Title of the proposed project
Development of a Toolbox for Evaluation and Identification of Urban Road Safety Improvement Measures

Investigators
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Ms. Anjana S, Research Scholar
Safe or unsafe?
Aim and Objectives

- **Aim**
  Develop tools and techniques for analysing, evaluating and identifying road safety improvement measures in urban areas.

- **Objectives**
  - Design and develop a database of accidents, geometry and traffic for both midblocks and intersections.
  - Investigate the effect of various factors on road safety through a careful analysis and interpretation of data.
  - Develop accident prediction models to predict the accident occurrences at roadway sections and intersections.
  - Generate safety factors from the accident prediction models to act as tools for safety evaluation.
  - Consolidate the results of safety evaluation as a toolbox.
Proposed Methodology

Urban Road Safety Management

Analysis
- Study area selection
- Data collection
- Database development
- Preliminary analysis
- Development of accident prediction models

Evaluation
- Development of accident modification factors
- Identify locations with potential for road safety improvement
- Recommend safety treatment measures
- Evaluation of safety treatment measures
- Development of toolbox
Urban Road Safety Analysis

Study area selection

Data collection

- Mid-blocks
  - Accident data
  - Road inventory
  - Traffic volume
  - Speed

- Intersections
  - Accident data
  - Layout inventory
  - Traffic volume
  - Type of control

Database development

- Digital
  - Microsoft Access

- Spatial
  - ArcGIS

Development of accident prediction models

- Mid-blocks
  - Uncontrolled

- Intersections
  - Roundabout
  - Signalised

6-Aug-12
Accident Modification Factor (AMF)

- Accident Modification Factors
  - Estimates the change in safety following
    - the implementation of a countermeasure,
    - a significant change in geometric design and traffic characteristics of a roadway
    - up gradation of a highway section or intersection.
  - AMF = $N_w / N_{w0}$ where,
    - AMF = accident modification factor associated with a specific improvement;
    - $N_w = \text{expected number of crashes with the improvement, crashes/yr}$; and
    - $N_{w0} = \text{expected number of crashes without the improvement, crashes/yr}$. 
Study area selection

Major urban centres in Kerala
  • Trivandrum
  • Ernakulam
  • Thrissur
  • Kozhikode
Core activities

Data collection and database development
- Accident data
- Road inventory data
- Intersection layout
- Signal controller settings
- Traffic data
- Traffic control measures

Data analysis and modeling
- Preliminary data analysis
- Dependant and independent variable determination
- Identification of suitable model form
- Accident prediction modeling

Development of AMF for geometric variables
- Selection of best model
- Midblocks
  - Single carriageway
  - Dual carriageway
- Intersections
  - Uncontrolled
  - Signal controlled
  - Roundabout
- Development of AMF
Works completed

- Literature review and preparation of synthesis report
- Preparation of data sheets for
  - Road inventory data
    - Single and dual carriageway
    - Uncontrolled intersections
    - Roundabouts
    - Signalised intersections
  - Classified volume count
  - Spot speed measurement
- Preparations of templates for data analysis
## Data collection

<table>
<thead>
<tr>
<th>Type of facility</th>
<th>Number of sites</th>
<th>Data collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midblocks</td>
<td>135</td>
<td>Accident data, Road inventory, speed, classified volume count</td>
</tr>
<tr>
<td>Uncontrolled intersections</td>
<td>60</td>
<td>Approach wise accident data, Intersection layout, approach speed, classified directional volume count</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>20</td>
<td>Approach wise accident data, approach and circulating speed, classified directional volume count, intersection layout</td>
</tr>
<tr>
<td>Signalised intersections</td>
<td>24</td>
<td>Signal controller settings, approach wise accident data, classified directional volume count</td>
</tr>
</tbody>
</table>
Data analysis and modeling

- Preliminary data analysis
  - Scatter plots
  - Correlation matrices
- Identified explanatory variables
- Identified accident prediction model forms
  - Multiple linear regression
  - Generalised regression
  - Poisson regression
  - Negative binomial regression
  - Zero inflated poisson regression
- Development of prediction models for
  - Single carriageway
  - Dual carriageway
  - Roundabouts
  - Signalised intersections
Accident prediction models - midblocks

- Negative binomial regression model for total accidents - single carriageway roads
  \[ TA = \exp(1.261 + 0.048 \times \text{Carriageway Width} - 0.005 \times \text{Shoulder Width} - 0.078 \times \text{Number of Sign Boards} + 0.084 \times \text{Minor Intersections} + 0.0379 \times \text{Exposure}) \]

- Linear regression model for accident rate - dual carriageway
  \[ AR = 0.676 - 0.052 \times \text{Carriageway Width} + 0.004 \times \text{Shoulder Width} - 0.082 \times \text{Median Width} - 2.123 \times \text{Median Height} + 0.036 \times \text{Number of bus stops} + 0.066 \times \text{Minor intersections/km} - 0.011 \times \text{Number of Signs/km} + 0.343 \times \text{Carriageway condition Rating} + 0.213 \times \text{Shoulder Condition rating} - 0.461 \times \text{Pedestrian Facilities} \]
# Model summary

## Negative binomial regression model - Single carriageway

<table>
<thead>
<tr>
<th>Over dispersion</th>
<th>Chi-square</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.864</td>
<td>76.94</td>
<td>0.000</td>
</tr>
</tbody>
</table>

## Linear regression model - Dual carriageway

<table>
<thead>
<tr>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>F value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.752</td>
<td>0.749</td>
<td>0.602</td>
<td>5.079</td>
</tr>
</tbody>
</table>
Accident prediction models - intersections

- Generalised linear regression model for roundabouts
  - Accidents per year = \( \exp(-4.491) \times (\text{Entering ADT})^{0.416} \times \exp(0.014 \times \text{Central Island Diameter} - 0.112 \times \text{Circulatory Roadway Width} + 0.084 \times \text{Weaving Width} + 0.027 \times \text{Weaving Length} + 0.002 \times \text{Entry Path Radius} - 0.007 \times \text{Angle to the Next Leg} + 0.197 \times \text{Splitter Island Type} - 0.01 \times \text{Splitter Island Length}) \)

- Linear regression model for signalised intersections
  - Accidents per year = \(-11.796 + 4.166 - 0.803 \times \text{Proportion of right turning traffic} + 0.055 \times \text{Total approach width} - 0.640 \times \text{Exclusive left turn lane} + 0.069 \times \text{V/C} - 0.447 \times \text{g/C} + 0.015 \times \text{Control Delay} + 1.118 \times \text{Approach grade}\)
# Model summary

## Generalised linear regression model - Roundabouts

<table>
<thead>
<tr>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>F value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.486</td>
<td>0.367</td>
<td>4.092</td>
</tr>
</tbody>
</table>

## Linear regression model – Signalised intersections

<table>
<thead>
<tr>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std error</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.554</td>
<td>0.464</td>
<td>1.268</td>
<td>6.204</td>
</tr>
</tbody>
</table>
AMF for carriageway width
AMF for median width
AMF for central island diameter of roundabouts
AMF for g/c ratio of signalised intersections
Practical application - midblocks

Safety evaluation of design alternatives

<table>
<thead>
<tr>
<th>Variables</th>
<th>Existing condition</th>
<th>Existing AMF</th>
<th>Proposed change</th>
<th>Proposed AMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of signs</td>
<td>1</td>
<td>0.925</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor Intersections</td>
<td>5</td>
<td>1.5239</td>
<td>4</td>
<td>1.257</td>
</tr>
<tr>
<td>Carriageway width</td>
<td>15</td>
<td>1.4643</td>
<td>14</td>
<td>1.396</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>3.16</td>
<td>0.9967</td>
<td>4</td>
<td>0.990</td>
</tr>
<tr>
<td>Base accidents</td>
<td>2 accidents</td>
<td></td>
<td></td>
<td>Percentage change in accidents</td>
</tr>
<tr>
<td>Existing accidents</td>
<td>4.24 accidents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidents after implementing safety treatment</td>
<td>3.1 accidents</td>
<td></td>
<td></td>
<td>(-)28.02%</td>
</tr>
</tbody>
</table>
## Practical application - roundabouts

<table>
<thead>
<tr>
<th>Variables</th>
<th>Existing Condition</th>
<th>AMF&lt;sub&gt;before&lt;/sub&gt;</th>
<th>Proposed change</th>
<th>AMF&lt;sub&gt;after&lt;/sub&gt;</th>
<th>% change in Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central island diameter</td>
<td>12.4 meters</td>
<td>1.063</td>
<td>10 meters</td>
<td>1.028</td>
<td>-3.29</td>
</tr>
<tr>
<td>Weaving width</td>
<td>23.88 meters</td>
<td>1.11</td>
<td>14 meters</td>
<td>1.05</td>
<td>-74.68</td>
</tr>
<tr>
<td>Weaving length</td>
<td>12.25 meters</td>
<td>1.43</td>
<td>30 meters</td>
<td>1</td>
<td>42.85</td>
</tr>
<tr>
<td>Entry path radius</td>
<td>301 meters</td>
<td>2.35</td>
<td>30 meters</td>
<td>1.04</td>
<td>-41.81</td>
</tr>
<tr>
<td>Angle to next leg</td>
<td>55°</td>
<td>1.18</td>
<td>90°</td>
<td>1</td>
<td>-21.25</td>
</tr>
</tbody>
</table>
Conclusions

- Robust models developed to evaluate safety performance of facilities
- Safety factors (AMF) are generated from safety prediction models
- Effective tool for evaluation of alternate safety treatment measures
- AMF’s used for safety evaluation of design alternatives
Acknowledgements

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THANK YOU