Attachment One

Network Screening Methodology

Introduction

Intersection safety is identified in the MAG Strategic Transportation Safety Plan as a regional priority. Recent crash statistics for the region show that 60% of traffic related injuries and 40% of fatalities are caused by crashes at intersections. In order to target locations for safety improvements it is necessary to screen the region's road network and identify all problem locations. A methodology that leads to a network screening of intersections based on crash risk is proposed as the screening methodology. Network screening based purely on crash frequency tend to be biased in favor of intersections with high volumes as they have higher numbers of crashes. Network screening by applying weights for different crash severities tend to bias the outcome in favor of location with a high crash high severity. At the 2009 TRB[1] meeting a paper, based on work done in Wisconsin DOT, presented a network screening methodology that incorporates information on the type of crash with the least amount of additional data requirements. This method has been adopted for use in the MAG region, and is referred to as the Network Screening Methodology (NSM). As recommended in the TRB paper the analysis period was kept to three recent years.

Intersection Safety Network Screening Methodology

The first step in the application of NSM for intersections is the identification of the complete list of intersections, number of crashes by crash severity (KABCO scale), number of vehicles involved in each crash, collision manner, number of pedestrian involved and the number of bicyclists involved. Only the crashes that are identified in ALISS as "intersection related" will be analyzed in the NSM. None of ALISS data will be corrected for errors prior to analysis. In other words, all crash data is assumed to be 100% accurate.

The NSM uses a composite ranking considering crash frequency, crash severity and crash type. This method was used by Wisconsin DOT in Network Screening their intersection.

Variables in Composite Ranking:

Crash Frequency (CF) Score:
The total number of crashes during the period of analysis or crash frequency at each intersection is summarized. The Crash Frequency or CF Score for any intersection is the ratio of, the crash frequency at the intersection to the highest intersection crash frequency for the region, for that year.

Severity Index (SI) Score:
Each intersection crash has an assigned crash severity based on the highest resulting injury from the crash. The equivalent sum of all crash severities at an intersection can be generated by the application of the Equivalent Property Damage Only (EPDO) scale listed in Table-1. The intersection EPDO is calculated by multiplying the crash frequency of a particular level of severity by the EPDO associated with that crash severity. The Severity Index Score for an intersection is ratio between SI at an intersection to maximum SI value for the region.

[1]Qin X., Laracuante L., Noyce D.A., Chitturi M. *Systemwide Intersection Safety Prioritization Development and Assessment.* In TRB 2009 Annual Meeting, Washington, D.C.

	Weights
Fatal Crash(K)	1,450
Incapacitating (A)	100
Non-Incapacitating (B)	20
Possible Injury (C)	11
PDO (O)	1
Unknown	1

Table 1. EPDO Equivalent Weights

Crash Type Score (CT) Score:
The ALISS database also provides information on the collision manner for each crash. Campbell and Knapp[2] have explained the procedure for calculated the average crash cost per vehicle/pedestrian/bicyclist for different types of collision manner. Table 2 lists the Crash cost by Injury Severity from FHWA. These crash costs are used in calculating Cost per Vehicle/Pedestrian/Bicyclist by Collision Manner.

Crash Severity	$ Value
Fatal Crash(K)	$5,800,000
Incapacitating (A)	$400,000
Non-Incapacitating (B)	$80,000
Possible Injury (C)	$42,000
PDO (O)	$4,000
Unknown	$4,000

Table 2: Crash Cost by Injury Severity

All the intersection related crashes in the database are queried for number of crashes by Injury Severity and number of units involved in the crashes by collision manner. Table 3 explains in detail the calculation of cost per vehicle/pedestrian/bicyclist by collision manner.

[2]Campbell J.R., Knapp K., *Alternative Crash Severity Ranking Measures and the Implication on Crash Severity Ranking Procedures*. Proceedings of the Mid-Continent Transportation Research Symposium, Ames, Iowa, 2005

Injury Severity	REAR END		ANGLE RIGHT ANGLE		SINGLE		SIDE SWIPE SAME DIRECTION		ANGLE OPPOSITE DIRECTION	
	Crashes	Units	Crashes	Units	Crashes	Units	Crashes	Units	Crashes	Units
O	23,133	48,912	17809	36534	4289	4289	7635	15535	12064	24845
C	6,488	14,405	5941	12632	532	532	702	1465	5035	10708
B	2,088	4,839	4249	9210	750	750	284	640	3971	8557
A	350	854	1183	2684	208	208	70	164	1189	2597
K	29	73	165	381	28	28	8	19	101	219
Unknown	0	0	0	0	0	0	0	0	0	0
	$840,268,000	**69,083**	**$2,090,878,000**	**61,441**	**$345,100,000**	**5,807**	**$157,144,000**	**17,823**	**$1,638,806,000**	**46,926**
Cost Per Vehicle	**$12,163**		**$34,031**		**$59,428**		**$8,817**		**$34,923**	

Injury Severity	REAR TO SIDE		SIDE SWIPE OPPOSITE DIRECTION		HEAD ON		OTHER & UNKNOWN		# of Peds	# of Bicyclists
	Crashes	Units	Crashes	Units	Crashes	Units	Crashes	Units		
O	1731	3466	403	836	195	410	558	1206	108	312
C	75	152	50	108	79	180	100	222	411	700
B	18	36	44	106	90	200	116	271	660	1010
A			14	34	36	80	35	89	318	223
K			1	3	8	19	7	21	62	12
Unknown	0	0	0	0	0	0	0	0	24	63
	$11,514,000	**3,654**	**$18,632,000**	**1,087**	**$72,098,000**	**889**	**$70,312,000**	**1,809**	**$557,390,000**	**270,500,000**
Cost Per Vehicle	**$3,151**		**$17,141**		**$81,100**		**$38,868**		**$352,110**	**$116,595**

Table 3: Crash Cost per Vehicle / Pedestrian /Bicyclist.

Table 4 summarizes the above calculations.

Collision Manner	Cost per Vehicle / Pedestrian / Bicyclist
Rear End	$ 12,163
Angle Right Angle	$ 34,031
Single	$ 59,428
Side Swipe Same Direction	$ 8,817
Angle Opposite Direction	$ 34,923
Rear To Side	$ 3,151
Side Swipe Opposite Direction	$ 17,141
Head On	$ 81,100
Other & Unknown	$ 38,868
Pedestrian Crashes	$352,110
Bicyclist Crashes	$116,595

Table 4. Cost per Vehicle /Pedestrian / Bicyclist by Collision Manner

The Crash Type (CT) value for an intersection is calculated by multiplying cost per vehicle/pedestrian/bicyclist with number of units involved in crash at an intersection by collision manner and calculating the sum of all results.

$$\text{CT Value} = \sum_{i=1}^{n} (N_i * CM_i)$$

N_i - Number of Units Involved in a Crash at an Intersection by Collision Manner
CM_i– Cost per Vehicle/Pedestrian/Bicyclist by Collision Manner

The Crash Type Score for an intersection is ratio between Crash Type value at a particular intersection to maximum of Crash Type value at all intersections in the region.

The composite final score (FS) for an intersection is calculated using the above three scores in the formulae below. Severity Index score is weighted higher in the final scoring process as the motive of the Network Screening process is to eliminate crashes with higher severity at intersections.

$$\text{Final Score (FS)} = \left(\frac{1}{5} * \frac{CF}{Max(CF)} \right) + \left(\frac{3}{5} * \frac{CS}{Max(CS)} \right) + \left(\frac{1}{5} * \frac{CT}{Max(CT)} \right)$$

The addition of crash rate, as a new factor, to the composite score was suggested by the MAG Transportation Safety Committee in October 2009 . This factor will be computed as follows:

CR value for intersection i
= Average annual crash rate at intersection i for the analysis period / Maximum value of all average intersection crash rates for the region
= CR / Max (CR)

The modified Final Safety Score is:

$$\text{Final Score}(FS) = \left(\frac{1}{5} * \frac{CF}{Max(CF)}\right) + \left(\frac{2}{5} * \frac{CS}{Max(CS)}\right) + \left(\frac{1}{5} * \frac{CT}{Max(CT)}\right)$$

$$+ \left(1/5 \times \frac{CR}{Max(CR)}\right)$$