Dilemma Zone Length & Location

Surrogate Safety Measures of High-Speed Signalized Intersections: Alabama Case Study

Common issue of Dilemma Zone
• Red-Light Running
• Right-Angle Crashes

Min-Wook Kang

Static
Type I dilemma zone
An area prior to the intersection stop bar where drivers neither safely stop nor proceed to the intersection before the end of yellow indication

Dynamic
Type II dilemma zone
An area prior to the intersection stop bar where drivers hesitate (when faced with a yellow indication) to stop or proceed the intersection before the traffic signal turns to a red indication

Min-Wook Kang

Driving distance during the yellow interval
\[ Y = V \times \left(1 - \frac{V^2}{2(a + Gg)}\right) \]

Safely Stop

SSD with speed \( V \)

Driving distance during the yellow interval

Optimal Yellow Interval (ETY)

\[ Y = \frac{V^2}{2(a + Gg)} \]

SSD

Safely Stop

SSD with speed \( V \)

Driving distance during the yellow interval

Optimal Yellow Interval (ETY)

\[ Y = \frac{V^2}{2(a + Gg)} \]

SSD

Safely Stop

Safely Go
Min-Wook Kang

Dilemma Zone

Why?
- Speed varies
- Location varies
- Time-of-day varies
- Preference varies

Varying decision
- Dilemma Zone is Dynamic

Type II Dilemma Zone

Area where drivers hesitate to stop or proceed the intersection before the traffic signal turns to a red indication

How to Quantify

Area where drivers hesitate to stop or proceed the intersection before the traffic signal turns to a red indication

Relevant to human behavior

Area where drivers hesitate to stop or proceed the intersection before the traffic signal turns to a red indication

Realistic to human behavior

W | situe \[
\begin{array}{c}
\text{BEGINNING OF DEcision ZONE} \\
\text{ZONE I: Predilection Stop} \\
\text{ZONE II: Predilection Go} \\
\text{ZONE III: Predilection ZONE} \\
\text{YELLOW SIGNAL Indication} \\
\text{END OF DECISION ZONE}
\end{array}
\]

Drivers make a decision to stop or go

Start location
- End location
- Length

Quantity Dilemma Zone

23 sites: 46 major road approaches

Located
- In high-risk signalized intersections identified through crash analysis;
- On high-speed roads with the posted speed limit of 50mph or higher;
- In rural/suburban areas;
- On freight routes in Alabama;
- On multi-lane highways;
- On divided highways;
- On federal or state highways
**Dilemma Zone Length & Location: Surrogate Safety Measures of High-Speed Signalized Intersections: Alabama Case Study**

**Figure:** Video sensor installation layout and existing references to capture driver behavior data.

**Dilemma Zones & Site-Specific Characteristics**

<table>
<thead>
<tr>
<th>Location</th>
<th>Dilemma Zones &amp; Site-Specific Characteristics (cont'd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cullman</td>
<td></td>
</tr>
<tr>
<td>Huntsville</td>
<td></td>
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<tr>
<td>Gadsden</td>
<td></td>
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<tr>
<td>Tuscaloosa</td>
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<tr>
<td>Selma</td>
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<tr>
<td>Prattville</td>
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<tr>
<td>Tuscaloosa</td>
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<tr>
<td>Opelika</td>
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<td>Phenix City</td>
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<td>Dothan</td>
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<tr>
<td>Montgomery</td>
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<tr>
<td>Mobile</td>
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<td>Ozark</td>
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<td>Ariton</td>
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</table>

**Descriptive Statistics of Dilemma Zones**

<table>
<thead>
<tr>
<th>Statistics</th>
<th>D</th>
<th>E</th>
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<tbody>
<tr>
<td>Mean</td>
<td>266.33</td>
<td>535</td>
<td>268.67</td>
</tr>
<tr>
<td>Mode</td>
<td>133</td>
<td>156</td>
<td>133</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>69.83</td>
<td>88.46</td>
<td>74.43</td>
</tr>
<tr>
<td>Sample size</td>
<td>368</td>
<td>7831.66</td>
<td>3944.37</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.11</td>
<td>16.15</td>
<td>3.98</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.96</td>
<td>0.10</td>
<td>-0.40</td>
</tr>
<tr>
<td>Minimum</td>
<td>180</td>
<td>280</td>
<td>150</td>
</tr>
<tr>
<td>Maximum</td>
<td>390</td>
<td>750</td>
<td>360</td>
</tr>
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**Dilemma Zone Quantification**

- 90% Go
- 90% Stop

**Diagram:**

- Distance from the stop bar (feet) at the onset of the yellow indication
- Drivers who proceed to the intersection
- Drivers who stop at the intersection

**Vehicles' Speed-Space Diagram**

- Approaching speed (mph)

**Figure:**

- Video sensor installation layout
- Existing references to capture driver behavior data

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1. Dilemma zone start & end locations very significantly despite the similarity of their facility type, speed limit, and land use.

2. The chance of RLR violations increases if the dilemma zone starts further from the intersection stop bar and its length is longer.

3. The chance of vehicles’ abrupt stops during the yellow interval increases if the dilemma zone starts further from the intersection stop bar and its length is longer.

4. The chance of RLR violations and the number of abrupt stops increases with the longer length of the yellow time difference ($Y_{diff}$).

5. Thus, dilemma zone size and location can be used for surrogate safety measures of a signalized intersection.

6. Use this information to prioritize (rank) intersections that need safety improvements.

$Y_{diff}$ is the deviation of an existing yellow time from a recommended yellow time calculated based on the ITE.
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