     1.5863
```

FIGURE 8 Example of MATLAB code and results

Treatment Effectiveness Evaluation

Evaluating the effectiveness of treatments after implementation requires a more rigorous statistical approach. Although the case studies conducted at different jurisdictions performed before and after studies which provide valuable metrics of conflict and risk reduction, the EVT modeling approach is proposed to produce rigorous before and after risk estimates, calibrate thresholds to estimate crashes, and quantify the effect of the treatment. For this purpose, additional conflict data will be required after the implementation of treatments. An EVT model would be developed with after data. Shape and scale parameters of before and after models would be compared to assess the change in model coefficients. Before and after risk and crash estimates would also be compared to quantify the safety effectiveness.

Transferability to Other Communities

Implementing the proposed methodology to other jurisdictions can be made possible by simply filtering safety event data and identifying critical conflicts. A traffic engineer can create pivot tables and charts which can be tabulated and formatted on a spreadsheet tool to automatically perform the conflict analysis. Similarly, a list of low-cost countermeasures that fit the jurisdiction needs, policies, and procedures can be developed with available CMFs and local costs of implementation. Crash costs can also be selected according to the jurisdiction preferences. One approach that may seem to require high levels of statistical knowledge is EVT modeling. However, as shown in Figure 8, MATLAB has a simple code that can be used to model using the GP distribution. A traffic engineer may review available MATLAB guidance with illustrative step by step examples of the **gpfit** function. It may take a small amount of time to learn how to prepare the data, select thresholds, import data, run the code, and interpret the results. Access to MATLAB may be a limitation due to its purchase price, so free statistical software such as R has even more capabilities and resources to model and conduct extreme value analysis. Calibration of the models may also seem complex. However, it can easily be performed using the solver tool in Excel^{TM} by matching the objective function (EVT estimated crashes), observed crashes, and specifying the extreme event threshold as the changing variable. Thus, a traffic engineer in any size municipality, if provided with conflict data, should be able to obtain the necessary resources and analysis tools to implement the proposed approach.

RESULTS

Bellevue Way & NE 8th St

Movement pairs with the highest number of critical conflicts where identified, all of which involve pedestrians at crosswalks. Table 4 provides a summary of critical conflicts by movements. Pedestrian volumes ranged between 153 to 251 pedestrians during 4-6 PM.

Since most critical conflict movement pairs involved crosswalks (Figure 9), countermeasures with CMFs targeting pedestrian crashes were considered. The intersection already has pedestrian countdown timers but could benefit from **1) exclusive pedestrian phasing and 2) higher visibility crosswalks and advanced pedestrian warning signs** on all approaches. To predict the value of these countermeasures, a benefit-cost analysis was performed. The selected treatments have a total cost of $18,000 ($15,000 and $3,000, from Table 1) and the aggregated crash cost benefit is $219,079, resulting in a benefit-cost ratio of 12.2.

TABLE 4 Critical Conflicts Bellevue Way & NE 8th St.

Movement 1	Movement 2	Critical Conflicts
North crosswalk	West right turn	20
South crosswalk	East right turn	15
East crosswalk	North right turn	11
South crosswalk	South through	10

FIGURE 9 Pedestrian conflict at Bellevue Way & NE 8th St

The EVT model results (k = -0.3756 and σ = 1.5058) indicated an overall risk of 0.000036 at the intersection with a calibrated PET threshold of 1.0019 s (or 3.9981 s exceedance to PET = 5 s) to estimate crashes. A total of 49 observed crashes were used for calibration. Model estimates may be used to follow up and determine the effectiveness of the treatment to reduce risk and crashes.

124th & NE 8th

Some of the highest number of critical conflicts were between left turning and through vehicles (Table 5). During a five-year period, 25 of the 32 crashes were angle or approach turn crashes. Also, the intersection has protected-permissive and permissive left turn signal phasing with left turn volumes of up to 219 vph.

TABLE 5 Critical Conflicts 124th & NE 8th

Movement 1	Movement 2	Critical Conflicts
East left turn	West through	712
East through	West left turn	317
North through	South left turn	105
North left turn	South through	62

Due to the high number of left turning drivers actively looking for acceptable gaps in through traffic during the permissive phase (Figure 10), the implementation of **protected left turn only phase** is recommended. The assumed cost of the treatment to change the left turn signal operation to protected only is $10,000 (from Table 1) and the aggregated crash cost benefit is $829,666, resulting in a benefit-cost ratio of 83.0.

FIGURE 10 Left turn conflict at 124th & NE 8th

The EVT model results (k = -0.3586 and σ = 1.4880) indicated an overall risk of 0.000089 at the intersection with a calibrated PET threshold of 0.8786 s (or 4.1214 s exceedance to PET = 5 s) to estimate crashes. Model estimates may be used to follow up and determine the effectiveness of the treatment to reduce risk and crashes.

112th & NE 8th

The intersection has a complex geometry (six legs, bike lanes, dual left turns, serves as ramp terminal) and is located in a commercial/office area. The eastbound approach has red light running enforcement. Crash data showed that there were an overall of 69 crashes (not 70, typo in pedestrians crashes of provided data) over five years. Most crashes were rear end and right angle crashes.

TABLE 6 Critical Conflicts 112th & NE 8th.

Movement 1	Movement 2	Critical Conflicts
South through	West through	103
South through	East through-hwy	94
South right	West through	16
North through	South left	11
East right	South crosswalk	9

Evaluation of critical conflicts helped identify the pair of movements with safety issues. Table 6 provides the list of movements and the corresponding number of critical conflicts. The results indicate that the southbound approach is associated with the most significant number of critical conflicts, Figure 11(a). The eastbound right turn is also of concern due to the presence of a channelized island and red light camera enforcement which may distract drivers from encountering pedestrians in the south crosswalk illustrated in Figure 11(b). The implementation of **signal coordination** (if not already in place) and **separate pedestrian phasing** is recommended. Selected treatments have a total cost of $65,000 ($50,000 and $15,000, from Table 1) and the aggregated crash cost benefit is $1,591,741, resulting in a benefit-cost ratio of 24.5.

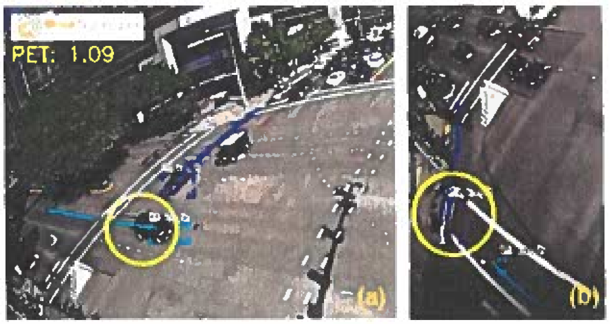


FIGURE 11 Through and ped conflicts at 112th & NE 8th

The EVT model results (k = -0.3802 and σ = 1.5033) indicated an overall risk of 0.000236 at the intersection with a calibrated PET threshold of 1.0763 s (or 3.9237 s exceedance to PET = 5 s) to estimate crashes.

CONCLUSIONS

A team of graduate students (UW-Madison) developed a methodology to demonstrate how conflict data collected through innovative technologies can be used to gain new insights into safety, selection of low-cost countermeasures at intersections, and effectiveness evaluation.

The proposed approach integrates traditional and alternative data keeping in mind that application should be transferable and adaptable to other communities. The focus is on critical conflicts (PET < 2 s), geometry including number of lanes and presence of sidewalks, signal control type, traffic volumes by movement, and bike/ped volumes. The objective is to identify associated movements leading to the most frequent critical conflicts. Data analysis facilitates the process to identify safety targets and evaluate potential safety improvements by type of collision, crash severity, location, and users involved. CMFs and cost of implementation for several proven low-cost countermeasures in the literature were considered. From a combination of safety targets, potential crash reduction, crash cost, and cost of treatment; the benefit-cost ratio can be obtained. The treatment must specifically target safety needs associated with movements and location of critical conflicts to select countermeasures with the highest potential for reducing risk and crashes.

Conflict data available can be used to model risk and estimate extreme events using EVT. The methodology consists of using before and after data, EVT modeling, and quantify the change in risk with the treatment to determine the effectiveness of the intervention. Conflict data and EVT provide a proactive approach to manage risk and evaluate the effect of treatments after implementation.

ADVISORS

Boris Claros, PhD
Assistant Researcher
TOPS laboratory
University of Wisconsin – Madison

David A. Noyce, PhD, P.E., F.ITE
Arthur F. Hawnn Professor
TOPS laboratory
University of Wisconsin – Madison

REFERENCES

1. TRANSOFT Solutions. Presentations and Case Studies: City of Toronto. 2020. Retrieved from: https://safety.transoftsolutions.com/wp-content/uploads/2018/10/Toronto-Case-Study.pdf
2. TRANSOFT Solutions. Presentations and Case Studies: Midtown Atlanta. 2020. Retrieved from: https://safety.transoftsolutions.com/wp-content/uploads/2018/10/Midtown-Atlanta-Case-Study.pdf
3. TRANSOFT Solutions. Presentations and Case Studies: Oakland County, MI. 2020. Retrieved from: https://safety.transoftsolutions.com/case-study-cross-sectional-roundabout-study-in-oakland-county-mi/
4. TRANSOFT Solutions. Presentations and Case Studies: City of Prince George, BC. 2020. Retrieved from: https://safety.transoftsolutions.com/case-study-prince-george/
5. Songchitruksa P, Tarko AP. The extreme value theory approach to safety estimation. Accident Analysis & Prevention. 2006 Jul 1;38(4):811-22.
6. Klebelsberg D. Derzeitiger sand der verhaltensanalyse des kraftfahrens. Arbeit und leitsung. Ablt. Arbeitswissenscaft soziale betriebspraxis. 1964;18:33-7.
7. Tarko AP. Use of crash surrogates and exceedance statistics to estimate road safety. Accident Analysis & Prevention. 2012 Mar 1;45:230-40.
8. Federal Highway Administration. Proven Safety Countermeasures. 2020. https://safety.fhwa.dot.gov/provencountermeasures/
9. Rice E. Low-Cost Safety Enhancements for stop-controlled and signalized intersections. Federal Highway Administration, U.S. Department of Transportation. 2009. Retrieved from: https://safety.fhwa.dot.gov/intersection/signal/fhwasa09020.pdf
10. Council FM, Zaloshnja E, Miller T, Persaud BN. Crash cost estimates by maximum police-reported injury severity within selected crash geometrics. Turner-Fairbank Highway Research Center; 2005 Oct 1.
11. Harmon T, Bahar GB, Gross FB. Crash costs for highway safety analysis. Federal Highway Administration, U.S. Department of Transportation. 2018. https://rosap.ntl.bts.gov/view/dot/42858
12. City of Bellevue, WA, Transoft Solutions, Together for Safer Roads, PacTrans. Video-based network-wide conflict and speed analysis to support Vision Zero in Bellevue (WA) United States: Executive summary. 2020. Retrieved from: https://bellevuewa.gov/city-government/departments/transportation/safety-and-maintenance/traffic-safety/vision-zero/video-analytics