A Systematic Approach for Segmentation in Highway Safety Management: Issues and Challenges

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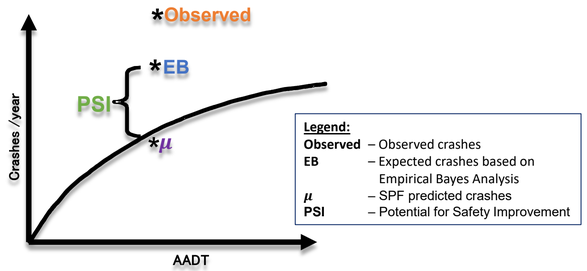
MOTIVATION

Studies have explored the influence of segmentation on safety performance functions (SPFs) development, there are numerous implementation challenges pertaining to segmentation that are not adequately discussed in the traffic safety literature. Segmentation of highway facilities is the backbone of SPF development.



Why segment infrastructure data?

- Identify homogenous highway segments for safety analysis
- Homogeneity is typically defined based on location and geometric characteristics
- Segmentation involves identifying continuous road segments that share the desired geometric characteristics in order to define homogeneous units of analyses.
- At state agencies location information can also be used to separate segments (i.e., route change, county, etc.)

RESEARCH QUESTIONS

The highlights in this study are as follows:

- What will happen if the geometric characteristics change over time for a particular location during the analysis period?
- What is the impact of inconsistent frequency of updates across locations?
- What is the extent of these temporal and spatial data inconsistencies?
- How do these issues impact SPF development as well as SPF implementation?

SEGMENTATION APPROACH ADOPTED

Sample: 15,000 centerline miles (California State Highway System)

Study period: 2013-2017 (5 years)

Infrastructure data: Highway segment and Intersection

Data source: Traffic Accident Surveillance and Analysis System – Transportation Systems Network (TASAS - TSN)

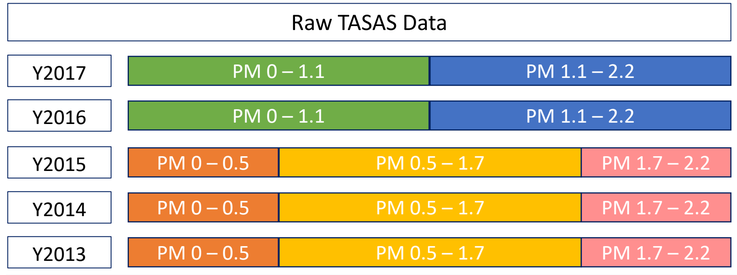
Information used for Segmentation

Location	Geometric
• County	• Number of lanes
• Route	• Lane width
• Route Suffix	• Inside shoulder width
• Postmile Prefix	• Outside shoulder width
• Postmile Suffix	• Median width
• Population group	• Design speed
• *Begin and End PM*	• *Intersection influence area*

Segmentation Process

1. Sort the data by location information
2. If consecutive segments share the same location & geometric characteristics:
   - Combine the two segments with the postmile
   - Take weighted averages of Average Daily Traffic

   Otherwise, start a new segment
3. Trim segment lengths to avoid overlaps with intersection buffer



- In the above scenario, segments can only be processed for years 2016-2017
- 1.5% of post-aggregated segments have less than 3 years of observations

Segmentation Approach

Before segmentation:

District	County	Route	Begin PM	End PM	Right shoulder width	Left shoulder width	Begin date	End date	Year
1	HUM	96	12.107	12.259	6	6	1/1/2014	12/31/2015	2015
1	HUM	96	12.107	12.259	4	4	12/22/2016	12/31/2016	2016
1	HUM	96	12.107	12.259	4	4	1/1/2017	12/31/2020	2017
1	HUM	96	12.259	12.365	4	4	1/1/2014	12/31/2015	2015
1	HUM	96	12.259	12.365	4	4	12/22/2016	12/31/2016	2016
1	HUM	96	12.259	12.365	4	4	1/1/2017	12/31/2020	2017

After segmentation:

District	County	Route	Begin PM	End PM	Right shoulder width	Left shoulder width	Year
1	HUM	96	12.107	12.259	6	6	2015
1	HUM	96	12.259	12.365	4	4	2015
1	HUM	96	12.107	12.365	4	4	2016
1	HUM	96	12.107	12.365	4	4	2017

Different segmentation across years is undesirable

Begin Pm	End PM	Merge 2013	Merge 2014	Merge 2015
12.107	12.259	1 HUM 96 R 1 1 40 12 12 0 0 6 0 6	1 HUM 96 R 1 1 40 12 12 0 0 6 0 6	1 HUM 96 R 1 1 40 12 12 0 0 6 0 6
12.259	12.365	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4

⇨ 2013 -2015 Criteria is not satisfied

Begin Pm	End PM	Merge 2016	Merge 2017
12.107	12.259	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4
12.259	12.365	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4	1 HUM 96 R 1 1 40 12 12 0 0 4 0 4

⇨ 2016 - 2017 Criteria is satisfied

Segment not merged

RESULTS AND DISCUSSION

- Demonstrated segmentation issues at an aggregate level - illustrative case studies of corner cases which are most impacted by inconsistent data updates.
- While the magnitude and impact of these issues may not be as significant for developing statewide SPFs, they may lead to omission of crashes/segments from the hotspot identification process which comprises the overall goal of road safety management.
- Limitations of using linear referencing system (LRS), which limit the extent of aggregation that can be undertaken through segmentation efforts.

CONCLUSIONS

- ✓ Case study contributes towards bridging the gap between research and implementation efforts of using SPFs, which are considered integral to several safety evaluation methods described in the Highway Safety Manual.
- ✓ The insights gained from this study can help agencies maintain more consistent data of traffic and geometric characteristics for road safety management.

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