Modelling Speeds of Arterial Weaving Sections in Metro Manila

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Outline

- Problem Motivation
- Review of Existing Methods
- Survey Methodology
- Results and Discussions
- Conclusions
- Recommendations
Signalized Intersections (before)
After Closure DLT from Arterial

- Left-turn from signalized intersection
- Left-turn diversion to U-turn plus right-turn (UTRT)
Through from Side Street

- Through movement at signalized intersection
- Through diversion to right-turn plus U-turn plus right-turn (RTUTRT)
Left-Turn from Side Street

- Left-turn movement at signalized intersection
- Left-turn diversion to right-turn plus U-turn (RTUT)
Weaving Areas Formed
Definition of a Weaving Area

- crossing of two or more traffic streams traveling in the same general direction without the aid of traffic control devices (HCM 2000)
Weaving Section in an Arterial

(b) Two-Sided Weave

➔ Freeway 2-sided weaving section...

Arterial weaving section...

➢ The HCM Type C (2-sided) weaving configuration best describes arterial weaving...
Capacity at Weaving Section

\[ q = ku_s \]

- Flow Rate, \( q \)
- Density, \( k \)
- Speed, \( u \)

- Densities and speeds are difficult to determine w/o proper equipment.
Messer & Bonneson’s Ramp Weave Model (NCHRP Web Doc 12)

Ramp weave on arterial cross streets in interchange areas
Ramp Weave Model’s Weaving Path

- Path B – C
Ramp Weave Model’s Non-weaving Paths

- Path A – C
- Path A – D
- Path B – D
Ramp Weave Models

Weaving Speed: \[ U_w = b_0 U_a b_1 e^{(-b_2 (1-P_U) V_w / 3600)} \]

- \( U_w \) - average speed of weaving vehicles, m/s
- \( U_a \) - average speed of entering vehicles, m/s
- \( P_u \) - probability of a weaving vehicle being unblocked
- \( V_w \) - weaving flow rate, vph
- \( b_0, b_1, b_2 \) - regression coefficients
Ramp Weave Models

Non-weaving Speed:

\[ U_{nw} = b_3 U_a^{b_5} e^{-b_5 V_a / 3600} \]

- \( U_{nw} \) - average speed of non-weaving vehicles, m/s
- \( U_a \) - average speed of entering vehicles, m/s
- \( V_a \) - arterial flow rate, vph
- \( b_3, b_4, b_5 \) - regression coefficients

➢ The weaving and non-weaving speed models need to be calibrated to get coefficients.
Survey Methodology

- Data collected using video recording stationed high vantage point;
- Recorded videos converted into digital format;
- Data were extracted by repeated viewing of the recording on a computer.
Site Selection

- Must have three or more lanes in each direction
- Traffic volume on the driveway should be relatively high
- Weaving length should be less than 305 m
- Presence of signalized intersections within the vicinity should be minimal
Site 1 (Banaue – Quezon Ave)
Site 2 (Scout Borromeo-Quezon Ave.)
Model Summary

Regression coefficients

<table>
<thead>
<tr>
<th></th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaving Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_0$</td>
<td>3.1140</td>
<td>1.8363</td>
</tr>
<tr>
<td>$b_1$</td>
<td>0.4675</td>
<td>0.5418</td>
</tr>
<tr>
<td>$b_2$</td>
<td>4.7944</td>
<td>0.6163</td>
</tr>
<tr>
<td>non-weaving Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b_3$</td>
<td>3.0603</td>
<td>4.2738</td>
</tr>
<tr>
<td>$b_4$</td>
<td>0.5261</td>
<td>0.4253</td>
</tr>
<tr>
<td>$b_5$</td>
<td>0.3339</td>
<td>0.5568</td>
</tr>
</tbody>
</table>

Weaving Speed: $U_w = b_o U_a^{b_1} e^{(-b_2(1-P_U)V_w / 3600)}$

Non-weaving Speed: $U_{nw} = b_3 U_a^{b_4} e^{(-b_5 V_a / 3600)}$
# Site 1 and 2 Calibration Results

## Site 1 manoeuvre speed model statistics

<table>
<thead>
<tr>
<th>Maneuver Speed Model</th>
<th>Observations</th>
<th>Root Mean Square Error</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaving</td>
<td>35</td>
<td>0.490 m/s</td>
<td>0.44997</td>
</tr>
<tr>
<td>non-weaving</td>
<td>35</td>
<td>0.447 m/s</td>
<td>0.54191</td>
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</tbody>
</table>

## Site 2 manoeuvre speed model statistics

<table>
<thead>
<tr>
<th>Maneuver Speed Model</th>
<th>Observations</th>
<th>Root Mean Square Error</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaving</td>
<td>18</td>
<td>0.444 m/s</td>
<td>0.44019</td>
</tr>
<tr>
<td>non-weaving</td>
<td>18</td>
<td>0.425 m/s</td>
<td>0.66295</td>
</tr>
</tbody>
</table>
Site 1 Model Testing

Parity Plot Site 1 Weaving (Testing)

\[ y = 0.4516x + 3.2301 \]
\[ R^2 = 0.4501 \]

Parity Plot Site 1 Nonweaving (Testing)

\[ y = 0.5335x + 3.5985 \]
\[ R^2 = 0.542 \]
Site 1 Validation

Parity Plots (Validation Data)

\[ y = 0.4006x + 3.4678 \]
\[ R^2 = 0.4399 \]

Parity Plot Site 1 Nonweaving (Validation)

\[ y = 0.4948x + 3.9681 \]
\[ R^2 = 0.471 \]
# Site 1 Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>Process</th>
<th>Maneuver Type</th>
<th>Comparison</th>
<th>Correlation</th>
<th>t-test</th>
<th>Goodness-of-fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Testing</td>
<td>Weaving</td>
<td>Obs - Pred</td>
<td>OK</td>
<td>OK</td>
<td>LARGE</td>
</tr>
<tr>
<td>Site 1</td>
<td>Non-weaving</td>
<td>Weaving</td>
<td>Obs - Pred</td>
<td>OK</td>
<td>OK</td>
<td>VERY LARGE</td>
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<td>Weaving</td>
<td>Obs - Pred</td>
<td>OK</td>
<td>OK</td>
<td>LARGE</td>
</tr>
</tbody>
</table>
Site 2 Model Testing

Parity Plot Site 2 Weaving (Testing)

\[ y = 0.4303x + 3.4524 \]

\[ R^2 = 0.4405 \]

Observed, m/s vs Predicted, m/s

Parity Plot Site 2 Nonweaving (Testing)

\[ y = 0.6613x + 2.7438 \]

\[ R^2 = 0.6629 \]

Observed, m/s vs Predicted, m/s
Site 2 Validation

Parity Plot Site 2 Weaving (Validation)

\[ y = 0.3938x + 3.6832 \]
\[ R^2 = 0.6199 \]

Parity Plot Site 2 Nonweaving (Validation)

\[ y = 0.3834x + 4.9606 \]
\[ R^2 = 0.3956 \]
## Site 2 Summary

<table>
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<th>Goodness-of-fit</th>
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<tbody>
<tr>
<td>Site 2</td>
<td>Testing</td>
<td>Weaving</td>
<td>Obs - Pred</td>
<td>OK</td>
<td>OK</td>
<td>LARGE</td>
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Conclusions

Ramp Weave Models

- Arterial and weaving flow rates affect weaving and non-weaving speeds.
- Weaving and non-weaving speeds decrease as the arterial flow rate increases.
- Weaving and non-weaving speeds decrease with increased weaving flow rates.
- Weaving speeds are lower than non-weaving speeds.
Conclusions

- Approach speeds are higher than non-weaving speeds.
- Weaving length significantly affects the weaving speed.
- Shorter weaving length yields lower weaving speeds.
- The models developed can accurately predict weaving and non-weaving speeds.
Recommendations

• More extensive data collection from other sites.
• Incorporate weaving length in the models.
• Use computer simulation to evaluate the speeds.
• Identify and develop a LOS criteria.
That ends the presentation... Thank you for listening...

- Questions
- Comments
- Discussion

Click to see first ever elevated U-turn slot in the Philippines/World?