DISPERSION OF TRAFFIC QUEUES

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Stellenbosch University
Hillier and Rothery, 1967
Contents

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• Literature Study
  ➢ Background
  ➢ Shifted negative exponential distribution

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Overview

• Traffic queues disperse as they progress from the intersection
• Natural forming headways:
  • Time
  • Distance
• Dispersion distance is crucial for signal timing and cycle lengths
• Time headway distribution models provide accurate representation of queue behaviour and road capacity
Literature study – background

- Time headway is measured from the leading vehicle’s nose to the following vehicle’s, passing a specific point P.

- Time headway distribution models:
  - Single headway
  - Mixed headway
Literature study – background

- Single headway distribution models:
  - Exponential
  - Normal
  - Gamma
  - Lognormal
- Mixed headway distribution models:
  - Semi-Poisson
  - Combined single statistical distributions
  - Followers and non-followers
  - Travelling queue distribution
- Shifted single headway models improves accuracy
Van As & Joubert, 1990
Literature study – Queue dispersion

• Queue Dispersion Behaviour – Queues become less dense further from intersection
• Formulate separation point at 3.5 seconds
• Negative exponential model interpolated from vehicle follower behaviour graph
• Shifted negative exponential model acquired by shifting with the minimum time headway
Methodology

- GoPro Hero2 HD video cameras positioned at distances 500, 1000 and 1500m from intersection
- Recording times 07:30-08:30, 11:00-12:00 and 16:30-17:30
- Stopwatch application
- Time headways categorised into second intervals
- Plot vehicle follower behaviour graph
- Negative exponential distribution interpolated
- Shifted negative exponential distribution
R310

SARF/IRF 2014 | 2-4 September, South Africa
Data Analysis

- **R310**
  - Multi-lane
  - Many passing opportunities
  - Chaotic right lane (Daganzo,)

- **R44**
  - Two-lane
  - Few passing opportunities

- **R44 has more accurate queue dispersion behaviour**
## Data Analysis

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<th>HEADWAYS EQUAL OR GREATER</th>
<th>% HEADWAYS EQUAL OR GREATER</th>
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Data Analysis
07:30 – 08:30

% Headways equal or greater

Headways (seconds)

500m
Data Analysis

07:30 – 08:30

% Headways equal or greater

0 2 4 6 8 10

Headways (seconds)

1 000m
Data Analysis

07:30 – 08:30

% Headways equal or greater

Headways (seconds)

1 500m
Results
07:30 – 08:30

\[ s = 58.284e^{0.5493h} \]

- Dispersion points
- Dispersion point at 3.5 sec

Distance (m)

Headways (seconds)

(3.5, 399)
(4, 500)
(5, 1000)
(6, 1500)
Results

11:00 – 12:00

\[ s = 31.25e^{0.6931h} \]

- Dispersion point
- Dispersion point at 3.5sec

\[(3.5, 354)\]
\[(4, 500)\]
\[(5, 1000)\]
Results

16:30 – 17:30

$s = 100.95e^{0.5493h}$

- Dispersion points
- Dispersion point at 3.5sec

(3, 500) (3.5, 690)

(4, 1000)

(5, 1500)
Shifted Negative Exponential Distribution

\[ z = 100(1 - e^{-0.252t}) \]

\[ z = 100(1 - e^{-0.252(t-0.407)}) \]
R310 Results:

• Dispersion distance = 595m
R310 Results:

- Time headway distribution models:
  \[ z = 100(1 - e^{-0.255t}) \]
  \[ z = 100(1 - e^{-0.255(t-0.653)}) \]
Conclusions

• Dispersion distance is affected by:
  • Traffic flow & composition
  • Higher speed limits
  • Multilane roads

• The Shifted Negative Exponential Distribution gives a good fit of the data
Recommendations

• Larger data set

• Recording distance not more than 900m

• Shorter distance intervals between recordings
THANK YOU