Using a Systemic Approach to Crash Analysis

Developing a crash analysis for rural areas can be a challenging task. Traditionally, a crash site analysis approach is employed for most roadways. In other words, the analysist looks for hot spots (cluster of crashes) to surface and then develops countermeasures based on the crash type. However, in rural areas, hot spots generally do not exist. Due to the low volume of rural roads, the crashes tend to be dispersed with no apparent pattern. Traditional approaches such as developing a crash rate or using procedures from the Highway Safety Manual are not effective in determining an effective safety strategy for low volume county roads. As such, using a systemic approach can be effective.

Crash frequency is also an attractive quantitative screening technique because the only data required are crashes and their physical locations. Other data like traffic volume and roadway features are not necessary for using this technique, making it relatively quick and easy

A high number of severe crashes are spread over a wide area. These crashes are rarely identified through the traditional site analysis approach because it is difficult to isolate high crash locations on low volume roads. The systemic approach provides the local agencies an alternative method to address these crash types and fulfill a previously unmet need.

Systemic starts with a different premise for identify safety problems, leading to a different set of countermeasures. Site analysis is based on crash history at individual locations. The systemic approach looks at crash history on an aggregate basis to identify high-risk roadway characteristics. The site analysis approach results in safety investments at high-crash locations and systemic leads to widespread implementation of projects to reduce the potential for severe crashes.

The systemic approach considers multiple locations with similar risk characteristics. When examining the system as a whole, a particular roadway element may have a high crash experience, and it is more cost-effective to correct the problem on a system-wide basis rather than by individual high crash location. This allows for a wider deployment of low-cost countermeasures.

The systemic approach does have it challenges. Data availability dictates the level of detail in the analysis. While a systemic analysis can be completed with nearly any amount of data, using more data will allow for more refinement of potential risk factors.

- Resource availability determines the extent of improvements that can be made. Resources may also impact the level of analysis that can be completed. However, CDOT is implementing a Safety Circuit Rider Program that will give Colorado Counties access to safety professionals.
- An agency's established priorities may define the direction of the analysis.

- The relationship between the State and local agencies may impact the funding available for systemic improvements on non-state routes as well as the extent systemic improvements are applied to non-state routes.

The major steps (which are thoroughly described in the FHWA Systemic Safety Project Selection Tool document published in 2013) in the systemic process are:

- Identify Focus Crash Types and Risk Factors:
  - Select Focus Crash Types,
  - Select Focus Facilities, and
  - Identify and Evaluate Risk Factors.
- Screen and Prioritize Candidate Locations:
  - Identify Network Elements to Analyze,
  - Conduct Risk Assessment, and
  - Prioritize Focus Facility Elements.
- Select Countermeasures:
  - Assemble Comprehensive List of Countermeasures,
  - Evaluate and Screen Countermeasures, and
  - Select Countermeasures for Deployment.
- Prioritize Projects:
  - Create a Decision Process for Countermeasure Selection,
  - Develop Safety Projects, and
  - Prioritize Project Implementation.

Using descriptive statistics and applying a systemic approach, a 10-year crash analysis (2009-2018) was completed to compare/contrast the first harmful event between an urban and a rural county. Prior to this discussion, one needs to understand a couple of terms.

There are 64 counties in Colorado. Eleven of these counties have populations of 150,000 or greater. The other 53 counties have populations of 66,000 or less. One can make a logical distinction between urban (150,000 or greater) and rural (66,000 or less)

Another item to consider is the crash definition of the first harmful event as per CDOT crash summaries. The first harmful event in a crash is what the vehicle hit or did first. For example, a vehicle may leave the road hit a delineator post and then overturn. The first harmful event in this scenario, is the delineator post. The second harmful event is the overturn. If for example a vehicle overturned without hitting an obstacle, the first harmful event would be an overturn. Given this, one can still get some meaningful data by comparison of the first harmful event. Below are the first harmful event comparing urban to rural crashes based on the above definitions.

Urban	
Rear End	13601
Broadside	6952
Overturning	4910
Parked Motor Vehicle	4574
Unknown	4366
Sideswipe Same Dir	4053
Fence	3860
Approach Turn	3529
Embankment Cut/Fill	2421
Trees/Shrubs	1885

Rural	
Overturning	5228
Embankment Cut/Fill	2606
Fence	2533
Wild Animal	1927
Trees/Shrub	1668
Rear End	925
Sideswipe Opposite	811
Broadside	808
Large Boulder/Rocks	750
Domestic Animal	675

A quick comparison of the top 10 first harmful events, one can surmise that in urban areas, rear ends and broadsides are the most prevalent crash types compared to the rural crashes which are overturning and embankment. One can conclude that the urban crashes are mostly related to intersection type crashes and the rural crashes are leaving the roadway crashes.

Something interesting to note is comparing the eastern slope rural areas to the western slope rural areas. The western slope includes:

- Moffat
- Routt
- Hinsdale
- Grand
- Summit
- La Plata
- Montezuma
- Dolores
- Eagle
- Pitkin
- Rio Blanco
- Garfield
- Mesa
- Delta
- Montrose
- Gunnison
- Ouray
- San Miguel

It also includes a portion of Saguache, Archuleta, Mineral and San Juan Counties.

The following compares the rural western slope to the rural eastern slope:

Rural Western Slope	
Overturning	2593
Embankment Cut/Fill	1425
Fence	1415
Wild Animal	1120
Trees/Shrubs	924
Rear End	556
Sideswipe Opposite	509
Large Boulder/Rocks	453
Broadside	424
Parked Motor Vehicle	352

Rural Eastern Slope	
Overturning	2635
Embankment Cut/Fill	1181
Fence	1118
Wild Animal	807
Trees/Shrubs	744
Domestic Animal	437
Broadside	384
Rear End	369
Utility Pole	317
Sideswipe Opposite	302

Antidotally, one might assume there would be more overturning crashes and embankment crashes for the western slope due to the mountainous areas and curvilinear road alignment when compared to the eastern slope. Contrarily, the first 5 trends for crashes as defined by the first harmful event are same for both the eastern and western slope. In fact, out of the top 10 events, 8 events are common for both the western slope and eastern slope.

In summary, when dealing with descriptive statistics and crash frequencies, the analysist will look for trends that are overrepresented when compared to the norm. The norm being data sets that are compiled from all other counites in Colorado. I believe one can reasonably separate the crash trends based on “urban trendlines” and “rural trendlines” because the trends are so similar for the rural eastern and western slope, rural crashes can be categorized as a signal element.

Using this methodology along with other tools such as crash tables indeed gives the analysist a clearer picture of what crash trends are overrepresented in each county and the selection of appropriate countermeasures.